CONCEPTUALISING, EVALUATING AND ENHANCING A DESIGN THINKING CURRICULUM USING A CRITICAL REALIST PERSPECTIVE

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ABSTRACT

This research involved the design, evaluation and enhancement of a design thinking curriculum for first-year, undergraduate product design and business students, using critical realist ontological perspectives, and an approach that integrated a critical realist theorising methodology within case studies that formed units of analysis in action research cycles. Design thinking was conceptualised as a set of practices that enables people to explore, reframe and propose solutions to complex and ill-defined problems across a range of contexts. Successful exercise of the practices and specific skills (mechanisms) associated with design thinking requires students to have relevant conceptual, procedural and conditional knowledge, specific mindsets and sensorimotor capabilities (attributes). A curriculum was defined as a set of views about the features of a learning environment that would enhance the probability of students' successful learning.

The project was founded on the researcher's interest in design thinking and the use of rigorous research for curriculum design, evaluation and enhancement purposes. It also took account of a review of literature, which indicated gaps and limitations in design thinking education, including application of critical realist ontological perspectives and the use of integrated critical realist, case study and action research methodologies to assist the iterative development of design thinking curricula. A critical realist paradigm position was utilised because it aligned with the researcher's ontological and epistemological beliefs, and interest in identifying the mechanisms of entities in a learning environment that may influence students' development of design thinking expertise.

An initial 'ideal' design thinking curriculum was designed and enacted within a course for two product design students and a course for business students. For each of these case studies, tendencies in students' response to the learning environment were identified drawing a mix of qualitative and quantitative data that were gathered using student interviews and questionnaire surveys, reviews of student project portfolios, and ongoing researcher observations and reflections. Explanatory theory concerning the relationship between students' learning responses and the learning environment (influenced by the curriculum) was then developed using a critical realist theorising methodology that included abductive and retroductive reasoning processes. The theory focused on entities in the learning environment (e.g., students, teachers, learning resources and tools) that have mechanisms which are possible causal explanations for learning responses, as well as the attributes of entities (e.g., agency, cognitive maturity, font size and colour) and other conditions (e.g. timing) that might account for the exercise and outcomes of these mechanisms. This theory, which took account

of potential context (case) differences, informed decisions about subsequent changes to components of the curriculum. The modified curriculum was enacted in another action cycle with further groups of product design and business students to evaluate the explanatory power of the theory and the practical adequacy of its use for curriculum enhancement. Three of these action cycles were completed.

The findings indicate strong positive tendencies in all students' responses to the curriculum across the three cycles. The research identifies influential causal mechanisms, attributes and other conditions, and highlights ways of adjusting the curriculum to acknowledge differences in students' design knowledge and learning histories. Critical realism-based conceptualisations of learning, learning environments, curriculum and design thinking are presented, along with proposals for a 'signature' learning environment for design thinking, a comprehensive design thinking expertise framework and an end-of-project 'ideal' curriculum. A critical discussion is provided of issues and opportunities associated with the use of a critical realist perspectives and and approaches in higher education curriculum research.

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ATTESTATION OF AUTHORSHIP

"I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning."

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ETHICS APPROVAL

AUT ethics approval number 12/140.

PART ONE: BACKGROUND AND RESEARCH DESIGN

CHAPTER ONE: INTRODUCTION

This thesis reports on a research project in which critical realist ontological perspectives, and case studies that were embedded within action research cycles, were utilised to design, evaluate and improve a curriculum aimed at developing the design thinking expertise of university-level undergraduate product design and business students. Explanatory theory concerning the case studies, which was developed using a critical realist theorising methodology, informed the on-going development of the curriculum. In this chapter, I provide the background, context and justifications for the research, present the research aims and associated questions, summarise the research design and outline the structure of the thesis.

1.1 Background and context of the research

I have been a design educator for over 18 years, and during this period I have developed and taught a number of university-level programmes in product design, and in business. I have been interested in the design and development of curricula, and in finding systematic and rigorous ways of developing, evaluating and improving learning environments.

I have also been interested in new design tools, processes, and emergent trends in both design, especially the growing impact of design on business, and in social innovation. In this context, I have developed a specific interest in design thinking which is a capability that I believe could support and drive effective and successful innovation across a range of disciplines and professional areas. In response to this interest and belief, I have attempted to integrate design thinking principles and practices into curricula for a number of courses and other learning projects.

As an outcome of these initiatives, I became aware that while many students understand and embrace aspects of design thinking, utilise associated practices effectively, and develop good capabilities, there are many students who struggle to comprehend key concepts or apply them competently. As an initial response to my concern about this situation, I reviewed literature on design thinking education. While the review provided some helpful insights, it also revealed that there were few research-based evaluations of frameworks and resources that might be used to support the teaching and learning of design thinking. Further, there were limitations in these evaluations that needed to be addressed.

This prompted me to undertake several interrelated initiatives that were intended to deepen my knowledge and experience, help develop resources, and provide a research basis for further development and evaluation of curriculum. With colleagues, I developed, implemented and informally evaluated a design methods toolbox of 50 design methods (Withell, Diegel, & Reay, 2010). Design thinking workshops, based on the Stanford University d.school design thinking model (d.school, 2010), were then developed with a colleague to provide postgraduate students, local business leaders and university staff with an introduction to, and capability development in, design thinking through experiential workshops (Withell & Reay, 2011). In addition, I visited the d.school at Stanford University to observe a design thinking workshop as it was being delivered to 120 corporate executives. The findings of this visit are presented in Appendix I.

Informed by the insights from the evaluation of the design thinking workshops, and the visit to Stanford University, I then developed an initial prototype of a design thinking project to explore the application of key design thinking concepts within an existing undergraduate third-year Product Design studio project. This also offered me the opportunity to more rigorously reflect on the learning and teaching processes that might assist the development of design thinking capabilities, and on the overall response of undergraduate students to such an initiative.

Based on my evolving experience and knowledge development, a growing belief in the value of design thinking to augment design and other specialist disciplines, and a wish to provide students with generic twenty-first century skills and competencies, I advocated for the development of a specialist design thinking curriculum for first-year business students, and a specialist design thinking project for product design students. The university approved the curriculum development proposal. Informed by the experiential activities, and my growing commitment to research-informed teaching, I identified that there was also a unique and significant opportunity to formally research and evaluate the curriculum development and enactment in partnership with students and staff, and to utilise the findings to further optimise the curriculum.

1.1.1 Conceptualising design thinking

Given the opportunity to develop the curriculum, and to formally research and evaluate it, I revisited research literature. The review focused, in particular, on current conceptualisations of design thinking including epistemological perspectives, and associated theories, as well as design thinking education, and education research approaches that might be appropriate and useful for framing and undertaking the research.

The concept of design thinking emerged from study into the various aspects and dimensions of design in the late 1960s. Sometimes called the 'Design Methods' movement (Buchanan, 1992), the research was grounded in a rational, or objective, scientific tradition (Cross, 2001a), and was undertaken to provide insights into the processes and methods which designers utilised when responding to design problems that were becoming increasingly complex (Beckman & Barry, 2007; Kimbell, 2009).

Reflecting subsequent epistemological shifts in the design community, from positivist to constructivist and pragmatic conceptions, design and design thinking increasingly emphasised the cognitive-related processes and dispositions of designers. Schön's (1983) work on what he termed *reflection-on-action* was considered to be a key to understanding how design practitioners engaged with problems based on personal judgment. In the 1990s these processes were associated with problem framing and problem solving (Buchanan, 1992). By the 2000s, a more integrated manifestation of design thinking emerged that was linked with an innovation agenda, and the adoption of design thinking within a range of 'non-design' disciplinary and professional contexts (Johansson & Welch, 2009). This connection with innovation was marked by a focus on design thinking models and approaches that could be applied in commercial contexts. Companies such as IDEO developed and promoted such models very successfully (Lindberg, Noweski, & Meinel, 2010).

Design thinking has been given considerable attention recently in the mainstream business media (Johansson-Skoldberg, Woodilla, & Cetinkaya, 2013), and scholars and educators have demonstrated increasing interest as well. However, this does not imply that there is clarity and consistency in conceptions of design thinking and the concept has been subject to rigorous and, at times, quite negative critique. For example, design thinking has been described as overhyped (McCullagh, 2010; Norman, 2010) confusing (Carr, Halliday, King, Liedtka, & Lockwood, 2010), lacking strong support from empirical evidence (Badke-Schaub, Roozenburge, & Cardoso, 2008) not well understood and often disputed (Kimbell, 2011; Stewart, 2011). Notwithstanding this critique, the literature does confirm that there are both varied and overlapping ways of conceptualising design thinking.

For example, Cross (2011b) argued that design, and therefore design thinking, was a distinct discipline and culture that is underpinned by what he calls a *designerly way of knowing.* Lawson (2006) suggested designers have mindsets that are solution-focused, and utilise distinct behaviours and problem-solving strategies. Many researchers appear to have used prevailing *constructivist* (or *constructionist*) orientations to conceptualise design thinking, although others have examined *pragmatism* (Melles, 2008; Romme, 2003) and, given its inter-subjective and trans-disciplinary nature, *critical realism* (Di Russo & Feast, 2013; Hodgkinson & Starke, 2012).

Associated with these conceptions of design thinking were several theories and models. Theories identify the properties of the phenomenon of design thinking, and the interrelationships between those properties. Five general properties have been identified and elaborated: mindsets, reasoning, cognition, collaboration, and practices.

Researchers have described a wide range of mindsets and attitudes associated with design thinking including *optimis*m (T. Brown, 2008), *empathy* (Eagen, Aspevig, Cukier, Bauer, & Ngwenyama, 2011), being *radical* (T. Brown, 2008), and being *motivated, playful* and *curious* (Owen, 2007). A number of reasoning and cognitive processes used in the framing and solving of complex and ill-defined problems have been identified. These include *inductive*, *deductive* and *abductive* reasoning (Cross, 2004; Dunne & Martin, 2006; Rylander, 2009). Researchers have also differentiated *constructive* cognition (Cross, 2011b), *convergent/divergent* cognition (T. Brown, 2009; Dym, Agogino, Eris, Frey, & Leifer, 2006; Lindberg, Gumienny, Jobst, & Meinel, 2008), *intuitive* cognition (Eagen et al., 2011; Pombo & Tschimmel, 2005), *reflective* (Cross, 2011a; Donald Schön, 1988) and *metacognitive* cognition. Effective collaboration has also been considered essential to effective design thinking (Lindberg et al., 2010; Owen, 2007) and variations in levels of expertise in the use of design thinking capabilities have been conceptualised (Cross, 2011b; Dorst, 2008).

A similarly diverse range of design thinking practices have been identified (Di Russo, 2013; Kimbell, 2009). These include *ethnographic research* (T. Brown, 2009; Cross, 2004), *visual mapping* (Serrat, 2010), and *prototyping* (Lockwood, 2010b). These properties and their relationships have been represented in several models of design thinking processes. They include linear models (Liedtka & Ogilvie, 2011), cyclic models (Kumar, 2003), and more flexible and adaptable models (Lindberg et al., 2008).

The contexts and disciplines within which design thinking has been applied are now wide-ranging. They include product development and user experience design (Lockwood, 2010b), business, enterprise and management (Leavy, 2012; Liedtka & Ogilvie, 2011; Lockwood, 2010a; Ward, Runcie, & Morris, 2009), service industries (Gloppen, 2009; Stickdorn & Schneider, 2011), social innovation (T. Brown & Wyatt, 2010), biotechnology (Friedman, 2003), libraries (Bell, 2008; Howard & Davis, 2011), and legal practice (Szabo, 2010).

1.1.2 Research into design thinking education

The review confirmed that a strong case existed for undertaking a rigorous, longitudinal project that involved the research-based development and evaluation of a design thinking curriculum that could be implemented in university undergraduate programmes. The case takes into account other educators' advocacy for such programmes, the emergence of a community of educators interested in the design of these programmes, the increasing number of programmes now being implemented, and a critique of the status of research on these programmes.

With respect to advocacy, Noweski et al. (2012) contended that design thinking is an effective way of engaging students with twenty-first century skills and competencies. In keeping with this stance, several researchers have specifically advocated for the teaching of design thinking to students who are undertaking programmes beyond those explicitly associated with 'design'. For example (Dunne & Martin, 2006) engineering education, (Dym et al., 2006) engineering education, and (Owen, 2007) preparing students for careers in government and policy making organisations.

A much smaller, but emerging, body of research that specifically examined and discussed the development of design thinking courses and curricula in higher education contexts was identified. For example, Rauth, Koppen, Jobst , and Meinel (2010) examined the underlying methods and mechanisms of design thinking courses taught at the d.school at Stanford University, California and at Potsdam in Germany, and Melles and colleagues (2008; 2011) described the development of a design thinking course at Swinburne University. The authors provided some commentary on insights gained, and recommendations for teaching design thinking. Other research included the development and prototyping of the curriculum for a one-week workshop (Cahen, 2008), and a postgraduate business course in design thinking and cross-disciplinary management (Beckman & Barry, 2007).

In addition to the review of literature, and in order to gauge the level of interest in such programmes and to inform my own initiatives, I also made a web-based audit of current design thinking education programmes. I identified 65 individual design thinking educational programmes that I categorised using a model adapted from Melles and colleagues (2008; 2011). Appendix II provides a summary of nine key undergraduate, one-semester design thinking courses delivered in universities or institutions of higher education.

From the literature review and my own experience and knowledge, I discovered that there was a relatively small body of both general research into design thinking education, and specific research-based evaluations of university-level design thinking curriculum. There were only four examples of research that examined both the development and the implementation and operation of design thinking curricula (Bruton, 2010; Goldman et al., 2012; Noweski et al., 2012; Thoring & Müller, 2011). Most of this research was underpinned by constructivist views of education, and there was a general lack of coherent definitions of design thinking, and associated theories. Research also tended to focus on one key aspect of the design thinking curriculum under investigation, such as the student development of knowledge, shifts in mindsets or prototyping, rather than a more holistic set of outcomes associated with design thinking expertise. Explanatory theory for students' response to curricula were also limited Thoring & Müller, 2011). Most of this research was underpinned by constructivist views of education, and there was a general lack of coherent definitions of design thinking, and associated theories. Research also tended to focus on one key aspect of the design thinking curriculum under investigation, such as the student development of knowledge, shifts in mindsets or prototyping, rather than a more holistic set of outcomes associated with design thinking expertise. Attempts to develop explanatory theory for students' response to curricula were also limited.

1.2 Paradigm positioning

The decision to embark on a research-informed curriculum development project led me to carefully consider my paradigm positioning. I recognised that it had implications for both my development of a design thinking curriculum and the research that I undertook to evaluate the relationship between the curriculum and students' development of design thinking expertise. Critical realism was selected primarily because it represented my ontological position (realism) and epistemological position (relativism). It also aligned with my pragmatic interest in identifying processes, conditions and contextual factors that underpin phenomena and their relationships, which in this case were design thinking expertise development and a design thinking curriculum. It was also selected because of its ability to bridge the socio-cultural and scientific domains, and its relativist epistemology, which accommodated constructivist concepts in relation the construction of knowledge. In addition, an emancipatory axiological position associated with critical realism also aligned with my values as a researcher, teacher and design thinker, and the values of design thinking. Critical realism provided a strong foundation for my conceptualisation of the phenomena I was interested in, including design thinking, learning, learning environments, and curriculum. Critical realism also emphasises the complexity of such phenomena and their interrelationships, a position which reflects my everyday experience of learning and teaching.

Critical realism also offered useful perspectives on the research aims, methodologies and approaches. From a critical realist perspective, while reality is *imperfectly apprehensible,* understandings of reality that are developed through research can be described as *practically adequate.* Attempts to comprehend reality involve developing deeper levels of understanding of (a) properties and mechanisms of specific entities, and (b) the interactions of mechanisms of entities which may account for tendencies or outcomes which people experience and observe. Critical realism endorsed ‘methodological pluralism’ (Cameron, 2011; Christ, 2013) and the use of a mixed data types and data gathering and analysis methods. Theorising processes that included abductive and retroductive analysis were also advocated. At the outset of the research, it was noted that there were few clear and detailed examples of the application of these processes, including in education contexts (Di Russo & Feast, 2013; Wuisman, 2005).

1.3 Concepts and theories of learning, learning environments and curriculum

When designing and evaluating the curriculum, it was necessary for me to conceptualise, from a critical realist ontological perspective, what a curriculum was, along with learning, and a learning environment. My review of the small, but growing, body of critical realist educational literature provided the foundational ideas for these concepts. For example, using a critical realist perspective, and building on the work of Bhaskar (1978, 1979) and G. Brown (2007, 2009), I initially defined learning as an emergent outcome of experience, described as a change in a student’s attributes, such as the acquisition of knowledge or change in mindsets, and a process where students exercise mechanisms that have the potential to change their knowledge-related, and other, attributes. A learning environment was conceptualised as an episodic, open, dynamic and complex system, containing assemblages of entities/structures, and mechanisms that influence (enable or constrain) learning. A learning and teaching environment was also conceptualised as being stratified, having layers from the *empirical* (the experiences of students and teachers), *actual* (observed learning activities and outcomes) through to the *real* (the underlying causal mechanisms influencing learning, which are not observed, but can be inferred). A curriculum, on the other hand, was defined as an entity (a plan), with mechanisms that inform and guide the activation of a learning environment.

It is important to note that my definitions and conceptualisations of learning, learning environments and curriculum evolved along with my deepening understanding of critical realism, and were further refined throughout the action research process.

1.4 Research design

1.4.1 Research questions

The following was my initial, main research question:

Can an innovative design thinking curriculum, founded on relevant theories and constructs, and developed and evaluated by action research and co-creation approaches, enhance the development of design thinking expertise of university students?

Aligning with my action research methodology and my ongoing reflexivity and reflection, I clarified and extended some of aspects of the initial question throughout the research process. The following was the updated main research question that I developed:

Can a university-level, design thinking curriculum that is developed and evaluated using critical realist ontological perspectives and theorising methodology, and action research and case study methodologies, enhance the design thinking expertise of university students?

This overall research question was further developed into a number of interrelated sub-questions.

1. How can learning, learning environments, and curriculum be conceptualised, from a critical realist perspective?
2. How can design thinking be conceptualised from a critical realist perspective?
3. What are key outcomes (tendencies) in relation to the enactment of a design thinking curriculum in a learning environment, students' experiences of the learning environment, and their achievement of the intended learning outcomes?
4. How are those outcomes influenced by context differences, including the learning backgrounds of design and business students?
5. How do the attributes and associated mechanisms of enitities in a design thinking learning environment (informed by a curriculum), enable or constrain students' learning and development of design thinking expertise?
6. What is a 'signature' design thinking learning environment, and associated 'ideal' design thinking curriculum?
7. What features of a critical realist theorising methodology, used in conjunction with case studies and action research, enable or constrain the design and evaluation of university-level curriculum?

1.4.2 Research methodologies

As noted above, the research approach integrated three methodologies: a critical realist theorising methodology, case study and action research. The theorising methodology was used to develop explanatory theory about the relationship between students' design thinking learning, and the learning environment in which their learning occurred – in case studies of the implementation of design thinking curricula. Theory that emerged from the case studies informed on-going curriculum design decisions that were evaluated across three action research cycles.

1.4.3 Sources of data

Data were gathered from two key sources: myself, providing the perspectives of the researcher and teacher, and from the groups of students who participated in the case studies. Student groups included a group of 48 students in the course Product Design Studio II (one group of 24 students in semester two, 2012, and another group of 24 students in semester two, 2013), and a group of 72 students in the business course Design Thinking (one group of 36 students in semester one, 2013, and another group of 36 students in semester two, 2013).

1.4.4 Data gathering

Data were gathered through the documented reflections of my experiences as the researcher and curriculum designer, and my observations of, and discussions with, teachers. Data was gathered from student participants using surveys, key informant interviews, and from reviews of students' portfolios of design thinking process work.

1.4.5 Data analysis and theorising

The critical realist theorising methodology included six key steps that were applied within the case studies, and across the action research cycles. This included: (1) an initial inductive analysis of the survey and interview responses and the researcher reflections, underpinned by triangulation, to identify key tendencies in students' responses to the implementation of the curriculum and their development of design thinking expertise; (2) analytic resolution to identify the learning tendencies and learning environment entities that would be the focus for development of explanatory theory drawing on a deductive analysis of interview and reflection responses to identify references to possible entities in the learning environment and their properties and mechanisms; (3) abductive and retroductive analysis to infer attributes, mechanisms, and contingent relationships of entities in the learning environment that could account for these tendencies, (4) assessment of the explanatory power of the inferences (explanatory theory) across comparative and successive case studies; (5) testing explanatory theory by evaluating the effect on students' learning of changes made to the learning environment, based on the theory; and (6) assessment of the practical adequacy of theory with respect to its use during curriculum design work and everyday teacher decision-making. It is important to note that some of these steps were applied simultaneously, and not all of these steps were used in all of the case studies.

Quality criteria and ethics

The following criteria were used during each of the action research cycles to evaluate the quality of the research, and the outcomes.

- Validity: A quality criteria model proposed by Finlay (2006), and based on key concepts developed by Ballinger (2006) and Lincoln and Guba (1985), was used for this research.
- Credibility: The research utilised four data sets (both quantitative and qualitative), each with a different perspective on the same subject being studied (the design thinking curriculum), and with the research process effectively repeated three times, across three action cycles. Each data set was relatively extensive (for example, one set of data includes 23 key informant interviews, each about 45 minutes long) and the findings were analysed using a process of triangulation.
- Transferability: The research documentation outlined a high level of detail regarding the background to the research, the research setting and the research process.
- Confirmability: My ongoing reflexive analysis was outlined as part of the researcher's reflections, demonstrating a high level of confirmability.

Given that the research was undertaken in a university context, and the participant students and lecturers sit within the same department, careful thought was given to key ethical considerations. After the application, and a reasonably lengthy negotiation, the AUT University Ethics Committee granted ethical approval.

1.5 Thesis structure

The thesis is structured into three parts. Part One provides a detailed background and foundation to the research including chapters on the literature review; my paradigm positioning and key concepts; and the research design. The design of the initial 'ideal' curriculum is also presented. Part Two provides a detailed account of three action research cycles that the case studies were embedded in, including the explanatory theory that was developed and its implications for curriculum decisions.. Part Three provides a detailed discussion of the outcomes of the research, significant findings and conclusions. Appendices provide more detailed information on key aspects of the research, the curriculum development and evaluation process, and curriculum documentation. A brief overview of the purpose of each of these chapters is presented below.

PART ONE: BACKGROUND AND RESEARCH DESIGN

In **Chapter One**, I present the context for the research including my own interests, motives and questions in relation to design thinking education, and identify contributions that I considered that I might make to related research. I also introduce the concept of design thinking and related research on design thinking education, provide a brief summary of the main tenets of my paradigm positioning, outline the main design features of the research project that I initially conceived, and provide an overview of the structure of the research report.

The experience-based views about design thinking education that were the origins for this research were complemented by a critical review of related research literature. In **Chapter Two** I present this critical review along with concepts of design and design thinking, contexts in which the application of design thinking have been advocated and adopted and the development and evaluation of design thinking education initiatives. I identify gaps and limitations in previous research that I identified and decided to attempt to address. These include the absence of a critical realist based concept of design thinking and design thinking curriculum based on this concept, a paucity of rigorous research-based evaluations of design thinking curricula, limited attention in such evaluations to potential explanations for students' response, and no precedents for a project involving iterative design, evaluation and enhancement of design thinking curricula based on critical realist concepts and methodology. The latter involved an integration of case study, critical realist and action research methodologies.

Given the significance of paradigm positioning for my conceptualisation of the phenomena I set out to investigate, as well as the research design, I outline in **Chapter Three** the ontological, epistemological and methodological and methods perspectives of critical realism. I note that I could locate relatively few examples of higher education research that were underpinned by a critical realist position and that there were opportunities for my research to contribute to both critical realist-based conceptualisation of learning and teaching phenomena and the use of critical realist based research approaches in practitioner higher education research. In the concluding section, I review existing conceptualisations of design thinking, curriculum, learning, learning environments, discuss the presence or absence of critical realist-based concepts, and present the critical realist-based concepts that I adopted at the outset of the research.

In **Chapter Four**, I present a detailed description of, and justification for, my decisions concerning the research design, including research aims, questions, methodologies, methods, data and data sources, data gathering and analysis, quality criteria and ethical considerations. Again, I discuss the influence of a critical realist stance on these decisions as well as precedents for practitioner curriculum evaluation and development research.

In **Chapter Five** I outline my curriculum design framework, present pedagogical theories that informed my curriculum design decisions, and summarise my application of the framework and theories to the design of the first of three iterations of a design thinking curriculum. Key ideas are illustrated and selected examples of the curriculum documentation provided.

In **Chapter Six** I provide a detailed description of the application of the curriculum design framework to the design of the initial 'ideal' design thinking curriculum for enactment in Action Research Cycle One. Key ideas are illustrated, along with selected examples of the curriculum documentation.

PART TWO: ACTION RESEARCH CYCLES

In **Chapters Seven** to **Nine** I provide a detailed overview of each of the three action research cycles. This includes a description of the curriculum enactment, data gathering, and the progressive application of my critical realist theorising methodology to the case studies within each action research cycle. The overall findings in each cycle are identified, along with opportunities for improving the curriculum for each subsequent curriculum enactment.

In **Chapter Ten** I provide a comparative analysis of individual case studies. This analysis includes the use of Mann Whitney U Tests (Mann & Whitney, 1947) to compare quantitative survey data from four combinations of individual case studies and the identification of similarities and differences in students' interview statements concerning their learning and the learning environment.

PART THREE: DISCUSSION AND FINDINGS

In **Chapter Eleven** I provide a critical discussion of the key outcomes of the research in relation to the subsidiary research questions. This includes presentation and discussion of updated critical realist conceptualisations of learning, learning environments and design thinking, a 'signature' learning environment, a design thinking expertise framework, and examples from an end of project 'ideal' design thinking curriculum. Summary reflections on the integration of case studies, a critical realist theorising methodology and action research and are also discussed. In addition, a critical realist framework for analysing problematic tendencies is presented, and is applied to the analysis of four key tendencies that emerged from the curriculum enactment.

In **Chapter Twelve** I provide the final conclusions of the research in relation to the overall research question. This includes a summary of the conclusions, discussion of contribution of knowledge to four related discipline areas, discussion of the strengths and limitations of the research, and the identification of future research opportunities.

Appendices I–VI. In the appendices I provide important supporting material and examples that were not included in the individual chapters.

CHAPTER TWO: LITERATURE REVIEW

In this chapter, I critically review literature on design thinking and design thinking education, and identify the related gaps and limitations that provided the case, and represented opportunities, for this research project. The chapter is structured into three sections:

1. The concept of design thinking.
2. Design thinking education.
3. Overall conclusions (limitations, gaps and opportunities).

SECTION ONE: THE CONCEPT OF DESIGN THINKING

In this section, I review literature on conceptualisations of design thinking. The review focuses on the associated concepts of design and innovation; the history of the emergence of concepts of design thinking; associated paradigm perspectives, design thinking theories and constructs including mindsets, reasoning, cognition and practices; the contexts in which design thinking has been advocated and adopted; and current critiques of design thinking.

2.1 The concepts of design and innovation

As a concept, design thinking has evolved from design, and in contemporary contexts design thinking is closely associated with innovation. However, Buchanan (1992) argued that no single definition adequately encapsulated the diversity of ideas and meanings that have been associated with 'design', and that meanings and associations continue to evolve and develop over time.

Design is both a *noun* and a *verb* and can be conceived as the *end product of a process*, or as the *process itself* (Lawson, 2006). Further, Cross (2011b) described design as "the conception and realisation of new things" with "its own distinct 'things to know', 'ways of knowing', and 'ways of finding out about them'" (p. 17). From my perspective, design could be best described as a human-centred process of planning for the creation of something that is 'built', such as objects, graphics, and spaces, but can also include services, experiences and systems.

Innovation, on the other hand, can be defined as a concept that encompasses design, but also concerns the effective implementation of the outcomes of design processes (Wylant, 2008). From my perspective, while design is conceived of as the planning and creation process, the concept of innovation is broader, and encompasses both the problem and opportunity identification and definition, and the translation, implementation and realisation of design ideas into 'real' manifested outcomes.

2.2 The evolution of design thinking concepts

Design thinking is not a new term. It first emerged in the 1960s from research into the practice and processes of design that was intended to make design processes more explicit, and to acknowledge the many disciplines that were drawn on in design work (Beckman & Barry, 2007). Sometimes called the 'Design Methods' movement (Buchanan, 1992), the research was grounded in a rational or objective (*positivist*[1]) scientific tradition (Cross, 2001a), with a goal to inform and improve the practice of design itself, as well as to increase understanding of design (Bauer & Eagen, 2008; Curedale, 2013). This research led to a relatively idealised view of the design process as a set of recommended methods, that involved "breaking a complex problem into a set of smaller, well-defined problems and to seek experts in the sub-disciplines to solve those problems" (Beckman & Barry, 2007, p. 26).

The notion that design was a part of the science of the *artificial*, as opposed to the science of the *natural*, and was *a way of thinking,* was also first proposed in the 1960s. Simon (1969) further positioned design alongside the professions of engineering, management and medicine, and argued that in comparison to the traditional professions which were concerned with *what is*, design was concerned with *what ought to be* (Shamiyeh, 2010). Simon (1969) was one of the first to describe design as *human-centred.* He suggested that everyone designs, when they devise courses of action aimed at changing existing situations into preferred ones (Simon, 1969).

The early 1980s marked a significant shift in perspectives on design thinking as traditional objective perspectives on design and design methodology began to be challenged. Schön's (1983) work on what he termed *reflection-on-action* was considered to be a key to understanding how design practitioners reframed problems based on personal judgment, as a *way of knowing* (Cross, 2008). Schön (1983), from a *pragmatist*[2] position, proposed an epistemology of studio-based practices, using artistic and intuitive processes, which design practitioners could use to address problems that were defined by uncertainty, instability, uniqueness and value conflict (Cross, 2001a). Schön was also instrumental in proposing that a constructivist-based, design studio teaching approach could be also relevant to the learning and teaching of non-design subject matter.

At this time, increased attention was given to the cognitive processes of designers. This is evident in the work of Lawson (1980) who investigated the ways in which designers and non-

[1] *Positivism*: is defined as a paradigm position that emphasises "the importance of objectivity, systematic and detailed observation, testing hypotheses through experimentation, and verification. This process would ensure the finding of facts, which were equated with Truth" (Giddings & Grant, 2002, p. 13).
[2] *Pragmatism*: is defined as a method in which the 'truth' of a proposal is measured by its correlation to experimental results and practical outcomes ("Pragmatism," 2008).

designers solved problems. Cross (1982), on the other hand, using a *constructivist*[3] position, focused much more on what designers do, their cognition processes, and how they generate knowledge during the activity of designing, which he termed a *designerly way of knowing* (p.xx). The research focused on the behaviours, mindsets and solution-focused strategies that architects and designers utilise. This increased interest in design thinking was further confirmed by the publication of *Design Thinking* (Rowe, 1987).

The shift from a *design studies* tradition to a more intellectually orientated approach was sustained through the 1990s. A so-called *second generation* of design theories and methods also emerged that characterised design as a socially orientated process (Beckman & Barry, 2007). Buchanan (1992) was a significant contributor to these evolving perceptions of design and design thinking through this period. For example, he conceptualised design problems as indeterminate or ‘wicked problems’. Such problems have been described as those for which not all the necessary information is, or can be, available, as contradictory, and as having changing requirements and complex interdependencies (Rylander, 2009). Wicked problems are also so complex that they cannot necessarily be analysed and fully understood in order to be solved afterwards by rational scientific processes (Poulsen & Thogersen, 2011). These problems required the designer to have a distinctive way of looking at and defining problems, and design was therefore perceived as a problem-framing or formulating process, as well as a problem-solving process. Getting to a collectively acceptable starting point, or problem framing, was considered a major part of the design process (Beckman & Barry, 2007), and the social aspects of design work were acknowledged. Buchanan also articulated the need for recognition of design thinking as part of a “liberal art of the technological culture” (Buchanan, 1992).

By the early 2000s, this more integrated conception of design thinking, which was also associated with an innovation-centric agenda (Lugmayr, Stockleben, Zou, Anzenhofer, & Jalonen, 2013), was widely adopted and also considered to have relevance in a wide range of disciplinary and professional contexts, and for ‘non-designers’ such as business managers (Johansson & Welch, 2009, p. 3). Lindberg et al. (2010) referred to design thinking as *meta-disciplinary* and in the business and management areas, design thinking emerged as an approach for enhancing managerial behaviours and processes by partially modelling ‘managing as designing’. This perspective was reinforced and promoted by organisations such as the Californian design consultancy IDEO (Johansson & Welch, 2009), which was repositioned as an innovation strategy organisation. IDEO has subsequently developed, commercialised and

[3] *Constructivism:* is defined as a paradigm position founded on the basis that “humans generate knowledge and meaning from their experiences, mental structures, and beliefs that are used to interpret objects and events”. “Learning happens when learners construct meaning by interpreting information in the context of their own experiences” ("Constructivism," 2012, p. 783).

promoted key design thinking models and approaches with great success (Lindberg et al., 2010).

There was a marked increase in design thinking publications between 1999 and 2009 (Johansson-Skoldberg et al., 2013) (Figure 1), and design thinking currently receives considerable attention in the mainstream business media, with magazine stories and case studies. In addition, a number of individuals and organisations have published practical design and method guides (Liedtka & Ogilvie, 2011; Stickdorn & Schneider, 2011).

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Figure 1. Number of publications on design thinking (Johansson-Skoldberg et al., 2013, p. 123)

In addition to academic research on design thinking, a number of useful 'real-world' case studies of successful application of design thinking in business have emerged; for example, from organisations such as Proctor and Gamble (Leavy, 2010), Apple (Thomke & Feinberg, 2009), Kaiser Permanente, Shimano, and Nike (Leavy, 2012).

The move to a more integrated conception of design was also accompanied by increasing research into design thinking (Bauer & Eagen, 2008). Johansson-Skoldberg et al. (2013) described two key discourses associated with this research: the academic construction of professional designers' practice called *designerly thinking;* and the practice of design in non-design contexts (e.g., management and business) by people who do not have a scholarly background in design. The latter was termed a *design thinking* discourse. Johansson-Skoldberg et al. (2013) have also summarised the associated shifts in concepts of design thinking (Table 1).

Table 1. Changing concepts of design thinking (Johansson-Skoldbwerg et al. (2013)

Concepts of Design Thinking
Design and designerly thinking as the creation of artefacts (Simon, 1969)
Design and designerly thinking as a reflexive practice (Donald Schön, 1983)
Design and designerly thinking as a problem -solving activity (Buchanan, 1992)
Design and designerly thinking as a way of reasoning/making sense of things (Lawson, 2006; Cross, 1982, 2006, 2011)

As indicated in the preceding commentary, one of the key factors accounting for the shifts and variability in concepts of design thinking is paradigm and theory positioning.

2.3 Paradigm and theoretical perspectives of design thinking

Several researchers have explored the ontological and epistemological perspectives that underpin concepts of design, and design thinking.

Cross (1982) proposed that design, and therefore design thinking, represents a 'third' culture alongside the sciences and the humanities that has distinct phenomena (the artificial), methods and values. His ideas are presented in Table 2. He stated that design, in addition to having a unique language and material culture, also has its own *things to know*, *ways of knowing,* and *ways of finding out* about these things. He referred to the latter as a *designerly way of knowing*, implying therefore that design has a unique, epistemological and knowledge generation perspective.

Table 2. Comparison of design to the sciences and humanities. Adapted from Cross (2011b)

Attributes	**The Sciences**	**The Humanities**	**Design**
Phenomenon of study	The natural world	The human experience	The artificial world
Appropriate methods	Controlled experiment	Analogy, metaphor, evaluation	Modelling, pattern-formation, synthesis
Values	Objectivity, rationality, neutrality and concern for the 'truth'	Subjectivity, imagination, commitment and concern for 'justice'	Practicality, ingenuity, empathy and concern for 'appropriateness'

Feast and Melles (2010) cited Cross (1999) as an instance of someone who held a constructivist view with respect to the way he conceptualises design practice and design research. They noted that Cross differentiated three design knowledge domains that researchers could focus on:

- Design epistemology – the study of designerly ways of knowing
- Design praxeology – the study of practices and processes of design
- Design phenomenology – the study of the form and configuration of artefacts.

He contended that research on designerly ways of knowing is likely to be the most helpful for design practice and education.

In emphasising the fundamental epistemological differences between science and design, Liedtka (2004) also argued that while science seeks to uncover *what is*, design seeks to uncover *what might be*, but *is not yet.* In a similar way, Lawson (2006) contended that while scientists have mindsets that are problem-focused, architects and designers have mindsets that are solution-focused, and that designers utilise distinct behaviours and strategies. In a study of how architects approach design, he noted that architects were more inclined to propose a series of solutions, and to have solutions eliminated until they found an acceptable one (Lawson, 2006). Cross (2011b) described the nature of design as *constructive, normative and creative*, and stated that “the solution is not simply lying there among the data, like dog among the spots in the well known perceptual puzzle; it has to be actively constructed by the designers own efforts” (p. 24).

Several researchers have explored the processes that underpin a designer’s knowledge development. For example, Owen (2007) proposed that design thinking draws upon what he calls both the *analytic* (“the realm of theory”) and the *synthetic* (“the realm of practice”), and suggested a model in which knowledge is *constructed***.** See figure 2.

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Figure 2. Dynamic process of knowledge building (Owen, 2007, p. 19)

In explaining Owen’s (2007) model, and its link to innovation in other disciplines, Beckman and Barry (2007) stated, “He suggests that there is an innovation process that fits all fields, although the specific tools and techniques used in each may differ, as may the emphasis on theory versus practice” (p. 27).

Further to concluding that design involves a dynamic and iterative *finding* and *making* model of knowledge development, Thoring and Müller (2011) conceptualised knowledge development in design as a typology. These authors proposed that design knowledge is constructed through a series of transitions in "levels of design knowledge", as presented in figure 3.

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Figure 3. Typology of design knowledge (Thoring & Müller, 2011, p. 2)

These researchers appear to have used *constructivist* (or *constructionist*[4]) concepts to conceptualise design, and the way that designers think. Other researchers have also proposed a strong link between design/design thinking, and constructivism (Conole & Alveizou, 2010; Goldman et al., 2012; Johansson & Welch, 2009; van der Merwe, 2010), and the prevalence of constructivist and constructionist epistemological perspectives in design research was confirmed by Feast and Melles (2010) who analysed approximately 300 journal articles, conference papers, book chapters, and state of the art reviews to identify paradigm positions. They reported that the prevailing paradigm was *constructionism.* As Feast (2010) subsequently observed, researchers' epistemological perspectives will be reflected in their "characterisation of design practice" (p. 3) as well as their orientation to research.

At the same time, some researchers have drawn on other paradigm frameworks when conceptualising design and design thinking. For example, Melles (2008) proposed that design thinking, as the logic for ill-defined problem solving, is fundamentally *pragmatic.* Romme (2003) also argued that design is fundamentally pragmatic in nature, being normative and synthetic, directed toward desired situations, and having an interest in causality.

[4] *Constructionism* is referred to in this research as a variant or subset of the paradigm position of *constructivism*, a learning theory where ideas get formed and transformed when learners are involved in making tangible objects (Goldman et al., 2012).

On the other hand, Di Russo and Feast (2013) have argued that critical realism provides a more appropriate paradigm foundation for research into contemporary design practice as it bridges the explanatory powers of *objectivism* and the *social-cultural reality* of design practice. Hodgkinson and Starke (2012) also advocate the use of critical realist based research approaches in research on design practice: “Critical realism is a powerful tool in understanding the interplay of structure and agency in design activity dependence, and in theorizing generative mechanisms” (Hodgkinson & Starke, 2012, p. 606).

Further to these discussions, Bauer and Eagen (2008) suggested that design thinking is actually *multi-epistemic,* and that design thinking has six modes, each with its own distinct epistemological profile. They contended that in the context of design thinking, interacting with the world is as much *feeling, sensing, intuiting* as it is utilising *cognitive* and *analytical* processes.

The review of literature concerning paradigm perspectives reinforced the need to confirm and clarify my own paradigm positioning as this would have implications for my own conceptualisation of design thinking and design thinking curriculum, as well as the aims and design decisions for my research.

2.4 Design thinking theories

Associated with the conceptions of design thinking represented in definitions are theories and models of design thinking.

> A theory is a set of interrelated constructs (concepts), definitions, and propositions that present a systematic view of phenomena by specifying relations among variables, with the purpose of explaining and predicting the phenomena (Kerlinger, 1986, p. 9)
>
> Theory incorporates points of view about (a) the things that make up a phenomenon (i.e. properties) and that differentiate it from other phenomena, (b) the presence or absence of a relationship between phenomena, (c) the direction of these relationships, (d) the impact of changes to phenomena that are in a relationship, and (e) the nature of the relationship between phenomena: cause-effect or probabilistic (Haigh, 2013, p. 23)

Theories of design thinking identify properties of the phenomenon termed design thinking and interrelationships between those properties. The latter include practice or procedural relationships. They may also identify other phenomena that are *influences* on or *effects* of design thinking. Models are graphic representations of the constructs and propositions of a theory.

A review of theories and models indicated that there are five general categories of properties that have been associated with design thinking: mindsets, reasoning, cognition, collaboration, and practices. Theories may also differentiate levels of design thinking expertise and some theories focus on the nature of design thinking practice, specific practices and the processes that design thinkers may engage in.

2.4.1 Mindsets

The concept of mindsets has been defined as an set of *attitudes* that someone holds ("Mindset," 2010). Other terms associated with mindset include *stance*, *vision*, *view*, or *outlook*.

The proposition that designers not only think differently, but also have a distinct set of approaches, strategies and tools for tackling and solving problems, as noted previously, is strongly underpinned by the concept of a *mindset*. A mindset plays a foundational role in the way that a design thinker approaches, constructs and applies knowledge. Authors and researchers have identified and described a range of mindsets that are associated with design thinking. Key mindsets are:

- *Empathic*: Having a deep empathy for, and understanding of, the people for whom you are designing, is a critical aspect of design thinking (Eagen et al., 2011). T. Brown (2008) noted that empathic mindsets are "powered by a thorough understanding, through direct observation, of what people want and need in their lives" (p. 86). An empathic mindset is often referred to as human-centred (Goldman et al., 2012). Clark and Smith (2008) linked this mindset to concepts of *emotional intelligence*.
- *Optimistic:* Design thinking is rooted in optimism. According to T. Brown (2008), design thinkers take the stance that no matter how challenging the constraints of a given problem, there is at least one potential solution that is better than the existing alternatives.
- *Experimental:* This mindset embraces an experimental orientation, and a willingness to push ideas around (Goldman et al., 2012). Having an "experimental stance changes one's approach to problem solving by allowing one to do, make, and visualize as integral parts of thinking and of the evolving ideas" (Goldman et al., 2012, p. 17).

- *Radical:* Significant innovations do not come from incremental tweaks and design thinkers strive to pose questions and explore constraints in creative ways that proceed in entirely new and radical directions (T. Brown, 2005).

Owen (2007) has proposed other mindsets, including *motivation*, *sensitivity*, *a questioning attitude, sustained curiosity*, *playfulness*, *tolerance for ambiguity*, *systemic vision,* and *personal courage.*

2.4.2 Reasoning

The concept of reasoning has been defined as the capacity, and processes that someone uses to consciously *make sense* of things, or reach *conclusions* (Oaksford, 2005). Another term associated with reasoning is *judgment*.

Dunne and Martin (2006) describe design thinking as the reverse of scientific thinking. Whereas the scientist analyses facts to discover patterns, the designer invents new patterns and concepts to address facts and possibilities. They state that “design thinking includes *inductive*, *deductive* and *abductive* reasoning” (Dunne & Martin, 2006, p. 517). The literature review indicated that the capability to engage in abductive reasoning is emphasised (Dew, 2007; Leavy, 2010), and is associated with the problem-framing and reframing process (Dorst, 2008). A number of authors have defined abductive reasoning in the context of design thinking as the logic of ‘what might be’ (Martin, 2009), or *solution focused* thinking (Dorst, 2008). Curedale (2013) described abduction as an *inference* to the best explanation. Abductive reasoning typically begins with an incomplete set of observations and proceeds to the likeliest possible explanation for the set. Its goal is “What is possible to be true?” (p. 17).

The related capacity to engage in problem framing or reframing is similarly emphasised (Buchanan, 1992; Cross, 2001a, 2011b; Lindberg et al., 2010), in part because design problems are often ill-defined or ‘wicked’. Many have argued that the ways designers and design thinkers orient, approach and tackle such problems are necessarily unique, and that traditional ‘linear’ techniques are inappropriate. Cross proposed that rather than attempting to define or understand the problem fully, before making solution attempts, designers are likely to move to early *conjectures* about creative directions and ‘solution spaces’, and use these conjectures as an emergent way of exploring and further defining problems. This approach to problem framing, reframing and solving, is also somewhat characteristic of reflective practice as identified by Schön (1988).

Also associated with problem framing is *insight generation.* Insights are synthesised from the findings of research in design thinking. Synthesising is a critical part of design thinking, as it assists design thinkers to converge, and make judgments about highly divergent and often conflicting information (Lindberg et al., 2008).

The design thinking process can also be conceptualised as a series of value-laden decisions. da Silva Viera, Badke-Schaub, Fernandes, and Fonseca (2008) differentiated two forms of *decision-making* in design thinking, those made on the basis of personal preferences and those based on value judgments. Five types of value judgments in design thinking are inferred: *emotional*, *intuitive*, *rational*, *experience* and *constraint-based* (da Silva Viera et al., 2008). They were defined as:

- Emotional: Decisions made on arguments based on circumstances, mood or in relation to others.
- Intuitive: Decisions made on arguments based on the ability to understand something immediately, without the need for conscious reasoning.
- Rational: Decisions made on arguments based on reasoning and logic.
- Experience: Decisions made on arguments based on practical contact with the subjects and observation of facts or events resulting in mature knowledge.
- Constraint-based: Decisions made on arguments based on the limitations or restrictions that reframe the problem.

2.4.3 Cognition

The concept of cognition has been defined as, “The *mental processes*, *forms* and *products* of knowing” (*Better by Design*, 2011). It is important to note that cognition has been identified as different from the concept of reasoning, which, as noted previously, is a set of processes specifically focused on sense making and judgment.

According to Cross (1992), design thinking involves cognitive processes that are manifested in design action, and he also argued that these cognitive processes are distinct from those utilised in other disciplines (Cross, 2011b; Dorst, 2008). This has been verified to some degree by Alexiuou (2009), who used magnetic resonance imaging of the brain to demonstrate that brain patterns of creative activities in design thinking associated with ill-defined problems were different from those utilised to solve well-defined problems; indicating there are indeed distinct kinds of thinking, which involve distinct cognitive functions and distinct brain networks.

Cognition in design and design thinking can also be conceived as encompassing a cycle of modes of thinking that moves progressively from *constructive* to *synthetic* modes (Cross, 2011a). In this process, "designers use codes that translate abstract requirements into concrete outcomes" (Cross, 2011a, p. 29).

- *Constructive thinking*: Constructive thinking involves constructing knowledge through the design process. Aligning with a constructivist stance, Cross (2011b) argued that design, and design thinking, is effectively an overarching *constructive* style of thinking. He observed that design thinking is about making constructive responses to practical problems, issues and situations, which means being practical, and involves creating solutions and resolving problem areas (Cross, 2011b).
- *Analytical thinking:* Analytical thinking involves the identification of individual parts or details of something from the overall whole. Sometimes it is also defined as the ability to approach a problem by using a logical, systemic and sequential approach. Design thinkers use analytical modes of thinking, in conjunction with other modes, to explore, unpack and frame problems, as well as when making decisions about solutions (Owen, 2007).
- *Abstract thinking:* Abstract thinking involves using concepts to make generalisations beyond the obvious, and to use patterns, or a variety of ideas or clues to solve larger problems (Beckman & Barry, 2007).
- *Synthetic thinking*: Synthetic thinking involves the combining of parts, ideas and concepts into a complex whole. Design thinking relies on synthesis at various points in the process, such as synthesising research, prioritising ideas and specifying design concepts (Lindberg et al., 2008). Kolko (2010) also argued that synthesis, in the context of design thinking, is an abductive sense-making process.
- *Creative thinking:* This mode of thinking involves the construction or creation of new ideas and concepts. Many researchers have identified creative thinking as core to design thinking. For example, T. Brown (2008) contended that design thinkers not only rely on analytical processes, such as those that produce either/or choices, but also utilise creative thinking, which he conceived as the ability to 'see' and 'grasp' all of the key—and sometimes contradictory—aspects of a problem, and propose new solutions that go beyond and dramatically improve on existing alternatives. Bauer and Eagen (2008) associated *imagining*, *associative thinking* and *day dreaming* with the creative thinking of designers and Owen (2007) referred to creativity in design thinking as *conditional inventiveness*.

- *Divergent/convergent thinking.* Closely related to creative thinking, divergent and convergent approaches to thinking are fundamental in problem solving, and are essential drivers for creative design work (T. Brown, 2009; Dym et al., 2006; Lindberg et al., 2008). Divergent thinking involves exploring as many creative ideas and solutions as possible, while convergent thinking involves reducing or selecting ideas down to the 'best' possible solution. Design thinking can be considered interplay between divergent exploration of a problem and solution space, and use of the convergent processes of synthesis and selection (Beckman & Barry, 2007; Owen, 2007; Plattner, Meinel, & Leifer, 2011).
- *Intuitive thinking*: Intuitive thinking describes the ability to develop knowledge without the use of reason. A primary characteristic of design thinking is the use of *intuition* where design thinkers are often able to access insights and knowledge without any trace of process (Eagen et al., 2011; Pombo & Tschimmel, 2005). Martin (2009) described the role of intuitive thinking as a very important balance to analytical thinking. He proposed that design thinking sits at the juncture of two types of thinking, analytical and intuitive thinking (Figure 4)

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Figure 4. The relationship between analytical and intuitive thinking (Martin, 2009)

- *Reflective thinking:* Reflective thinking has been described by Dewey (1933), as an active and careful consideration of any belief or form of knowledge in the light of the grounds that support it, and the further conclusions made about it. Informed by Schön (1988). Cross (2011a) stated that 'designing' operates as a reflective conversation with the situation, as an interactive process.
- *Metacognitive thinking (metacognition):* Metacognitive thinking can be simply described as *knowing about knowing,* or about when and how to use particular

strategies for one's own learning or for problem solving. Metacognition, in the context of design thinking, can also be "characterized by an awareness that it is essential to be aware of where one is in the design thinking process in order to agilely respond to changing parameters of a problem" (Goldman et al., 2012, p. 17).

2.4.4 Collaboration

Collaboration has also been identified as essential to effective design thinking. According to T. Brown (2011), the notion that design should be undertaken by the lone creative genius has been replaced with the view that designers are necessarily enthusiastic, interdisciplinary collaborators. The literature strongly emphasises the social dimension of design thinking work.

The prevailing view is that all stages of the design thinking process are best undertaken by people working in multi-disciplinary teams (Lindberg et al., 2010; Owen, 2007), and with the best design thinkers having significant experience in more than one discipline. In discussing the role that design thinking has in facilitating collaboration, Lindberg et al. (2010) argue that, "Design thinking processes generally allow multi-professional teams to develop mutual understanding due to its strong emphasis on team-based learning regarding both the problem and potential solutions" (p. 35).

Dym et al. (2006) identified and described a group of factors that are important determinants of effective collaboration, including the ability of the team as a whole to maintain sight of the *big picture*, *handle uncertainty*, *make decisions* and *communicate* in the several languages of design.

2.4.5 Expertise

Rather than just being a set of abilities, Lawson and Dorst (2009) proposed that design can be further conceptualised as an *expertise*, and stated, "Designers can learn to become more expert at what they do" (Lawson & Dorst, 2009, p. 88). Similarly, Cross (2011b); Dorst (2008) argued that design capabilities could be categorised into *levels of ability* or *expertise*. They also proposed that the *expertise development model* proposed by H. Dreyfus and Dreyfus (1986) was a useful model for the design profession, comprising levels of *novice, advanced beginner, competent, expert, master* and *visionary*.

While concepts of expertise in design have received relatively limited attention in the design research community, Cross (2004) identified a number of research projects that have explored concepts of design and design thinking expertise, including general understanding of design expertise (Cross, 2003; Schön 1988), cognition in design expertise (Christiaans & Dorst, 1992;

Kavakli & Gero, 2001), and design expertise in education (Adams, Turns, & Atman, 2003; Cross, Christiaans, & Dorst, 1994). While expert designers might have highly developed abilities, it is also apparent that non-designers have some aspects, or lower levels of design ability (Cross, 2011b). Given Cross's (2011b) view on non-designers, there is potential to introduce and teach them design thinking.

In addition to helping conceptualisation of design thinking, expertise frameworks can assist the development of a profile of the attributes of a design thinker. In turn, this profile can support development of learning outcomes for design thinking education programmes.

2.4.6 Practices

In contrast to the cognitive, and socially-oriented theories of design thinking, design thinking has also been conceptualised as a practice, methodology, or set of processes underpinned by various clearly defined methods or techniques. For example, Lockwood (2010) explained design thinking "is not a substitute for design, but rather a methodology for innovation" (Lockwood, 2010b, p. 11). Arguably, the conceptualisation of design thinking as a process has parallels in the earlier, more positivist oriented, and idealised, research of the 'Design Methods' movement (Beckman & Barry, 2007).

Kimbell (2009) proposed a view of design thinking called *design-as-practice* that goes beyond traditional dimensions. Reflecting a generally constructivist view, Kimbell (2009) stated that "design-as-practice mobilizes a way of thinking about the work of designing that acknowledges that design practices are habitual, possibly rule governed, often shared, routinized, conscious or unconscious, and that they are embodied and situated" (p. 10).

Building on the work of Kimbell (2009), Di Russo (2013) presented a stratified model of design thinking practice (Figure 5) in which each layer represents a higher order of complexity. She explained that this stratification of design allows a better definition of what currently constitutes design and design thinking practice, and what may be involved in the future.

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Figure 5. Stratified design thinking practice mode (Di Russo, 2013)

T. Brown (2009) acknowledged the complexity of design thinking practice by providing a mindmap of the ‘what’ and ‘how’ domains of practice. The related key ideas, concepts, methods and processes are visualised in a manner that is, arguably, more sympathetic to the concept of design thinking (Figure 6).

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Figure 6. Design thinking explanatory model (T. Brown, 2009)

A number of specific design thinking practices have been identified. They include:

- *Ethnographic research practices:* Primary design thinking research techniques are often drawn from ethnography. Techniques can include observation, focus groups, extreme user interviews, and journey and empathy maps (T. Brown, 2009; Cross, 2004).

- *Visualisation and visual mapping practices*: “Design thinking is, inherently, a visualisation and prototyping process powering deep understanding of what people want in their lives as well as what they like” (Serrat, 2010, p. 3). Brown’s mindmap is an example of a visualisation practice.
- *Ideation practices*: Ideation, closely associated with creative thinking, involves bringing ideas to life, and exploring them through a range of methods. Ideation practices can include brainstorming, body storming, sketching and drawing and prototyping (T. Brown, 2009; Cross, 2004).
- *Prototyping practices*: Prototypes are physical or virtual representations of ideas (Gerber & Caroll, 2012). “Prototypes can be concept sketches, rough physical mock-ups, or stories” (Lockwood, 2010b, p. 7), and are especially useful in iterative design thinking processes to explore and evaluate collaborative ideas in parallel (Dow et al., 2012).

2.4.7 Process models

Several design thinking process models have been developed and are widely recognised. For example, the d.school model (Figure 7) comprises six key stages in the design thinking process. Each of these stages is comprised of a number of key design thinking methods. While the model articulates a sequential process, it also highlights that these stages can be repeated/cycled through a number of iterations.

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Figure 7. ‘Mode by mode’ of the design thinking process (d.school, p. 517)

Liedtka and Ogilvie (2011) developed a similar model aimed at business managers, underpinned by a series of questions (Figure 8)to drive the process.

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Figure 8. Model of the design thinking process for managers (Liedtka & Ogilvie, 2011, p. 21)

Several researchers have argued that design thinking is a complex activity, and that its principles ask for much more flexibility in representations of the process. Kumar (2003) presented an iterative and cyclic model of design thinking illustrated in Figure 9. This model differentiated the several modes of planning rather than steps, and emphasised the iterative and interconnected nature of the design process.

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Figure 9. Cyclic model of design thinking by Kumar (2003), in Dubberly (2004, p. 125)

T. Brown (2008) presented another cyclic model of design thinking, described metaphorically as slightly more of a complex system of spaces rather than a predetermined series of orderly steps (Figure 10).

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Figure 10. Cyclic model of design thinking spaces (T. Brown, 2008, p. 88)

While idealised cyclic models might be useful in conceptualising design thinking, Meinel and Leifer (2011) created a model that they believe is closer to the reality of the design thinking process (on the right) in comparison to the idealised model (Figure 11).

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Figure 11. The ‘reality’ of the design thinking process (Meinel & Leifer, 2011, p. xiv)

In questioning the need for a design thinking process model, Lindberg et al. (2008) argued that while idealised process models are very useful from a conceptual point of view, especially for introducing basic ‘step by step’ processes, they can create contradictions in themselves. “There is a fundamental conceptual conflict between the same principles that ask for situational flexibility and adaptability of workflows, and the normalization of workflows as suggested by those models” (Lindberg et al., 2008, p. 243). In response, they presented a flexible and adaptable model, illustrated in Figure 12, aimed at advanced design thinkers. The model is based on eight working modes, which dynamically move between problem and solution spaces. This arguably more sophisticated model links many of the cognitive and reasoning processes identified previously in the chapter.

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Figure 12. Divergent/Convergent thinking (Lindberg et al., 2008, p. 251)

Design thinking process models range from idealised 'step by step' models through to those that propose more flexible implementation of processes. The latter appear to better represent the 'real' complexity evident in the way cognitive and reasoning processes may be deployed for design thinking purposes and align better with constructivist views of design thinking.

2.4.8 Conclusions

The theories reviewed above highlighted the numerous constructs associated with design thinking and the complex relationships between aspects of design thinking. The associated models helped me 'grasp' these possible constructs and relationships, and to consider my own conceptualisation. I could recognise that a number of key elements from the theories aligned with my existing concept of design thinking and were also supported by my experience of teaching design thinking. They included but were not limited to:

- The place of positive and optimistic attitudes and mindsets.
- A need for 'step by step', but flexible, approaches to applying reasoning and cognitive processes.
- The roles of problem framing, creative, abductive and synthetic thinking as cornerstone thinking processes.
- The role of ethnographic research, underpinned by an empathic mindset, visual mapping, brainstorming, sketching, and rapid and iterative prototyping as key practices.
- The importance of collaboration to underpin practices and processes.

At the same time, I recognised that I needed to further develop my own theory, as there wasn't one theory that aligned completely with my own views. In order to construct that theory, I also recognised that I needed to settle on a definition of design thinking that took into account my paradigm positioning and 'other' theories that I subscribed to. Having a theory of design thinking would be a pre-requisite for the development of a design thinking curriculum.

2.5 Contexts in which design thinking has been adopted

As identified previously, the concept of design thinking has evolved from the study of how designers 'think' and 'practice', and has been adopted as a framework for innovation that has been utilised within a range of disciplines and professional areas (Johansson & Welch, 2009).

The business and management disciplines were generally the first to embrace the concept that design thinking had the potential to augment existing practices and drive innovation within organisations (Johansson & Welch, 2009). Leavy (2010) noted that design thinking has something very significant to offer when applied to businesses and business management and strategy, and that "the design perspective … can be applied to a much wider range of challenges, beyond product aesthetics and ease of use, including the search for innovative strategies, business models and organizational structures and process" (Leavy, 2012, p. 26). Lockwood (2010b) also explained design thinking can be applied to a product, a service, an experience, a future state, or even to the design of a business itself.

Liedtka and Ogilvie (2011) argued that competent managers have qualities that are similar to those of accomplished designers, including an ability to embrace uncertainty, an ability to collaborate, a willingness to experiment, and a concern to develop insight based on deep understandings of people (not targeted market segments). They emphasise that these qualities can be taught and developed by business managers and strategists, a view endorsed by a number of other researchers and commentators. Liedtka and Ogilvie (2011) also proposed that design thinking could be used in small enterprises to drive innovation across such areas as vision, strategy, identity, product and service, user experience, and innovative culture. Other researchers have similarly explored design thinking in business contexts (Carr et al., 2010; Clark & Smith, 2008; Drews, 2009; Dunne & Martin, 2006; Innes, 2011; Leavy, 2012).

Several researchers have explored the application of design thinking in other professional contexts, including product development and user experience design (Lockwood, 2010b), business, enterprise and management (Leavy, 2012; Liedtka & Ogilvie, 2011; Lockwood, 2010a; Ward et al., 2009), service industries (Gloppen, 2009; Stickdorn & Schneider, 2011), social innovation (T. Brown & Wyatt, 2010), biotechnology (Friedman, 2003), libraries (Bell, 2008; Howard & Davis, 2011), and legal practice (Szabo, 2010).

The contexts in which design thinking are utilised have clearly evolved, initially into the business and management disciplines, and as a framework to drive business innovation. More recently it appears design thinking has been adopted by a range of socially orientated disciplines including the service industries, education, and the social innovation sector. This shift in contexts tends to align with evolving conceptualisations of design thinking.

In addition to general reflections on the increasing spread of design thinking in new discipline areas, the literature on contexts for application of design thinking prompted me to consider how I might explore, in this study, the curriculum considerations associated with introducing students from diverse disciplinary and professional backgrounds to design thinking.

2.6 Contemporary critiques of design thinking

Recently, design thinking has come under increasing scrutiny and critique and a number of designers have expressed unease at the increasing 'appropriation' of design thinking, and its uncritical deployment in non-design contexts (Stewart, 2011). Badke-Schaub et al. (2008) also concluded that many of the claims regarding design thinking are not supported by empirical evidence. They contended that the emphasis on research into design thinking as business strategy, as promoted by companies like IDEO, has come at the expense of research into the more traditional aspects of design thinking.

Other researchers have also provided a more critical view of design thinking. For example, Carr et al. (2010) examined the influence of design thinking on business, and argued that many managers were confused by the term design thinking, and that there was much disagreement of its value as an innovation tool. McCullagh (2010) described the hype surrounding design thinking in the mid 2000s, and argued that since the 2008 global financial recession, many design managers had stepped back from using design thinking in their organisations. Newman (2011) echoed this, and claimed that design thinking's time had not come, and that many companies that bought into design thinking had not seen the positive impacts on innovation that it promised. Norman (2010) argued that design thinking was 'a useful myth', describing it as nothing that has not already been done in other disciplines beyond design, such as science, engineering, law and medicine.

Johansson-Skoldberg et al. (2013) reflected that it would be easy to dismiss the recent intensive discourses on design thinking as temporary. Previous prophets of design thinking have renounced the concept, including Bruce Nussbaum, Parson New School of Design (Nussbaum, 2013); Professor Fred Collopy, Case Western University; and Roger Martin, Dean of the Rotoman School of Management. Nussbaum refers to his colleague's blog (Walters (2013) who, in bringing a reality check to the application of design thinking in business, states that, "Design thinking neither negates nor replaces the need for smart designers doing the work that they've been doing forever" (p. 1).

These critiques of design thinking encouraged me to more deeply reflect on my own experiences and understandings of design thinking, and to be more critical when further examining the literature. It also reiterated the need for strong evaluation-based research into design thinking.

SECTION TWO: DESIGN THINKING EDUCATION

While there is a substantial body of general research into design thinking (Johansson-Skoldberg et al., 2013), there is a relatively small, but emerging, body of literature and research specifically on the educational aspects of design thinking. This research reflects the growing number of organisations and institutions that are developing and enacting professional workshops and academic programmes on design thinking (Stewart, 2011).

In this section, I first review literature that provides examples of advocacy for learning and teaching of design thinking. Two examples of frameworks and models that have been proposed for the development of design thinking programmes are then reviewed. Further examples of curricula that have been implemented in higher education contexts are reviewed, along with their underpinning concepts of design thinking and paradigm and theory perspectives. The small number of existing research-based evaluations of design thinking programmes are then outlined and critiqued.

2.7 Rationale for teaching design thinking

Several authors have advocated teaching design thinking to students engaged in both design and non-design programmes of study, and identified potential benefits.

Owen (2007) advocated educating product designers in design thinking methods, specifically to prepare them for more generic creative roles in areas outside of specialist design, given the large number of specialist design graduates who end up working in non-design but ‘creative’ jobs. Withell and Reay (2011) suggested that the benefits of teaching design thinking to product design students in authentic contexts included the development and refinement of thinking and design process competencies, as well as generic professional skills such as communication, collaboration, and group management and facilitation.

Noweski et al. (2012) suggested that design thinking education is an excellent way of helping non-design students acquire twenty-first century competencies. These competencies included problem solving, collaboration, agility and adaptability, curiosity and imagination, empathy, and the ability to synthesise and be creative. Similarly, Goldman et al. (2012) argued that design thinking provided students with a relevant, socially situated, complex problem-solving methodology that could be used in varied discipline contexts, including business and management, and engineering.

Dunne and Martin (2006) suggested that design thinking could positively influence business and management education, specifically MBA programmes. They contended that if design thinking was taught alongside existing traditional courses and models, students could be encouraged to think broadly about problems, develop a deep understanding of users, and recognise the value of others’ contributions. Eagen et al. (2011), and Koria, Graff, and Karjalainen (2011) proposed that the benefits of design thinking included helping business students develop multi-disciplinary skills, and their ability to think divergently and convergently, manage conflicting ideas and concepts, and create new business ideas.

Dym et al. (2006) argued that design thinking can enhance engineering education. They identified current limitations in the *objectivistic* epistemological approaches used in engineering education where students learn “proven principles” which “are applied to analyse a problem to reach verifiable, ‘truthful’ answers or solutions” (p. 104). They advocated for integrating design thinking into engineering to help students develop other problem orientations, conceptual, and decision-making skills. They also concluded that including design thinking in an engineering curriculum could also improve student retention, satisfaction, diversity, and learning.

Collectively, these authors suggest that design thinking, when utilised along with existing traditional objectivist/positivist oriented disciplines, offers new ways of thinking and associated epistemological perspectives that could have generic learning benefits, as well as benefits for specific professional roles. Overall, the research emphasised the need to consider both categories of outcomes when providing a rationale for developing and implementing a design thinking curriculum, and when assessing actual outcomes for students.

2.8 Conceptions of design thinking and curriculum

Some of the theories of design thinking implicitly or explicitly anticipate the development of design thinking curriculum. From the literature, I identified three examples that I immediately considered relevant and helpful for my development of a curriculum. They also alerted me to the need to base a design thinking curriculum on a coherent theory of design thinking and to give careful thought to pedagogy that may be unfamiliar to some students and teachers.

Beckman and Barry (2007) presented a conceptualisation of design thinking as a learning process that has parallels with Owen's (2007) assessment of the knowledge fields of design thinking, and Kolb's (1984) Experiential Learning Theory (ELT). Owen outlined how design thinking is different from other types of thinking, and provided a framework based on a map of fields in relation to context and process, from *symbolic* to *real*, and from *analytic* to *synthetic* (Figure 13).

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Figure 13. Knowledge fields model (Owen, 2007, p. 17)

Beckman and Barry (2007) compared Owen's model to Kolb's (1984) cyclic experiential learning theory model which promoted the role of *experience* in learning through four stages. The two models were then synthesised to present a new, cyclic, design thinking, innovation process model, illustrated in Figure 14, that integrates a series of cognitive thinking styles, and key modes/stages of design thinking.

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Figure 14. Learning styles model of design thinking (Barry & Beckman, 2008, p. 44)

This model provides a framework that can assist the conceptualisation of appropriate design thinking learning outcomes and of learning and teaching methods that align with those outcomes.

Having described *multi-epistemic* modes of design thinking, Eagen et al. (2011) explored pedagogical models that they believed were needed to teach design thinking in business education contexts. The *multiple ways of 'knowing'* that they identified included *emotion, sensation, intuition, imagination,* and *interrogation.* With these modes in mind, they considered the role and implications of teaching intuition and empathy, use of action learning, and the necessity for pedagogical shifts to successfully embed the teaching of design thinking in business schools. These shifts included a move from lecture to studio-based learning, encouraging students to think beyond the knowledge of the teacher to create something *new*, the use of action learning cycles using reflection, questioning, conjecture and refutation, and encouraging collaboration. It appeared that Eagen et al. (2011) did not go on to develop and evaluate a programme based on these proposals.

Dym et al. (2006) examined opportunities and issues associated with integrating design thinking into engineering education. They suggested a number of frameworks including project-based learning (PBL), effective enquiry, and divergent and convergent questioning processes as useful approaches to enable this to happen. They outlined the complexities involved in introducing design thinking to engineering education, and identified strategies for getting students to work in teams, assessing work, and engaging faculty members in a design thinking pedagogy. These strategies appeared to have foundations in constructivist, knowledge generation models of design thinking, but acknowledged the *multi-epistemic* nature of design thinking, and identified some of the issues associated with bringing design thinking into non-design contexts.

2.9 Examples of design thinking curriculum

A number of examples of university-level design thinking curricula that have been implemented were identified. Most of these presented the views of curriculum designers, and teachers, and insights gained from teaching design thinking.

In 2008, Melles and colleagues at Swinburne University initiated the development of a design thinking course, as part of a minor in design management, which aimed "to introduce students to concepts and methods associated with design thinking in a range of design and non-design contexts" (Melles, 2008, p. 305). The development of the curriculum was informed by a review of literature on design thinking and of precedents for such courses. The course, which was introduced in 2011, was one semester long, and both literature- and project-oriented. The learning activities included participation in lectures and tutorials; reviewing readings; use of multi-media resources, including those from the Stanford University d.school bootcamp manual (d.school, 2010), and group projects that focused on 'real-world' problems that were occurring in on-campus locations. Students applied the d.school process model when engaged in their projects (i.e. Empathy – Define – Ideate – Prototype - Test). The assessment tasks included a review of design thinking literature, project reports and a reflective learning blog (Melles, Howard, & Thompson-Whiteside, 2012; Melles & Misic, 2011).

Melles and Misic (2011) subsequently provided useful reflections on the students' response to the course, and reported on a number of lessons learnt. These included the difficulties of teaching a course on design thinking for the first time. The difficulties included the students' initial tendency to default to rather limited product, interface or spatial based solutions, rather than solutions encompassing a broader system and organisational perspective; the students' general inability to critically engage with literature and write a literature review; and a lack of time for students to fully develop and test their proposals. A more systematic evaluation of this initiative was underway.

Cahen (2008) outlined the development and prototyping of a one-week design thinking workshop. The concept of design thinking was linked to Creative Problem Solving (CPS) theory and the Torrance Incubation Model of Teaching and Learning (TIM) was drawn on when developing the pedagogy. As with the previous example, the Stanford University d.school bootcamp model (d.school, 2010) provided a framework for the curriculum. Cahen reflected on the success of the workshop and identified a number of key issues and their learning. The latter included an account of the positive role that experiential learning and application of the TIM-based pedagogy played in helping non-designers in the workshop gain an understanding of design thinking. The report includes anecdotal accounts accompanied by personal reflections rather than research-based findings and insights.

Rauth et al. (2010) examined the frameworks and methods of design thinking courses taught at the d.school at Stanford University, California and the d.school at Potsdam in Germany. Findings indicated that a linear process model that introduced students to various modes of design thinking was used initially to help them understand and internalise key design thinking concepts. As students developed confidence, the complexity of projects was increased, and students were encouraged to work more iteratively and flexibly. “Teachers reported that it is their purpose to change student’s behavior from a process-led thinking to a more creative and situation-based mode of working” (Rauth et al., 2010, p. 5). Teachers agreed that mindsets were important in design thinking education, although most teachers struggled to explain the concept. “It appeared to us, that the concept of mindsets in design thinking education is still new and not fully explored nor defined” (Rauth et al., 2010, p. 5). The development of students’ creative confidence was reported as a key outcome of the d.school design thinking education. This required students to be continuously exposed to creative challenges and to be prompted to question more and more of the initial beliefs.

Koria et al. (2011) outlined a two-year Master’s-level design thinking programme developed for the International Design Business Management programme of Aalto University, based on problem and practice-based learning approaches, and the use of authentic, industry design tasks, with courses in business studies, engineering, art and design. The programme was based on a conceptualisation of design thinking developed by Hassi and Laakso (2011), which categorised design thinking into various practices, cognitive approaches and mindsets illustrated in Figure 15 below.

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Figure 15. Design thinking framework (Hassi & Laakso, 2011, p. 6)

The epistemological perspective that underpinned the programme emphasised the role of *abductive reasoning* and *reflective* practice, rather than inductive and deductive reasoning. A culture of collaboration and authentic 'real-world' projects were considered key drivers for learning design thinking at postgraduate level. However, they also observed that "collaborative work is both the key vehicle for innovation to happen and at the same time the key challenge in terms of learning needs" (Koria et al., 2011, p. 7). Collaboration-related challenges that they identified included building a common language and approach when team members have varied discipline backgrounds, and the need to build trust in the relevance and depth of each team member's knowledge and experience. In response, they described the careful design of each intervention, and how the modelling of collaboration was essential to the success of each of the projects. This included having facilitators with cross-cultural and multi-disciplinary experience, to efficiently and competently mentor teams.

Davis (2010) outlined key lessons from teaching design thinking in an experimental elective course to business students at the University of Louisiana at Lafayette, BI Moody College of Business. Davis argued the business students and design students are very different in their learning habits and styles, and it was important to consider the factors that may inhibit business students' creative thinking. These factors included perceptions of not being creative that there is only one answer, wanting perfection, innovation is something you do alone, and a general fear of failure. He provided key ideas, based on his own experience, that underpin design thinking, including the ability of everyone to be creative if they desire, the need to create a place for creativity to occur, failing early and often, curiosity, collaboration, and a questioning approach. Davis outlined teaching strategies and methods used in the teaching process including the key stages of the design thinking process and associated methods. He also argued that it was important that the new design thinking methodology took into account the business student's traditional model of learning, which emphasised identifying and achieving measurable outcomes, and to provide assessment procedures that were familiar. With respect to the latter, he also noted that getting students to keep a process book was very important as a means of documenting work for later review and reflection.

Wang and Wang (2011) described the teaching of design thinking to Master's level information technology (IT) students, to help them develop what they termed higher order thinking skills. They called this approach JAP (Joint Analysis Process), which was underpinned by a combination of two learning pedagogies, analysis and team collaboration. JAP is a multiple-team-based teaching method comprising a series of iterative cycles of knowledge-sharing sessions that have to result in a consensus among the students instead of unconstrained discussion or debating. They reported it was important to facilitate team building with groups of between 30 and 40 students, integrate knowledge learned from other disciplines, and use a mixture of teacher and student grading. They also reported a high level of student satisfaction with their learning approach to design thinking.

Collectively, the above analysis offered further useful insights for my development of a design thinking curriculum and again alerted me to possible issues and challenges associated with implementation and students' response to new pedagogy. The latter included:

- Issues with orienting students to design thinking.
- Preconceptions that students may have about a lack of creative ability or fear of failure.
- The limitations of students' ability to think beyond existing frameworks such as product/spatial-based solutions.
- Developing and managing effective team collaboration.

At the same time, a number of possible strategies to overcome such challenges were proposed. These included introducing design thinking as a linear sequence of processes, and then subsequently encouraging students to use particular processes and practices more flexibly and iteratively. Other strategies were:

- The use of experiential and authentic learning processes such as reflective practice, and 'real-world' problems.
- A focus on building students' abductive reasoning and collaboration capabilities;
- The role of team facilitators to help manage teams.

- Bridging design thinking pedagogy with traditional models used in business schools including aligning assessment tasks that provide measurable outcomes.

2.10 Research-based evaluation of design thinking education

Four research-based evaluations of design thinking curriculum initiatives were identified.

Goldman et al. (2012) described a research project at Stanford University that explored the learning of design thinking, specifically how the assessment of students' progress contributes to the learning process. The research used a reciprocal research and design (RR&D) process and methodology that was oriented around experiential and socio-cognitive views of learning. They argued that the "human-centered focus of design thinking, and the deep and radical collaborations that define the process provide a deeply social process for learning" (p. 19). Using RR&D, the goal was to develop tools that could help assess what students were learning in the design thinking programmes. The findings from prior studies on assessing the learning of design thinking were considered first and an assessment rubric developed that focused on four key design thinking mindsets: *human-centred, experimental, collaborative*, and *metacognitive*. The authors acknowledged that these mindsets all have clear epistemological viewpoints, and are always in a state of flux. Ways of assessing a shift in a student's mindset, termed a 'mindshift', were considered, and a number of related assessment tools developed including an assessment matrix, based on ongoing observations of expert and novice designers. The matrix consisted of skills, processes and mindsets related to design thinking and assessment across three levels of expertise. A dashboard (Figure 16) was developed to help students and teachers track learning.

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Figure 16. Design thinking learning dashboard (Goldman et al., 2012, p. 29)

This research provided some insights into the conceptualisation of design thinking, the framing of learning outcomes as *shifts in thinking*, and the complexities involved in trying to assess these outcomes. Given that this was the first piece of research, and first use of the tools, the authors indicated that future research would further investigate the usefulness of the tools in documenting students' skills and mindshifts in design thinking, and whether they are useful across a variety of educational settings, and with groups rather than individuals.

Bruton (2010) described both the development and evaluation of a curriculum for an entrepreneurial venture design studio, based on the principles of design thinking. The course was based around a number of principles that positioned design thinking as interdisciplinary and combinatory, requiring relentless prototyping, and producing outcomes that involve a narrative or story. Bruton described a curriculum development framework building on the work of on Alberti, Sciascia, and Poli (2004). This involved categorising the knowledge that students would develop in the course as *functioning knowledge*, defined by Biggs (2003) as *knowledge within the experience of the learner that is based on a performed understanding.* This is illustrated in Figure 17.

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Figure 17. Relationships between different types of knowledge. Adapted by Bruton (2010), from Biggs (2003)

The goal of the evaluation was to fully understand students' perspectives throughout the learning process, based on survey feedback from students, although no detailed description of the data collection and analysis process was provided. Bruton reported that the students' responses to the introduction of the curriculum was overwhelmingly positive and students "frequently express a desire for the approach, their preference for the enacty medium and their feeling of gaining skills relevant to their careers and new ventures; students were able to meet or exceed all learning objectives to do with toolset, mindset and network building, and collaborative knowledge creation" (Bruton, 2010, p. 27). In addition to the knowledge development of students, the researcher noted that, based on teacher and industry judge feedback, the resulting new venture concepts using design thinking were considerably more innovative and feasible, than had been those resulting from other approaches.

Bruton's research, which appeared to be underpinned by both constructivist and pragmatist views of design thinking and education, provided useful insights into, and a potential model for, the conceptualisation of curriculum, as well as a useful development framework, and categorisation of design thinking knowledge. In addition, it also provided useful assessment and outcome evaluation models.

Building on a conceptualisation of design thinking as a process of knowledge construction and learning, Thoring and Müller (2011) reported on research that categorised the types of design knowledge developed by students using case studies from the d.school design thinking programme at Stanford University. Over a period of three years, the researchers observed student projects to identify and assess how information was exchanged, stored, or created within the student teams using a typology of design knowledge developed by Thoring and Müller. The typology followed a broad, pragmatic view of knowledge, where all patterns that enable actions or decisions are conceptualised as knowledge. The typology was used to track and map the design knowledge developed by students through the d.school design thinking process, using participatory observation from team members and an independent observer.

Informed by the findings, Thoring and Müller created a theoretical model (figure 18), that aimed to demonstrate that new knowledge is generally created in one of three transitions, by transforming one type of knowledge to another one (Thoring & Müller, 2011).

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Figure 18. Mapping design thinking process steps to knowledge types (Thoring & Müller, 2011, p. 5)

These findings have provided some deeper insights into the design thinking process, particularly types of knowledge generated and used, and could potentially help teachers to plan and manage these knowledge transition points for students.

While validating design thinking as a useful approach, the work also provided a useful framework of design thinking competencies as cognitive, attitudinal, and practice-related. It also highlighted the struggles that some teachers, not familiar with constructivist approaches, which are central to design thinking, may have in teaching design thinking, and the need for good teaching recommendations and resources.

SECTION THREE: OVERALL CONCLUSIONS

In the course of this review I identified gaps and limitations in existing research on design thinking programmes that I considered I should address when conceptualising and designing my research.

2.11 Gaps and limitations in existing research

Only three examples of rigorous, research-based evaluations of design thinking educational programmes or curriculum were identified (Bruton, 2010; Goldman et al., 2012; Thoring & Müller, 2011). I noted that none of these specifically involved the design, evaluation and further development of a university-level curriculum through a number of iterative cycles. In addition, I identified that there was no research that specifically:

- Investigated concurrently the multiple perspectives of students, teachers and the curriculum developer.
- Compared the perspectives of students from different educational backgrounds, such as design and non-design students.
- Utilised combined action research and case study methodologies.
- Was founded on a critical realist paradigm position (apart from Di Russo and Feast's more general research in 2013 into design thinking that utilised critical realism).
- Provided comprehensive recommendations for the teaching of design thinking at university level.

In addition to these gaps, there were limitations in these three studies, or their reports, that I considered I should address.

- The underlying concepts of design thinking and associated theories were not presented.
- Other than Thoring and Müller (2011), they were one-shot investigations rather than sustained and iterative investigations.
- They focused on selected outcomes of the design thinking curriculum or educational programme under investigation, such as student development of knowledge, shifts in mindsets or other skills, rather than a more holistic set of outcomes associated with design thinking expertise.
- Evaluation mainly focused on tendencies in students' responses, rather than the systematic development of explanatory theory concerning the relationship between these tendencies and features of the learning environment. There were no instances where a critical realist theorising methodology was used for this purpose.

2.12 Research opportunities

In response to this critique, I developed a research project that aimed to:

- Design and evaluate a university-level design thinking curriculum.

- Conceptualise key phenomena using a critical realist ontological perspective and relevant theories.
- Provide a rich description of curriculum enactment and its effects across different contexts using varied forms of data gathered from multiple perspectives including curriculum designer, teachers, design students and non-design students.
- Apply a critical realist theorising methodology to develop explanatory theory concerning the relationship between the learning environment, as influenced by the curriculum, and student learning processes and outcomes.
- Make changes to the curriculum in the light of explanatory theory and assess their consequential effect on students' learning.
- Iteratively repeat the design (action) and evaluation (research) process to further improve the curriculum through a number of cycles.

As previously noted, critical realism was the paradigm position that underpinned this research. Critical realism most closely aligned with my personal ontological and epistemological views, and coincided with my personal interest in identifying and understanding the underlying factors that may be causing 'things' to occur. Critical realism also appeared to offer frameworks and processes that could assist me to investigate and understand the complexity of learning and teaching and for generating explanatory theory, and to go beyond tendencies in students' responses. I also noted that the use of critical realism in educational research was growing, and that while no one had utilised critical realism as a foundation for the design and evaluation of a design thinking curriculum, there were some precedents for its use in curriculum-related research. My research might contribute to a growing body of knowledge about the use of critical realism in this area of education research. In addition, I also noted that it could provide further insights into use of action research and case study methodologies for the design and evaluation of university-level curricula.

Finally, I concluded that it would be important that the findings of the research resulted in a practical and optimised design thinking curriculum, as well as a deeper theoretical understanding of design thinking and design thinking education.

2.13 The next chapter

In the next chapter I introduce and explore fundamental concepts of critical realism, the paradigm orientation that I selected for my research. I also outline my initial thoughts regarding the implications of critical realism for my conceptualisation of key phenomena associated with the project, including design thinking, learning, learning environment and curriculum.

CHAPTER THREE: PARADIGM POSITION, IMPLICATIONS AND KEY CONCEPTS

In this chapter, I outline the ontological and epistemological orientation that I selected for my research, which was critical realism and its overall implications for conceptualization of the phenomena that I investigated and aspects of research design. I also present my initial critical realism based concepts of key phenomena, including design thinking, learning, learning environments and curriculum.

3.1 Background

In the previous chapter, I noted that it was important for me to identify my paradigm orientation as it would underpin my development of a design thinking curriculum and my conceptualisation and design of the research. As noted in the previous chapter, I identified critical realism as the paradigm orientation that I would adopt because it appeared to most closely align with my own personal worldviews and my interest in identifying and understanding the factors that may be causing 'things' to occur. In this instance, I wanted to understand both *how* students responded to the curriculum and *why* their responses occurred. Critical realism also offered useful frameworks and processes for investigating complex phenomena and for generating 'best guess' explanations for specific outcomes and overall tendencies in outcomes. These processes included the use of abductive and retroductive reasoning. In addition, given the prevalence of constructivist/constructionist views in recent conceptualisations of, and research into, design thinking and design thinking education, critical realism offered a distinct and fresh new research perspective[5].

3.2 Overview of Critical Realism

Critical realism is a relatively new philosophical orientation and approach for researchers that offers an alternative to the long established paradigms of *objectivism*/*positivism* and *subjectivism*/*interpretivism*. In this section, I provide a brief outline of critical realist perspectives in relation to ontology, epistemology and methodology. While there are some variations in views about the basic concepts and propositions of critical realism, those adopted within this project are essentially derived from the work of Roy Bhaskar (1978, 1979), who was the initial, and most influential, developer and proponent of critical realism.

[5] While I have noted that the use of critical realism is new, I have previously identified two examples of research that incorporate critical realist views about design and design thinking.

3.2.1 Ontology

Ontology can be described as the understanding of *reality* and what is *knowable* (Pratt, 2011; Sobh & Perry, 2005). Critical realism entails a deep ontological belief in an external world that exists and acts independently of our knowledge of it, or beliefs about it (Bhaskar, 1978). This is a *realist* ontological position. While *positivism* proposes a single knowable reality, and *interpretivism* proposes multiple mind-dependent realities, critical realism postulates that there are multiple perceptions about a single, mind-independent reality (Healy & Perry, 2000).

Critical realists believe that there is a real, but *imperfectly apprehensible*, world out there to discover (Sobh & Perry, 2005), and reality is complex and changing (Pratt, 2011). For example, social structures are real in that they persist in time and space, exist independently of the knower, and have causative influences on social events and the actions of people. In this sense, critical realism offers a unique *model for discovery*. For critical realists, “the ultimate goal of research is not to identify generalisable laws (positivism) or to identify the lived experience or beliefs of social actors (interpretivism). Rather, it is to develop deeper levels of explanation and understanding” of reality (McEvoy & Richards, 2006, p. 67).

Critical realist understandings of reality are further elaborated by the following interrelated concepts. The concepts I describe are largely based on the work of Bhaskar (1978); (Bhaskar, 1979); C. Brown (2007); Easton (2010); Elder-Vass (2004); Fleetwood (2009); Hood (2012); Houston (2001); Morén and Blom (2003); Pratt (2011).

3.3 Ontological stratification

Critical realists have an ontological belief in a world or reality that is both *differentiated* and *stratified*, consisting of three domains: the *empirical* domain*,* the *actual* domain, and the *real* domain.

- The domain of the *empirical* represents people’s individual experience of events.
- The domain of the *actual* is concerned with events and outcomes resulting from the generative powers of objects and their associated structures and mechanisms. These events may, or may not, be observed or experienced by people.
- The domain of the *real* consists of objects that have structures that possess generative mechanisms. These are not observable, but their effects may be experienced or observed.

Figure 19 visually describes a stratified reality with differentiated but nested domains.

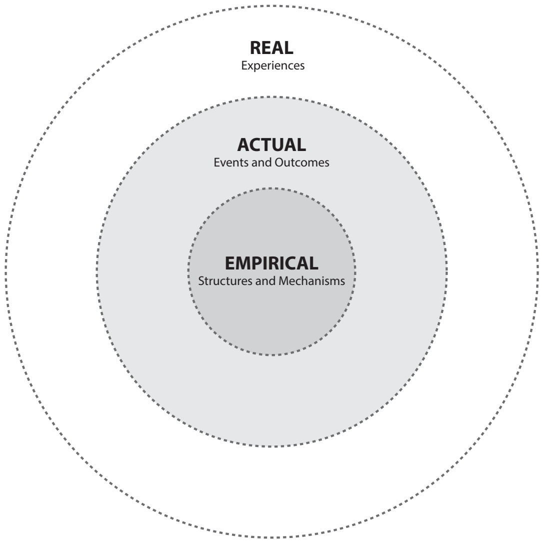

Figure 19. Model of nested domains

3.4 Entities/Things (Objects or Phenomena)

'Things' or entities can be *physical, material, cultural/ideational* and *practices.* Entities in the social world include people, positions/roles, relationships between *people* (e.g., student - teacher)*, organisations, policies, plans, rules, laws, beliefs, information systems, technologies, learning, teaching,* and *mentoring.* While defined and perpetuated by existing structures, these entities require human agency for their existence, and to activate their mechanisms. Some entities, such as *social relations*, depend on more than one object for their existence. *Positions, roles and practices* are examples of 'internally related' entities in social relationships. It is important to differentiate between things, their properties and their powers.

3.4.1 Structures

Entities are not 'empty shells', but have an intrinsic constitution or structure. In this way, entities may also be formed into an assemblage, either interrelated and/or interdependent, and called a structure. Structures are defined by a set of necessary relationships between these objects. An example is a social structure such as a student work group. Structures are more than the sum of these parts (i.e., the structure has emergent properties). Structures can be conceived of as nested and layered (stratified), interconnected, and interactive. Structures may have more or less stable properties.

3.4.2 Semi-open and open systems

Systems are closed, semi-open or open assemblages of entities and structures. For example, a social organisation may be considered an open system that comprises an amalgam of entities, such as departments, people, processes, and resources, all of which affect each other.

3.5 Attributes/properties of entities and structures

Entities and structures can be described as *having* particular attributes or properties, or ways of *being*. For example, attributes may include *having* particular bio-molecular properties, *being* cold, being extended in space, having knowledge about something, being a certain age, having a level of developmental maturity, having visual acuities or impairments, having employees or being a particular size.

Certain attributes or properties of entities or structures give them powers in the form of mechanisms (ways of acting/powers), which can generate events and outcomes. The attributes of an entity also determine its 'susceptibility' to the influence of the mechanisms of other entities. In addition, while entities are susceptible to the causal mechanisms of other entities they can also be independent of other entities.

3.6 Mechanisms/powers

Bhaskar has described mechanisms as "nothing other than the ways of acting of things" (Bhaskar, 1978, p. 14), the causal powers of things" (Bhaskar 1978, p. 50). Bhaskar (1975), observes that:

> The world consists of mechanisms not events. Such mechanisms combine to generate the flux of phenomena that constitute the actual states and happenings of the world. They may be said to be real, though it is rarely that they are actually manifest and rarer still that they are empirically identified by men *(sic)*. They are the intransitive objects of scientific theory. They are quite independent of men *(sic)* - as thinkers, causal agents and perceivers. They are not unknowable, although knowledge of them depends upon a rare blending of intellectual, practico-technical and perceptual skills. They are not artificial constructs. But neither are they Platonic forms. For they can become manifest to men *(sic)* in experience. Thus we are not imprisoned in caves, either of our own or of nature's making. We are not doomed to ignorance. But neither are we spontaneously free. (p. 47)

Other examples of critical realist definitions of mechanisms include, “ways in which structured entities by means of their powers and liabilities act and cause particular events” (Easton, 2010, p.122), and “capacities to behave in particular ways (Sayer, 2000, p. 11).

Mechanisms can be physical, social or cognitive. Mechanisms are real, but not necessarily tangible or directly observable. Mechanisms, if not already activated or exercised, can be considered as latent. In addition to activated or exercised, mechanisms are also said to be *in operation, in play, endured without activity, lack motion, be dormant, be held in abeyance* and so on.

3.7 Mechanisms, conditions, and effects

While the attributes or properties of something (e.g., a student) will determine whether or not it has particular mechanisms, there are further conditions that can determine whether those mechanisms are exercised or not.

For example, for many human mechanisms, such as *running or collaborating*, one of those critical conditions is the attribute of ‘agency’. Agency can be described as the capacity of an ‘agent’ (such as a person), to act in a world. For example, people vary in their ‘sense of agency’ with respect to exercising their learning-related mechanisms. Agency means that people have the power to reproduce or change the attributes of other entities or to create new entities. Bhaskar (1982) described the interplay between individual agency and social structure. “Society is not the unconditioned creation of human agency (voluntarism), but neither does it exist independently of it (reification). And individual action neither completely determines (individualism) nor is completely determined by (determinism) social forms” (p. 286).

A further condition is the exercising of the mechanisms of other entities, such as the mechanisms of teachers, institutional learning and teaching policy, or other students. These mechanisms may trigger, turn off, constrain, and block a student’s learning mechanisms.

The outcomes or effects of mechanisms do not occur ‘spontaneously’. Mechanisms are exercised in real space and time to produce (cause) a given effect. Critical realists seek to explain ‘tendencies’ in these effects by identifying the underlying ‘causal mechanisms’. Whether particular effects occur (e.g., whether intended learning outcomes are achieved) will be determined by contextual factors, such as whether:

- An entity has attributes or properties that give it the power to act in a particular way (e.g., to imagine).

- The attribute of agency is a pre-requisite for exercising particular mechanisms (e.g., the student's imagining mechanisms).
- An interdependent set of mechanisms are successively and concurrently activated (e.g., perspective taking, procedural knowledge construction, and cognition mechanisms).
- The interactions occurring between mechanisms within and beyond the entity are an affordance (enable) or hindrance to (constrain) the likelihood of particular outcomes occurring.

In addition, there are other conditions such as duration, timing and sequencing of the exercise of multiple mechanisms that will determine whether particular effects occur.

3.8 Causality

The concept of *causality* is key in critical realist research. Critical realism stresses the importance of developing theory that explains unobservable structures and recognises the reality of associated causal mechanisms.

It is important to note that, given the complexity of open systems, the interactions of one mechanism will influence the operation of others, so that the outcomes of any intervention are never that predictable. Mechanisms produce only 'tendencies' that can be counteracted by other mechanisms. In identifying these tendencies, the researcher needs to ask, what produces it, what generates it, what determines it?

Figure 20 presents a critical realist causal model adapted from Sayer (2000). The model describes the relationship between entities and conditions (such as attributes), which give mechanisms (powers) to generate outcomes.

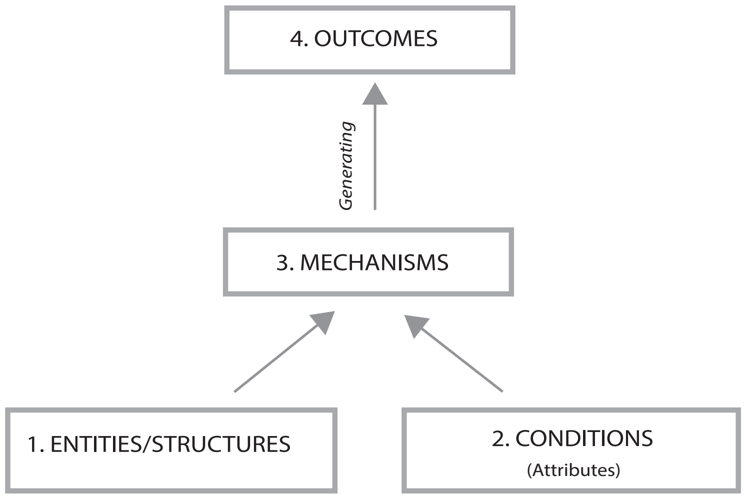

Figure 20. Critical realist causal model. Adapted from Sayer (2000, p. 15)

3.9 Epistemology

Epistemology is comprised of the views about the relationship between *reality* (what is knowable) and the knower (Pratt, 2011; Sobh & Perry, 2005). Critical realists take a relativist epistemological position. A relativist position entails a belief that truth or reality is relative to the knower's conceptual schemes, which can be referred to as frameworks, paradigms, worldviews, and perspectives. This means that the truth or reality is not absolute, objective, and universal, but rather varies with the conceptual scheme(s) being employed. Critical realists also take the view that 'truth' might be understood in terms of its practical adequacy. That is, in terms of the "extent to which it generates expectations about the world, and about the results of our actions which are realized. Just how practically adequate different parts of our knowledge are will vary according to where and to what things they are applied" (Sayer, 2000, p. 43). This means that it is not possible to know - with certainty.

3.10 Axiology

"Critical realism assumes a transcendental realist ontology, an eclectic realist/interpretivist epistemology and a generally emancipatory axiology" (Easton, 2010, p. 119).

The emancipatory agenda of critical realism (Easton, 2010; Kotta, 2011) aligns with my own principles and values. I have a passion for using research to assist in developing positive, empowering learning environments that help students develop attitudes and values, as well as cognitive capabilities that will enhance their lives. In addition to the general values associated with design thinking, such as empathy, human-centeredness and emancipation, I believe that designers and design thinkers have a responsibility to positively contribute to the economic, social, cultural and health wellbeing of individuals, businesses and society. In addition, I value honesty, transparency, as well as effective communication and collaboration in research.

3.11 Methodology

For critical realists, the primary purpose of research is the formulation and testing of propositions concerning causal or generative mechanisms, and their interplay and effects. "This is the arduous task of science: the production of the knowledge of those enduring and continually active mechanisms of nature that produce the phenomena of our world" (Bhaskar, 1975, p.47).

This stance reflects the view that the attention of researchers should shift from events alone to mechanisms as well.

> To switch from events to mechanisms means switching the attention to what produces the events – not just to the events themselves. Reality is here assumed to consist of several domains. One of these is that of mechanisms. These mechanisms sometimes generate an event. When they are experienced they become an empirical fact. If we are to attain knowledge about underlying causal mechanisms we must focus on these mechanisms, not only on the empirically observable events. (Danermark, Ekström, Jakobsen, & Karlsson, 1997, p. 5)

Critical realist research frameworks are inclusive and comprehensive. Critical realists generally take a pragmatic position in relation to research methodology and data gathering and analysis methods. This position reflects a belief that a mix of data types, both quantitative and qualitative, and forms of methodology and methods may well be required to address particular research problems or questions. Thus, critical realism has a foothold in the mixed-methods or 'methodological pluralism' camps (Cameron, 2011; Christ, 2013) and 'triangulation' is endorsed because it provides a 'family' of answers (Pawson & Tilley, 1997) "that covers its reality's several contingent contexts, to capture a single, external, and complex reality" (Sobh & Perry, 2005, p. 1203).

While critical realism accommodates mixed methodologies and methods, given its emphasis on the construction of explanatory theory, several researchers have proposed critical realist theorising methodologies and methods. For example, Danermark, Ekstrom, Jakobsen, and Karlsson (2002) identify the following steps that differ in purpose and related processes including: *description, analytical resolution, abduction/theoretical redescription, retroduction,* *comparison between different theory and abstraction, concretization and contextualizatio*n. Similarly, Bygstad and Munkvold (2011) identify: *description of events, identification of key component, theoretical redescription/abduction, retroduction/identification of candidate mechanisms, analysis of selected mechanisms and outcomes, validation of explanatory power.*

A distinctive feature of these methodologies is the use of abductive and retroductive reasoning in the analysis process (Christ, 2013).

3.11.1 Abduction

Abduction "maintains an explanatory function, a (re)description and (re)contextualisation of data used to gain knowledge about the interconnected workings of complex social phenomenon" (Christ, 2013, p. 114). While it involves analysing data without using an initial theoretical frame or premise, and along with retroduction, is used extensively in critical realist research (Meyer & Lunnay, 2013), extant theory may be drawn on to prompt ideas about possible social entities, their mechanisms, attributes, and interconnections. Abduction can be described as a way of forming associations that enable the researcher to identify relationships and connections, which are not otherwise evident or obvious, and allow the researcher to formulate ideas, and conceive of something in a different context (Danermark et al., 1997; Meyer & Lunnay, 2013). It also involves a "creative, imaginative or insightful moment in which understanding is grasped" (Lipscomb, 2012, p. 244). Curedale (2013) also described abduction as an *inference* to the *best explanation* for something.

3.11.2 Retroduction

Retroduction, on the other hand, is a method of conceptualisation which requires the researcher to identify the circumstances without which something (i.e., the concept) cannot exist (Meyer & Lunnay, 2013), or in other words, the 'conditions' fundamental to the existence of a phenomenon (Danermark et al., 1997). Retroduction moves the researcher from a documentation of observations and lived experiences, the domain of the *actual*, through the domain of the *empirical*, and to postulate about the underlying causal mechanisms that account for the phenomena involved in the domain of the *real* (McEvoy & Richards, 2006). Strategies for engaging in retroduction include transfactual questioning, and case study.

Transfactual questions such as, "what essential conditions of reality must exist for this research object to be possible?" are intended to move the researcher's thinking beyond empirical data, such as the research object, to consider or postulate the possible causal mechanisms (Crawford & Wright, 2010).

I adopted a modified version of these theorising methodologies for this project and the related steps are elaborated and illustrated in Chapter Four, Research Design.

3.12 Key phenomena from a critical realist perspective

It is a long-established convention that researchers should define key phenomena/related terms as part of the process of conceptualising a research project. In this instance, I wished to define phenomena that I was investigating from a critical realist perspective. Phenomena that I decided I should define at the outset of the study included design thinking, learning, learning environment, learning and teaching, structure and agency and curriculum. For each construct, I reviewed literature to identify whether critical realist based definitions already existed. In some instances they did. For others, I could not locate such definitions or they were implicit rather than explicit in literature, and needed further consideration. In the following commentary, I review and discuss these constructs, and state the definitions that I adopted before I began to finalize development of the cycle one curriculum. It is important to note that I critiqued and developed these definitions further on the way through the study, and I present my end-of-project versions in Chapter Ten: Discussion. This work makes an important contribution to the outcomes of the research.

3.12.1 Design thinking

As indicated in the literature review, I could identify no critical realism-based concepts of design thinking. On the basis of my emerging understanding of the ontological perspective of critical realism, I constructed a conception that is summarised in Table 3.

Table 3. Initial conceptualisations of design thinking from a critical realist ontological perspective

Critical realist perspectives	Relationship or alignment with design thinking
Phenomenon	Design thinking is a phenomenon (a framework, structure or system).
Axiological position	Emancipation, as a key concern of critical realism, aligns with some of the key drivers of design thinking, including: • empathy for other people; • human-centeredness; and • a motivation to improve other people’s lives through design.
Discovery/causality	Design thinking is concerned with discovering underlying causality within complex problems.
Entities	Entities associated with design thinking may include the *design thinker, the user/customer (or groups of), other stakeholders, resources, physical objects, ideas and concepts, techniques,* and *tools.* All entities have attributes (properties) and mechanisms (powers).

Attributes/properties	The design thinker (as a key entity) has attributes, such as *mindsets* and *knowledge*, and other attributes such as *agency*, that enable or constrain various design thinking and other mechanisms. Some of these attributes, which may be learned, give them powers that may be exercised.
Mechanisms/powers	A design thinker exercises various mechanisms during the process of design thinking, such as: • Collaboration • Looking, feeling and empathising • Cognition and problem reframing • Abduction • Creativity • Construction and prototyping.

3.12.2 Learning

Critical realism provides a relatively clear ontological position for education, based on the notion that the objects of our knowledge in the *natural* and *social* worlds exist whether or not we have knowledge of them. “This gives us the fundamental distinction between the *intransitive* world (natural and social) and our *transitive* knowledge of them” (G. Brown, 2009, p. 15). In other words, entities in learning environments, including physical objects, language, and tacit rules in group activities, all exist whether someone has knowledge of them or not. Knowledge of them is, however, constructed through *work* and is *contingent,* and there are *variations* in the knowledge that individuals construct.

For critical realists, learning is a process whereby the attributes (properties) of a person change. The attributes that may change through the exercise of learning mechanisms include biological, social, and psychological (including knowledge) attributes (G. Brown, 2009). Supporting this view, Luckett and Luckett (2009) suggested that “learning … involves ‘deep transformation’ of cognitive structure, identity and social structure” (p. 470). This could be defined as new knowledge, thinking and conceptual change, but also new ways of doing things and new ways of ‘being’. During the learning process, learners exercise (learning) mechanisms that change these attributes.

Brown (2009) also noted that traditional educational theoretical approaches such as *objectivism* and *constructivism* do not account for the range of knowledge across learning and teaching. In contrast to these positions, he stated “learning is better understood, not as a process grounded in empiricist or idealist conceptions of knowledge, but as emergent from ontology: a phenomenon emergent from an ensemble of mechanisms” (2009, p. 6). Brown proposed critical realism as an alternate orientation to education phenomena and for educational research, and stated that in contrast to *objectivism* and *constructivism*, “in critical realism it is the ontology that enables and constrains the acquisition of knowledge, that is, learning" (p. 14).

I also took into account other conceptions of learning that I considered could have implications for my concept. Literature concerning theories of learning usually differentiates concepts that stem from particular paradigms and/or that are associated with broad categories of phenomena. Thus, concepts/definition have had a foundation in Behaviourism, Cognitivism, humanism, social learning and constructivism. A summary of these key learning theories, adapted from a taxonomy developed by Ashworth, Brennan, Egan, Hamilton, and Sáenz (2004, p. 2) is presented in Table 4.

Table 4. Summary of key learning theories. Adapted from Ashworth et al., (2004, p.2)

Concepts	**Behaviourist**	**Cognitivist**	**Humanist**	**Social learning**	**Constructivist**
View of the learning process	Change in behaviour	Internal mental processes (including insight, information processing, memory, perception)	A personal act to fulfil potential	Interaction with, and observation of, others in a social context, Situated learning, communities of practice, distributed cognition	Construction of meaning from experience
Locus of learning	Stimuli in external environment	Internal cognitive structuring	Affective and cognitive needs	Interaction of persons, behaviour and environment	Internal construction of reality by individual
Purpose of education	Produce behavioural change in desired direction	Develop capacity and skills to learn bette	Become self-actualised, autonomous	Model new roles and behaviour	Construct knowledge

Some of these concepts can be re-interpreted from a critical realist perspective. For example, social learning perspectives emphasise contingent relationships between mechanism exercised by a learner and those of other learners that they are collaborating with, or have other relationships with.

I constructed the following initial definition based on my emerging understanding of critical realist ontological persepctives:

> *Learning is a change in a student's attributes which is emergent from their activation of various learning-related mechanisms. Their exercise of these mechanisms is enabled or*

constrained by their personal attributes and the mechanisms of other entities including the teacher.

3.12.3 Learning environments

G. Brown (2009), while acknowledging the relationships of critical realism to existing theories of learning from Vygotsky (1978) and other situated cognition theorists, foregrounded the ontology of learning environments as important when exploring critical realist concepts of education and learning. “The learning environment is not merely the context or the location of learning: it is the logical precursor to learning” (G. Brown, 2009, p. 6). He proposed that learning environments consist of tiered (stratified), relational and changeable physical, biological, social and cultural entities, whose properties give rise to a complex assemblage of causal mechanisms that enable and constrain learning.

> Thus, for example, learning is enabled and constrained by the lighting, heat, time of the day, time in the week and spatial layout of the classroom (mechanisms operating at the physical level), by whether the children are hungry or sated, tired or alert, well or unwell (mechanisms operating at the biological level), and by the learner’s motivation, aptitude and confidence (at the psychological level) (G. Brown, 2009, p. 24).

G. Brown (2009) also explained that learning environments make knowledge of the natural and social world possible, as they are open or, at most, semi-closed systems. He also proposed that learning environments are semi-permanent and often episodic, and are ‘moral’ environments because they involve values.

Reinforcing this view, Elder-Vass (2012) explained that learning events are caused by multiple, interacting causal powers of individual persons and the powers of social structures within learning environments. Collectively, mechanisms (powers) operating in a learning environment, and working on multiple levels, “interactively determine learning, but learning, which is emergent from them, cannot be reduced to any particular element or level” (G. Brown, 2009, p. 26). These findings suggested that when researching, and understanding learning environments as open systems, researchers need to be particularly cognisant of the variability of:

- Students’ beliefs and conceptions.
- Students’ responses to curricula, assessment tasks, and teaching strategies.
- The multiple causes of their learning operating within the learning environment.

I initially conceptualised a learning environment as:

> *An open, dynamic, and complex system, containing assemblages of entities/structures with associated attributes and mechanisms that can enable or constrain learning. A learning environment can also be conceptualised as being stratified, having layers from the empirical through to the real. Learning is emergent from the exercise of mechanisms in a learning environment.*

Figure 21 illustrates my initial critical realist model of a learning environment as applied to this project.

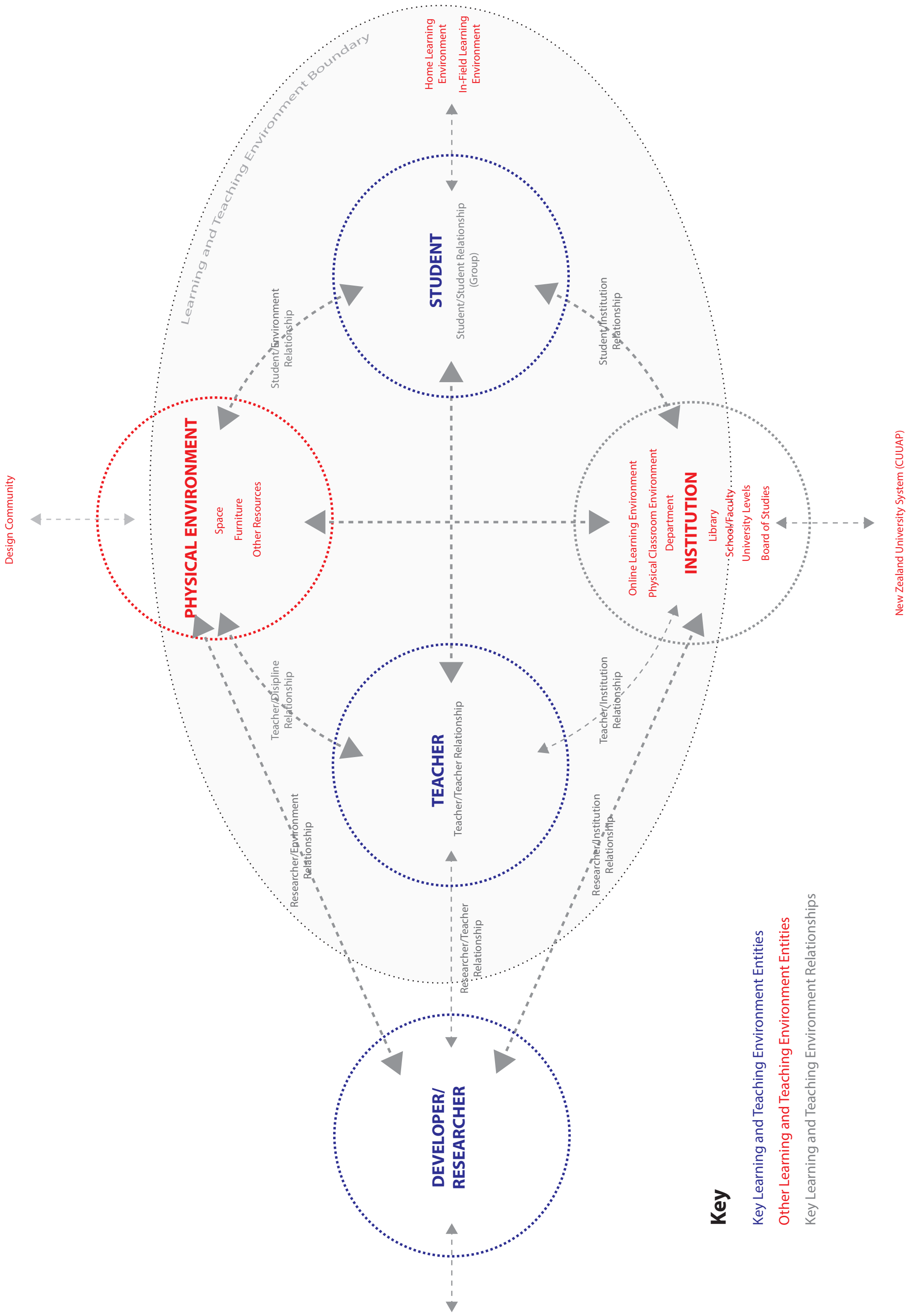

Figure 21. My initial critical realist model of a learning environment

This representation of a learning environment also takes account of models based on ecological and complexity theory perspectives.

The concept of learning ecologies builds on earlier concepts of information ecologies that have emerged in e-learning literature. Frielick (2005) proposed that learning and teaching settings and environments, such as the classroom, the lecture theatre, the e-learning environment, the department, and even institutions themselves, can be viewed systemically, and can be characterised by cognitive events and pathways in which the processes of information exchange and transformation occur.

“The key idea is that teaching/learning is an *ecosystemic* process of transforming information into knowledge, in which teacher, subject and student relationships are embedded or situated in a context where complex interacting influences shape the quality of learning outcomes” (Frielick, 2004, p. 328). Frielick (2005) described how the learning and the development of knowledge emerge from the complex interactions between the different parts, as information travels around the physical and mental pathways that constitute the total ecology of mind or mental system. This is presented in Figure 22.

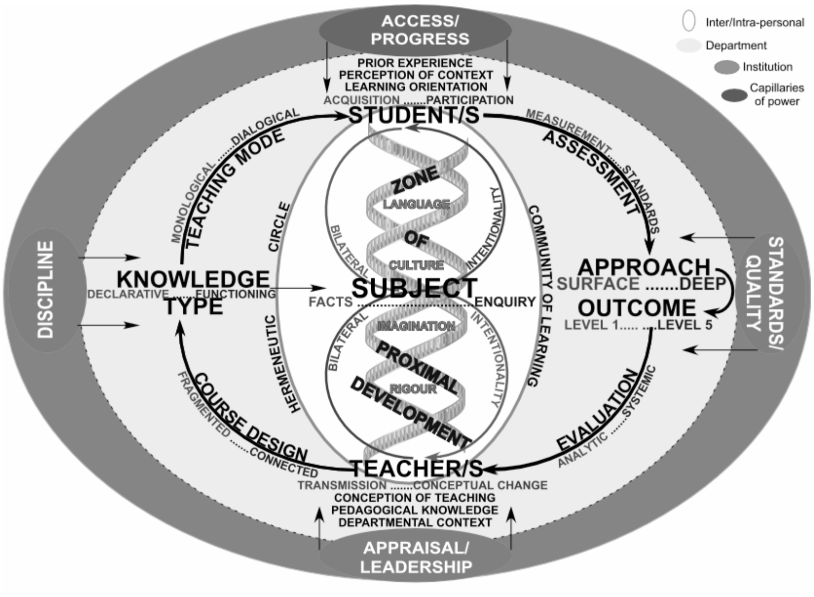

Figure 22. Ecological model of learning and teaching (Frielick, 2004, p. 330)

The concept of an ecosystem model appeared to correspond closely with critical realist concepts of learning environments as complex and dynamic systems (G. Brown, 2007, 2009).

Complexity theory

Complexity theory is the theory of complex systems. Often described as the science of the twenty-first century, complexity theory emerged during the 1980s, and offers a new lens with which to view the world (Wilson, 2009). Complexity theory emerged from research across a range of fields including biology, ecology, engineering and organisation behaviour and operation research.

> Complexity theory arises from the need to understand the richness in structure and behaviour often seen in large systems. The property that distinguishes complex systems from systems that are large but simple is the emergence of global features from local interactions, as captured in the popular saying “the whole is greater than the sum of its parts.” For example, a flock of birds emerges when individual birds coordinate their behaviour with each other. ("Complexity theory," 2006)

Complexity theory offers frameworks for understanding the complex systems operating in learning environments and curricula. “Complexity theory might be properly construed as a theory of education, oriented as it is to better understanding the co-implicated dynamics of many overlapping, interlacing, and nested systems” (Davis & Sumara, 2010, p.858). Davis (2010) described a number of ways in which complexity theory is impacting on the understanding of learning and teaching, including:

- Learning as dependent on, but not determined by teaching.
- Learning environments as spaces for knowledge-producing networks rather than contexts that are either teacher- or learner-centred.
- Characterising curricula not in terms of basics and foundations in discrete disciplines, but as nodes, hubs, and links in decentralised networks of human knowing.
- Interpreting development not as progress along a linear trajectory but as a process of recursive elaboration.
- Understanding learning events in terms of co-participation, co-emergence, and co-implication rather than strictly in terms of individual achievement and accountability.

Many of these concepts such as the contingent relationship between learning and teaching, and complex learning systems, align with critical realist concepts, as does co-participation, co-emergence, and co-implication, which align with critical realist notions of a social ontology, where the *group* is both the condition for, and outcome of, human agency (G. Brown, 2009).

3.12.4 Learning and teaching

Given critical realism's focus on discovery, understanding and the operation of underlying structures and mechanisms, it also offers views on learning- and teaching-related mechanisms (Crosthwaite, Jolly, Brodie, Kavanagh, & Buys, 2012). For example, Huckle (2004) argued that critical realism offers potential teaching mechanisms including:

- Probing student experience.
- Liberating knowledge of deeper realities (structures, processes and events).
- Revealing structures and processes that produce and reproduce powerful interests that prevent people from realising their potential.
- Exposing knowledge or ideology that sustains such interests.

These teaching mechanisms are relevant to teaching design thinking and they also suggest opportunities for the design of learning activities.

3.12.5 Structure and agency

The concept of agency, and its relationship to structure, is an important consideration when conceptualising learning and learning environments from a critical realist perspective.

Agency can be described as the ability of people to make choices that are not totally determined by circumstance and can be referred to as 'free will' (Burgoyne, 2007). Structures (such as social structures), on the other hand, are ontologically distinct from the human agents, as they constrain and enable (Bhaskar, 1978).

Kahn, Qualter, and Young (2012) argued that theories of learning typically downplay the interplay between social structure and student agency. Most theories of learning are divided into either those that prioritise individual cognition, and those that prioritise the context in which learning occurs. "In both of these traditions, the individual agent is dissolved" (Luckett & Luckett, 2009, p. 469). In response, Kahn et al. (2012) contended that in the learning process, agency is emergent and when learning, agents modify their intentions in response to their perceptions of the changing context, taking an active stance towards the realisation of their own projects.

G. Brown (2007) identified teachers as key causal agents in a learning environment, whose beliefs, reasons, skills, knowledge and dispositions are causes (but not the only causes) of student learning. Later, Brown (2009) noted that "the learning environment has a social ontology of neither individual agents nor structure/collectives, but [one] in which the *group* is both the condition for, and outcome of human agency" (2009, p. 31). Scott (2013) suggested that given learning is framed by structural impacts and agency, educational research should aim to focus on exploring the *meeting point* between structure and agency, rather than concentrating on one or the other.

I concluded that understanding and exploring concepts of student and teacher agency would be an important aspect of the curriculum design and the overall research. This included:

- Conceptualising, understanding and defining student and teacher agency as key attributes.
- The role that agency has in influencing (learning) mechanisms, and its impact on the development of other student attributes such as knowledge and mindsets.
- The relationship of structure (such as other entities and their mechanisms) in influencing emergent student and group agency.

3.12.6 Curriculum

While exploring detailed critical realist conceptualisations of learning environments, G. Brown (2007, 2009) also offered useful concepts of curricula. He contended that a curriculum is more than just the syllabus, or a guiding textbook that a teacher might follow, and explained that a curriculum entails not only normative decisions about what could or should be the case, but is also a moral and political entity, and decision making should reflect this. According to G. Brown (2009), concepts of emergence are also important when describing the relationships between learning, learning environments and curriculum. For example he states, "Meanings in the curriculum have a causal effect on the learning environment and the emergence of learning" (p. 26). From this perspective, a curriculum is not one of the entities that make up a learning environment. Rather, it is a separate entity that has mechanisms that can influence a learning environment. I initially conceptualised a curriculum as:

> *An entity (a plan) that is separate from a learning environment. A curriculum has attributes that provide it with mechanisms that inform and guide decisions about entities within a learning environment. It guides decisions about the entities that should be present, their properties and mechanisms, and their interrelationships. It is important to note that it guides decisions about entities that a teacher can control or influence. Some entities in a learning environment are not open to a teacher's control or influence. The latter can only be taken into account as these decisions are made. While a curriculum has an 'embodied' form, usually represented by text, images, plans,*

and diagrams which may imply a static, closed entity, a curriculum should be open to change and evolution.

The relationship between curriculum and learning environment is illustrated in Figure 23.

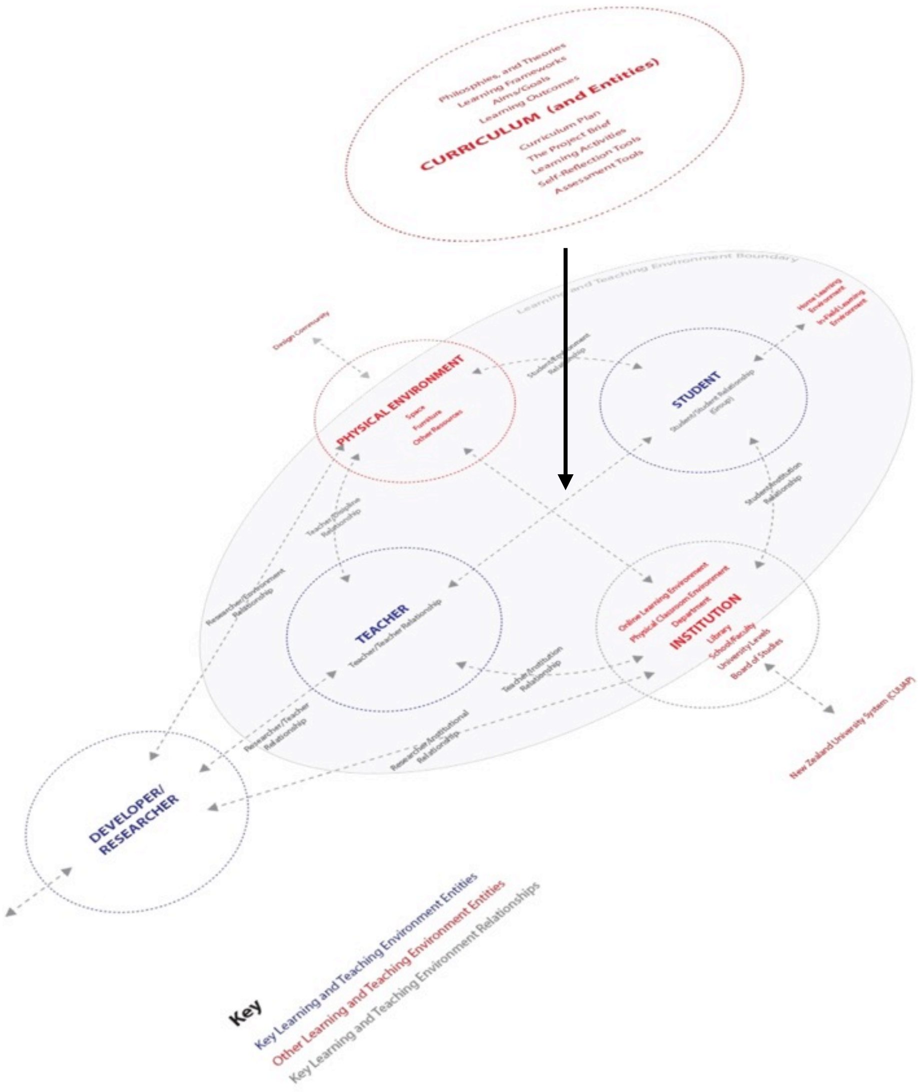

Figure 23. The relationship between learning environments and curriculum

This conceptualisation aligns in some respects with what are referred to as *process* concepts of curriculum. Process conceptualisations of curriculum generally have a *practical* or *emancipatory* orientation, with a focus on the experiences of students, and the flexible processes that enable learning (Fraser & Bosanquet, 2006). From this perspective, curriculum is more aligned and responsive to a range of learning needs, and focuses on the collaborative process of learning with the teacher and students defined as co-constructors of knowledge through negotiation. The emancipatory orientation strives for empowerment, rational autonomy and freedom. "Teaching is a shared struggle towards emancipation and functions to challenge common understandings and practices, and to enable students and teachers to change the constraints of the (learning) environment” (p. 281). ‘Process’ conceptualisations of curriculum are defined by:

- Framing of the learning environment.
- Process over content.
- Reflective practice.
- Changing students’ world-views.
- Interaction of student and teacher knowledge.

In a similar vein, but using slightly different terminology, Knight (2001) described various forms of curricula including the *planned* curriculum, the *created* curriculum which he contended is often wrongly referred to as the *enacted* curriculum, and the *understood* curriculum which he contended is often wrongly called the *received* curriculum.

The distinctions between these forms of curricula imply a sequence. The Australia Department of Education Training and Employment (2013) presented a cyclic process model which is illustrated in Figure 24.

Image removed due to copyright restrictions.

Figure 24. Forms of curricula (Department of Education Training and Employment, 2013)

This model also included two other forms of curricula, the *assessed* curriculum, and the *achieved* curriculum, which represents what students have achieved (learnt).

I recognised that these distinctions were relevant and helpful. For example, I identified that it could be useful to compare (a) the ideal and enacted curricula, (b) the enacted and experienced curricula, and (c) the experienced and achieved curricula. Explanations for the extent to which there were 'gaps' in these relationships could highlight entities and mechanisms that enabled or constrained students' development of design thinking expertise.

3.13 The next chapter

In the next chapter I outline my research design. This includes my research questions, which reflect the case that I developed for the research and discussed in Chapter One and in the literature review, and my research methodology, data gathering and analysis methods. I also link these to the critical realist ontological perspective described in this chapter. I also outline my quality criteria and ethical considerations.

CHAPTER FOUR: RESEARCH DESIGN

In the previous chapters, I presented the context and the case for the research and introduced my critical realist orientation. In this chapter, I describe the design of the research with respect to methodologies, the data and data sources, data gathering and analysis methods, quality criteria and ethical considerations.

It is important to note that while there are many consistent features for the data gathering and analysis methods that I used across three action research cycles, there were also modifications between cycles. These modifications are detailed in relevant chapters.

SECTION ONE: RESEARCH QUESTIONS

In this section, I present my research questions. Aligning with my action research methodology and my ongoing reflexivity and reflection, I clarified and extended some of the initial questions throughout the research process.

4.1 Research questions

4.1.1 Initial research questions

Can an innovative design thinking curriculum, founded on relevant theories and constructs, and developed and evaluated by action research and co-creation approaches, enhance the development of design thinking expertise of university students?

This overall research question was further developed into a number of interrelated sub-questions.

1. What is a clear and precise definition of design thinking that takes into account concepts associated with this research?
2. What are the components, theories and constructs that underpin an effective design thinking curriculum?
3. What are appropriate learning outcomes for an effective design thinking curriculum?
4. What factors influence the impact that an effective design thinking curriculum has on the experience and learning outcomes of students?
5. How can action research facilitate the design, development and refinement of an effective design thinking curriculum?

4.1.2 Emergent research questions

The following were emergent research questions that I recognised that I should address.

Can a university-level, design thinking curriculum that is developed and evaluated using critical realist perspectives and approaches, relevant theories and action research and case study methodologies enhance the design thinking expertise of university students?
The revised main question reflected the appreciation that I had gained, that a key distinctive feature of my project was its foundation in critical realism. Accordingly, I acknowledged this in the question. I also identified my use of a case study methodology as well as action research.

1. How can learning, learning environments, and curriculum be conceptualised, from a critical realist perspective? *In the light of my ongoing reading and deepening knowledge of critical realism, I recognised that I needed to define these key concepts from a critical realism perspective. As existing research gave limited attention to this perspective, I recognised that this could represent an important contribution of the research.*
2. How can design thinking be conceptualised from a critical realist perspective? *Similarly, while the influence of paradigm positioning on concepts of design thinking has been acknowledged, there were no reported attempts to elaborate a conception of design thinking from a critical realism perspective. Again, I recognised that this could represent an important contribution of the research.*
3. What are key outcomes in relation to a design thinking curriculum, and the enactment of an associated learning environment, students' experience of the learning environment and their achievement of the intended learning outcomes? *This question was an elaboration of the original sub-question 3.*
4. How are those outcomes influenced by context differences, including the learning backgrounds of design and business students? *In the original proposal, possible differences in the response of students enrolled in design and business undergraduate programmes were to be explored using a case study methodology. This objective was not associated with an explicit research question.*
5. How do the attributes and associated mechanisms of a design thinking learning environment (informed by a curriculum), enable or constrain students' learning and development of design thinking expertise? *This question is a modification of the original sub-question 4, and takes into account my clarification of the concepts of learning, learning environments and curriculum from a critical realism perspective.*

6. What is a 'signature' design thinking learning environment, and associated 'ideal' design thinking curriculum? *This is a revised version of sub-question 2. I believed that an adaption Shulman's (2005) notion of signature pedagogy was a relevant concept to associate with this question.*
7. What attributes of a critical realist theorising methodology, used in conjunction with case study and action research methodologies, enable or constrain the design and evaluation of university-level curriculum, and other educational research*. As I became more aware that there were no precedents for intensive research-based curriculum development and evaluation founded on critical realism, I considered that my answers to this question would also represent a significant contribution.*

SECTION TWO: RESEARCH METHODOLOGIES

In this section, I describe the theorising, action research and case study methodologies that were integrated for use in this research..

4.2 Definition of method and methodology

My understanding of the meaning of the term methodology is a strategy for generating new knowledge that is consistent with a certain epistemology and ontology (Daly, Speedy, Jackson, Lambert, & Lambert, 2005). It is also a plan of action, process, or design lying behind the choice and use of particular methods and linking the choice and use of methods to the desired outcomes (Crotty, 1998). A method, on the other hand can be defined as a particular approach to the collection and analysis of data, so that information can be obtained (Gray, 2009).

4.3 My critical realist orientation and methodology

As noted previously, this research used a critical realist ontological and epistemological orientation. Critical realism has a foothold in the methodological pluralism and mixed-methods camps (Cameron, 2011; Christ, 2013), and generally takes a pragmatic and inclusive position in relation to research methodologies, and data gathering and analysis methods. This position reflects a belief that a mix of data types, and types of methodology and methods, may well be required to address particular research problems or questions (Cameron, 2011; Christ, 2013; Sobh & Perry, 2005). For this project, individual case studies were embedded in action research and a critical realist theorising methodology was applied in the case studies. In the following commentary I describe each of these methodologies and their relationship.

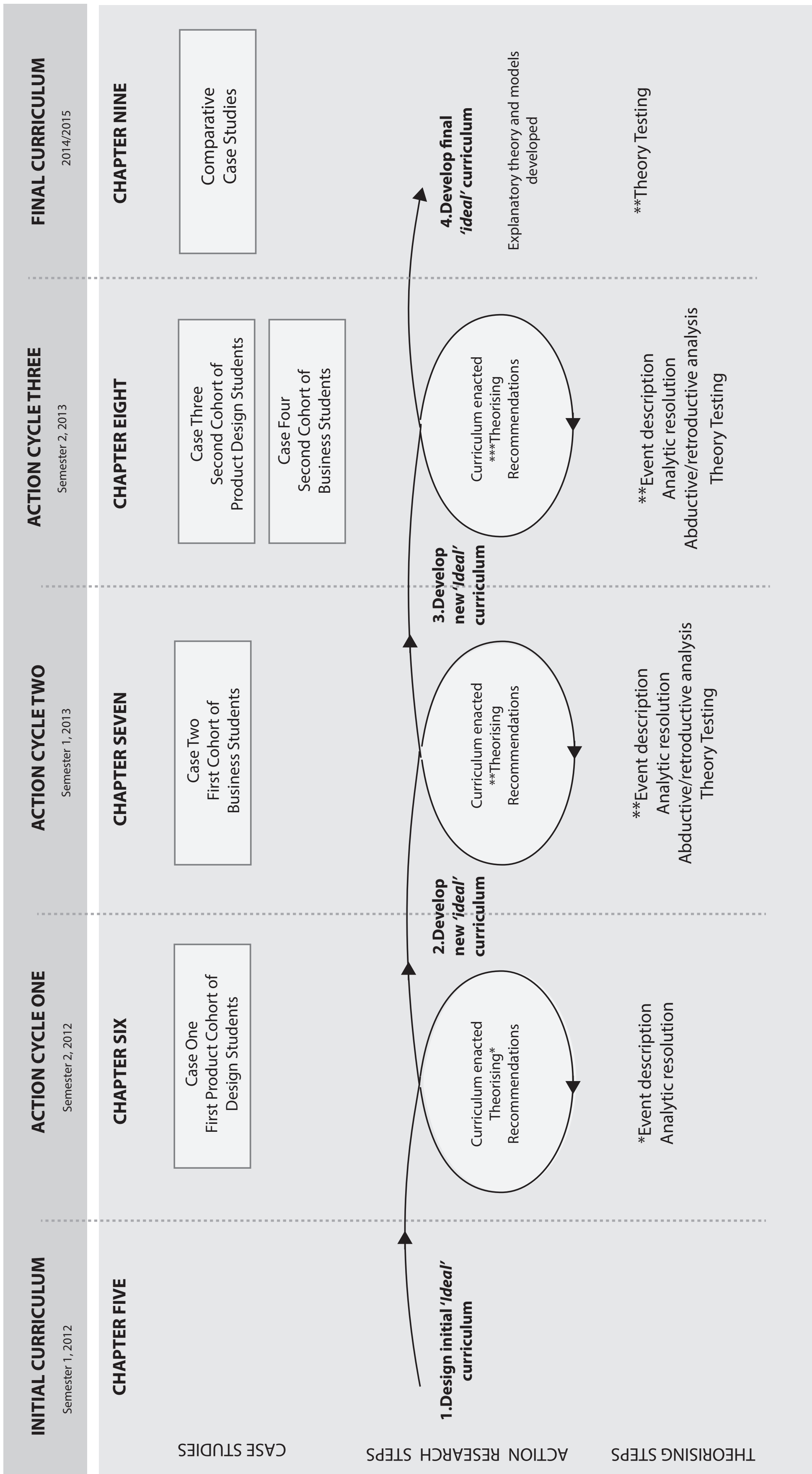

Figure 25. Overview of my research process

Figure 25 summarises the integrated relationship between three action research cycles, four individual and comparative case studies and a theorising methodology. The diagram also indicates steps in the theorising methodology that were applied to cases within the three action cycles, and at a further stage in the research that followed these cycles.

4.4 Action research

Action research is an methodology focusing on 'action' (Bryman & Bell, 2007; Gray, 2009), that drives "systemic inquiry that is collective, collaborative, self-reflective, critical and undertaken by participants in the inquiry" (McCutcheon & Jung, 1990, p. 148). Action research usually focuses on the development of solutions to 'real' problems in social contexts such as communities, organisations and businesses (Bradbury & Reason, 2003; Bryman & Bell, 2007), and in turn, facilitation of change (Collins, 2010). According to Gray (2009), there are a number of variants of action research as presented in Table 5.

Table 5. Variants of action research (Gray, 2009, pp. 314 - 315)

Type of Action Research	Description
Insider action research	Managers (or other professionals) are engaged in action research within their own organisations. The kind of issues addressed included systems improvement, organisational learning, and the management of change.
External action research	The researcher is independent of the professional context, but works collaboratively with professional practitioners to achieve change.
Action science	Attempts to integrate problem solving with theory building and change. This involves a form of social practice, which integrates both the production and use of knowledge within the organisation.
Participatory action research	Involves immersing participants in the focus of enquiry, the research methods, the data collection and the analysis. The goal is to transform situations or structures in an egalitarian manner in partnership with the participants.
Co-operative inquiry	While similar to participatory action research, co-operative inquiry focuses on research with people, rather than research on people.

The type of action research undertaken in this project is closely aligned with *participatory* action research.

The action research process is generally undertaken through a series of steps or cycles that include four main steps or processes (Gray, 2009). Figure 26 presents a generic model of an action research cycle, adapted from McNiff (1988). Each cycle includes *observation* (and other methods), *reflection*, leading to *planning* and *action*. This model provided the basis for my action research process.

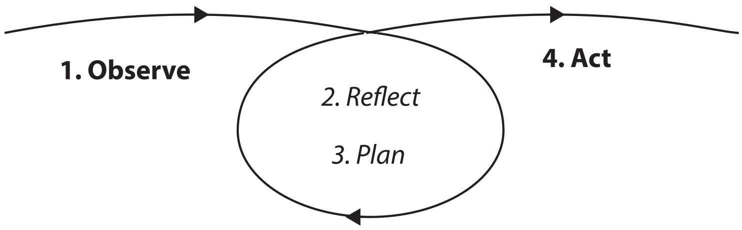

Figure 26. A generic action research cycle. Adapted from McNiff (1988, p. 44)

Notably for my research, there is a close alignment between these action research processes and design. For example, Friedman (2003) argued that the action research process is very close to the broadly accepted, generic design process including similarities between the cyclical action research process and the design process (i.e., problem/research - analysis - execution - production – evaluation). “I suggest that action research and the action of designing are so close that it would require only a few words to be substituted for the theoretical frameworks” (Swann, 1998, p. 56).

4.4.1 Action research and critical realism

Action research is compatible with a critical realist orientation. For example, Carol and Winter (2013) argued that “action research is a way of attempting to realise in practice the theoretical ideal of social inquiry proposed by critical realism” (p. 263). They proposed that the principles of critical realism are generally compatible with the values and processes of action research. Key alignments that they identified between action research and critical realism included contextual specificity, an emphasis on reflexivity, a mutual process of critical evaluative reflection, the goal to bring about change, and a continuous process of ‘causal exchange’ with objective reality. There is also a relationship between action research and the critical realist theorising methodology. Action research provides an opportunity for the researcher to verify and concretise explanatory theory.

4.4.2 Action research, education and curriculum design

A key purpose of action research in educational contexts is generally to help teaching practitioners understand and improve teaching and curriculum on an ongoing basis (McKernan, 1987). Kemmis (2009) noted, “Action research aims at changing three things: practitioners’ *practices*, their *understandings* of their practices, and the *conditions* in which they practise" (p. 1). Bryman and Bell (2007) also noted that the outcomes of action research are more readable, relevant and interesting to the practitioners, as well as other audiences.

Action research is particularly useful in the curriculum design process (Lee, Coombe, & Robinson, 2014). There are several different approaches that can be taken in action research but it usually involves individuals working within curriculum teams to progressively improve the way they identify issues and overcome challenges. Parsons and Beauchamp (2012) presented a useful cyclical model for curriculum development evaluation and revision that included four stages plus reviews: 1. Review: identify curriculum issues and concerns and identify background information, 2. Initiate: identify curriculum changes and implications, 3. Plan: develop project plan, 4. Develop: develop outcomes, resources, gather feedback and revise programme, 5. Implement: communicate information and offer teacher support, and 6. Review Implementation. The process is then repeated.

Key aspects of action research in curriculum design and development include the following:

- Collaboration: The core concern for action research is to develop practical as well as conceptual contributions to doing research *with* rather than *on* people (Bradbury & Reason, 2003). In other words, it is a participatory activity where the researchers work in equitable collaboration with the participants (Swann, 1998). The action research process in this research involved close collaboration with students and teaching staff throughout the design, enactment, and evaluation of the curriculum. This collaborative approach is often referred to as co-creation, co-design, or participatory research (Bryman & Bell, 2007).
- Reflection: Action research has a strong reflective element. Rearick (1999) described three types of reflection that can occur in action research as *autobiographical*, *collaborative* and *communal*. In autobiographical reflection, the researcher is the main focus, while collaborative reflection focuses on asking questions and seeking answers beyond the researcher. My research utilised some autobiographical reflection (especially when I was teaching), but mostly involved looking beyond myself, through my observations and discussions, to describe, analyse and understand the enactment of the curriculum, and the outcomes of the enactment.
- Reflexivity: In addition to the use of reflection, action research also emphasises the role of researcher reflexivity in ongoing cycles. Reflexivity in action research involves ongoing self-reflexivity regarding the researcher's place in relation to the research, and an ongoing criticality around the use of methodology and methods. The use of reflexivity in research is also very compatible with a realist epistemological approach.

Those involved in research, which is more relativist in intent, will tend to value more reflexive modes. This is sympathetic with the possibility of multiple understandings and interpretations (Finlay, 2006).

4.4.3 Micro-Politics and action research

According to Eilertsen, Gustafson, and Salo (2008), "action research is political by its very nature", and "when entering a social establishment action researcher *(sic)* inevitably becomes involved in and affects the power relationships between persons interacting in the context in question" (p. 1). It is therefore essential that the action researcher is aware of, at least at a micro level, the political and power relationships within the organisation they are studying, and the micropolitical consequences of their actions such as, "how action research in a certain context affect the existing balance of power" (p. 4). A good understanding of organisational political and power relationships can help researchers understand ethical considerations and the tensions and relationships within the organisation. It can also help them manage diverse interests and goals of participants and collaborators, and uncertainty and change brought about by the outcomes of the research.

Before undertaking this research, I identified the following key micropolitical and power relationships that I should specifically be cognizant of. They include:

- Within the department that staff and students were located in. This included relationships between senior management and teachers, and within the group of teachers that were enacting the curriculum.
- Within the learning environments that were under study, including relationships between teachers and students, ithin classes, within collaborative student groups, and between individual students.

I also noted that political and power relationships within and across the School of Art and Design, and across university as the whole might impact on the study (e.g., through the ethics approval process).

My exploration and understanding of micropolitical and power relationships as noted above, helped me to develop a set of ethical principles during the planning of research and to identify potential conflicts of interest, specifically relating to my roles as both researcher and teacher, and as a senior manager. This is explored in Section Six: Quality Criteria and Ethics.

4.5 Case study

Case study is "a research design that entails the detailed and intensive analysis of a single case. The term is sometimes extended to include the study of just two or three cases for comparative purposes" (Bryman & Bell, 2007, p. 275).

Case study research is concerned with the complexity and nature of a *case* in question. A *case* can be described as a particular subject, such as an issue, relationship, environment, situation, or setting (Bryman & Bell, 2007) or a phenomenon (Gray, 2009) under study. In this instance, the overall case was the design, enactment and evaluation of a design thinking curriculum. Within the overall case however, the enactment of the curriculum to each of the four groups of students was considered an individual case. In addition, a set of comparative case studies was used to to compare and contrast findings for the different groups of students, and to identify what was unique, and what was common.

4.5.1 Case study and critical realism

Aligning with a critical realist approach, case studies generally explore subjects where relationships may be ambiguous or uncertain, and where the goal is to attribute *causal* relationships (using *how* and *why* questions), rather than just describing a situation (Gray, 2009). Case studies are particularly "useful when the researcher is trying to uncover the context in which [the case] is occurring" (Gray, 2009, p. 247). Easton (2010) argued that critical realism is particularly well suited as a companion to case study research and proposed a model for a critical realist case study methodology. Aligning with my own research, he characterised the critical realist case study methodology as being well suited to cases as follows.

- A relatively clearly bounded, but complex, phenomenon. In my research, the phenomenon was the enactment of a design thinking curriculum.
- The events that are associated with the phenomenon are explored, such as the experiences of students and teachers, and students' learning outcomes.
- The entities/objects that characterise the phenomena being studied are wide-ranging. For my research, these include entities within and beyond the learning environment such as the teachers, students, and the curriculum itself.
- Eclectic, and flexible data collection, generally underpinned by semi-structured interviews, but very open to other methods such as observations.
- The use of retroduction to identify mechanisms that explain what caused particular events to occur, underpinned by the question of, "*What must be true in order to make*

this event possible?" In my research, the focus was on curriculum mechanisms and mechanisms in the learning environment.

- The development of the *best explanation* for the above, as was consistent with the data. In my research, these explanations informed further development of the curriculum.

4.5.2 Comparative case studies

As noted, the research included four individual case studies:

(a) Enactment of the curriculum to the first cohort of product design students (Case One).
(b) Enactment of the curriculum to the first cohort of business students (Case Two).
(c) Enactment of the curriculum to the second cohort of product design students (Case Three).
(d) Enactment of the curriculum to the second cohort of business students (Case Four).

These were the basis for four comparative case studies: Case One compared to Case Two; Case One/Case Three; Case Two/Case Four; Case Three/ Case Four.

4.6 Critical realist theorising methodology

A six step theorising methodology was used to develop, contextualise, verify and concretise explanatory theory in each case study.

These steps are described and related to this project below.

1. *Event-Outcome Description*: The intention of this first step was to provide a description of the enactment of the curriculum and its effects/outcomes, in particular tendencies in students' response to the enactment, as evident in several forms of related data. The latter included rating data, interview responses, teacher journal observations and reflections, and portfolio analysis, and was gathered using mixed methods (questionnaire survey, interview, reflection journaling, document review). Rating data were subject to descriptive and correlational statistical analysis. Initially, I analysed student interview responses inductively using a constant comparison analysis method. Responses associated with specific questions were identified and categorised, and in turn, themes and patterns of responses. I took note of the prevalence of particular views. This form of analysis allowed me to describe tendencies as well as variations in views about the curriculum and enactment of learning environment, and students' learning experiences and performance.

Analytic resolution: I identified the dimensions/elements of the phenomena that I decided to isolate and develop explanatory theory about for each case study. Across the cycles, I decided to focus on the mechanisms of entities that were potentially open to the everyday influence and control of students and teachers. I gave limited attention to social entities beyond the School/University, while acknowledging their potential influence. In cycle one, I kept the analytic focus broad. In cycle two, I focused in particular on student-related mechanisms, associated attributes and some contingent relationship with other entities in the learning environment. In cycle three, I focused in particular on teacher-related mechanisms that might have contingent relationships with the exercising of student mechanisms. The analytic resolution decisions were informed, in particular, by my use of a critical realist ontological framework to deductively identify possible references in the interview transcripts to entities, and their attributes, mechanisms and possible contingent relationships. Following the three cycles, I returned to a broad focus as I continued to develop explanatory theory for the overall case (i.e. design, evaluation and enhancement of an undergraduate design thinking curriculum).

2. *Abductive and retroductive theorising:* I developed explanatory theory for the tendencies that I had identified, initially without reference to existing theory. Figure 27 presents an example of this process using interactive mapping with post-it notes.

Figure 27. Example of post-it note mapping as part of abductive and retroductive theorising

Figure 28 presents the overall framework, further adapted from Sayer (2000, p. 15), which underpinned the theorising process.

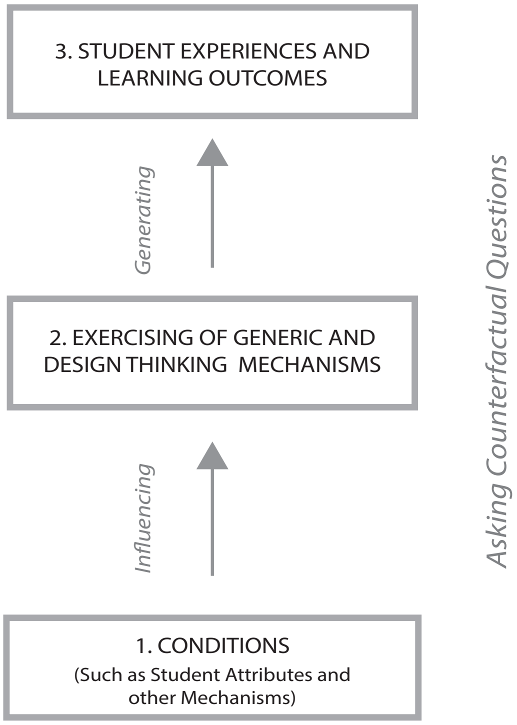

Figure 28. My overall critical realist theorising framework. Further adapted from Sayer (2000, p. 15)

The framework involved counterfactual thinking when an outcome, usually identified as a tendency in student experiences and/or learning outcomes, was identified within the case studies. It was used to prompt, challenge and develop tentative and emergent theory. Theory involved casual explanations about the conditions that were influencing student-related generic learning, and/or design thinking mechanisms in the learning environment. Examples of counterfactual questions include:

- *What attributes must students have before they can successfully exercise problem reframing mechanisms?*
- *If the teacher exercises/does not exercise empathising mechanisms during class sessions could this have an effect on students' conceptual knowledge of empathy?*
- *How might students' ability to exercise collaboration mechanisms affect their exercising of prototyping mechanisms – when engaged in a group prototyping task?*

I also explored extant theory that I thought could offer relevant causal explanations. The case studies were constantly in mind and being compared, with the expectation that they would prompt theory, in particular concerning context differences.

3. *Theory Testing*: I assessed the explanatory power of the inferences (explanatory theory) across comparative and successive case studies. As theory developed, I continued to consider whether it provided a valid explanation for tendencies that I identified in subsequent case studies.

4. *Further Theory Testing*: I further tested the explanatory theory by evaluating the effect on students' learning of changes made to the learning environment, based on the theory. At the end of each cycle, I reviewed the theory that I had developed (in reality numerous 'mini theories'), and in the light of them made adjustments to the curriculum. It is important to note that not all of these theories lead to curriculum adjustment.

5. *Assessment of the practical adequacy:* I assessed the practical adequacy of the theory with respect to its use during curriculum design work and everyday teacher decision-making. While I reflected on the utility of theory for curriculum design work during the cycles, this consideration received most attention at the end of the project.

It is important to note that while this is presented as a sequential process, in practice some steps were undertaken in parallel, or repeated. In addition, as noted previously, my understanding and application of critical realism and this methodology was emergent. Because of this, in the first action research cycle there was limited abductive and retroductive theorising. Once I had developed a deeper understanding and was more confident, I applied these modes of theorising more effectively in action cycles two and three. As a sequel to the theorising that occurred in each of the cycles, I attempted to bring the interrelated strands of theory together.

SECTION THREE: DATA SOURCES, DATA AND SAMPLING

In this section, I provide a detailed description of the data sources, data and sampling used in the research. Data were gathered directly from two key sources: myself, providing perspectives of the researcher and a teacher; and from students.

4.7 Researcher and teacher data

My personal reflections on my own experiences, observations and other teachers' feedback provided unique and useful data for the research. It is important to note that, given my role as Head of Department (HOD) which involved line management responsibilities, I was confined to a researcher role in cycle one, and precluded from also acting as a teacher. Subsequently, when I had stepped aside from my role as HOD, I was able to be a teacher-researcher in research cycles two and three. It is also important to note that I didn't gather data directly from the teachers involved, but rather reflected on their spontaneous feedback, and these reflections constituted data.

4.7.1 Researcher data

Throughout the design and enactment of the curriculum, and throughout each of the action research cycles, I wrote a series of researcher observations and reflections in both a handwritten journal, and a private online Wordpress blog. In the journal I captured observations, thoughts and my experiences on a daily basis. In the online blog, I recorded deeper reflections, usually on a weekly basis, and in relationship to the overall research questions. It is important to note that the blog was kept private, with only supervisors having external access. The researcher observations and reflections included:

- Personal thoughts that I had as I engaged in curriculum design work, reviewed data and considered opportunities for changes and improvement.
- Feelings that I experienced, including emotional responses to issues and incidents.
- Observations of interactions and discussions with the teaching staff, including their reactions, comments and feelings.
- Reflections on feedback from teaching staff after the curriculum enactment, including the identification of issues, and opportunities and ideas for curriculum improvement.
- I also recorded in-class observations of students' actions when I assumed the role of teacher.

Thoughts that I recorded in the journal and the blog were sometimes sketched in diagrams and models.

4.8 Student participants

The design thinking curriculum was enacted with the following groups of student participant groups:

- Year One Product Design students in the AUT University Bachelor of Design programme, undertaking a paper titled, *Product Design Studio II.*
- Year One students undertaking a course in the AUT University Bachelor of Business programme, titled *Design Thinking*.

4.8.1 Student data

The student data included (a) their self-reported experiences of the learning process, (b) their views about aspects of the curriculum that they liked or disliked, and considered beneficial or not for their learning, and (c) their perceptions of the impact of the curriculum on their design thinking expertise development. Three sets of student data were gathered.

- *Survey data*: The survey was designed to build a broad picture of the students' perceptions of their design thinking expertise development, their ratings of the various aspects of the curriculum, and their overall experience of the learning environment.
- *Interview data*: The interviews were designed to build a rich and more in-depth picture of students' experiences of the learning environment, their perceptions and understandings of their development of design thinking expertise, their ratings of the various aspects of the learning environment, and the impact that they had on them. In addition, the interviews were designed to elicit feedback and suggestions that students had for improving the curriculum, and improving the experience for other students.
- *Portfolio data*: Portfolios were designed for groups of students to visually and textually provide evidence of their design thinking process work. The portfolios provided a rich picture of students' design thinking process (such as examples of work through each stage of the process, with written descriptions of the work), and evidence of their achievement. It is important to note that student groups were asked to keep their portfolios up to date through the curriculum enactment (course or project), with the expectation that the portfolios were a sound overall representation of their work.

In planning the data gathering and analysis, I identified some potential limitations, especially in relation to student's self-reported data. As noted by Barker, Pistrang, and Elliot (2002) researchers need to be aware that with self-report data:

- The personal views of participants can be idiosyncratic, and therefore may bear little relationship to 'reality'.
- People are not always truthful, and may provide answers or discussion that they

believe that the researcher may want to hear.
- Participants may not be able to provide the level of detail, or the concepts that the researcher is interested in.

In addition, I noted that participants might:

- Give meanings to words that differ from those that the researcher had in mind.
- Differ from other respondents in the meaning they give to words.
- (Un)consciously not respond honestly. They may offer a response that they believe the researcher will consider desirable or that removes responsibility from themselves.
- May not have the self-knowledge required to make judgements.
- Avoid responses at the extreme end of scales (central tendency).
- May object to forced choices, requests for accuracy or precision that are not feasible, or to lack of opportunity to provide qualifications or explanations for responses.

Barker (2002) noted that "all measurement methods have limits, and the potential limitations of the data must be considered at the analysis and interpretation stage" (Barker et al., 2002, p. 96). I took several steps to reduce the likelihood of these limitations. When constructing items, I endeavored to use language that I believed would be familiar and meaningful for the students. However, time constraints meant that I could not pilot items. When presenting information about the project and the methods, I emphasized that honest and frank responses were being encouraged. I also used more than one method to gather equivalent data (see 4.14.5 Triangulation).

4.9 Population size and sampling

Bryman and Bell (2007) described the need for researchers to consider the sample size of a study, and to focus on the absolute size rather than the relative size of the sample. They also noted though, in citing Fowler (1993), that it is often difficult (due to a range of variables) for researchers to specify in advance of a study a desired level of precision in sample sizes.

4.9.1 Population size

The total size of the possible participants in the research was 120 students (n = 120). This was composed of a group of 48 students in the course Product Design Studio II (one group of 24 students in semester two, 2012, and another group of 24 students in semester two, 2013), and a group of 72 students in the course Design Thinking (one group of 36 students in semester one, 2013 and another group of 36 students in semester two, 2013).

4.9.2 Sampling

This research design used a *non-probability*, *convenience* sampling approach. A *convenience* sample is one that is available to the researcher by virtue of its accessibility (Bryman & Bell, 2007).

All students in both courses were approached to participate in the research. The recruitment process conformed with the conditions of AUT University ethics approval processes (see Section 4.17 Ethical considerations). As per the convenience sampling approach, while it was the goal of the researcher to get the largest sample size possible, agreement to participate appeared to be based on a number of factors, especially students' overall motivation and their general confidence in participating in research. In addition, a student's decision to participate may have been influenced by their:

- Understanding of the value of the research as presented, and a desire to improve the course/programmes for other students.
- Interest in design thinking as a design process.
- Interest in research, and research processes.
- General sense of loyalty to the department and university, and to the teaching staff involved.

All students who had agreed to participate were asked to undertake the survey. A *purposive* sampling approach was then used in selecting students for the key informant interviews from the pool of those who had completed the survey. *Purposive* sampling, also sometimes called *judgmental* sampling, is one that is selected based on the knowledge of a population, and the purpose of the study. Informants were selected based on characteristics identified by the researcher (see Section 4.11 Informant interviews for the case frame criteria used to select participants).

4.9.3 Response rates

Response rates in each of the action research cycles are described in the following chapters that report on the three action research cycles.

SECTION FOUR: DATA GATHERING

In this section, I outline and discuss in detail the data gathering methods.

4.10 Survey

All students who agreed to participate in the research completed a survey form that included items about design thinking expertise, aspects of the curriculum, and learning experiences. The same questionnaire was administered when students began the project or course (Week 1) and at the end of the project (Week 6) or course (Week 12). As per the ethics approval conditions, an independent third party administered the questionnaire. For all items, students were presented with a statement that they responded to by indicating a position on a Likert rating scale.

4.10.1 Design thinking expertise

In both the pre- and post -curriculum enactment survey, students were asked to rate their design thinking attributes (expertise). The goal of this part of the research was to develop an understanding of students' perceptions of their design thinking expertise and to show any pre to post shifts in this. Students were asked to respond to a Likert rating scale, which required them to indicate their level of agreement with each statement, from one to five (one being rating their ability as *excellent*, and five being a *very poor* rating). Table 6 shows an example of design thinking attributes to rate.

Table 6. Examples of survey questions relating to design thinking expertise

Please tick the box that best describes your ability to:
Collaborate with others
Generate a wide range of creative ideas
Construct 3D prototypes

4.10.2 Aspects of the curriculum

The goal of this part of the survey was to develop an understanding of students' perceptions of the value of various aspects of the learning environment. Students were asked to respond to a Likert rating scale which required them to indicate their level of agreement with the statement from one to five (one being an *excellent* rating, and five being a *very poor* rating). For example, questions included aspects such as in Table 7.

Table 7. Examples of survey questions relating to various aspects of the curriculum

Please tick the box that best rates various components of the design thinking curriculum, such as:
The learning approach
The structure
The assessment criteria

4.10.3 Overall experience

In addition to the other questions, in the post-curriculum survey, students were also asked to rate their overall experiences. The goal of this section of the survey was to develop an understanding of students' overall experience, how it impacted them overall in relation to the development of design thinking expertise and whether the impact was transferable. Students were asked to respond to a Likert rating scale, which required them to indicate their level of agreement with the statement from one to five (one being a *strongly agree* rating, and five being a *strongly disagree* rating), as in Table 8.

Table 8. Examples of survey questions relating to overall experience

Please tick the box that best describes the following:
I had a very good experience undertaking the design thinking project
I believe the project significantly developed my design thinking expertise
I believe I will be able to apply my design thinking expertise to my future design studies and work

Information about student's age (students were given a choice of age ranges) and their gender was also gathered in the survey.

4.11 Informant interviews

Key informant interviews are a flexible research method of research, and can uncover rich data (Bryman & Bell, 2007). For critical realists, informant interviews are an important method for both the appreciation and interpretation of informants' individual perspectives, and to help analyse the broader social contexts, constraints and resources with which the informants act (Smith & Elger, 2012).

Key informant interviews were utilised to collect in-depth data from a selected group of participant students. As mentioned previously, key informants were selected using a purposive sampling case frame to identify a sample of possible student participants. Case frame criteria included:

- Equal gender distribution (an equal number of males and females)
- Equal age range distribution.

Students who met these criteria were then invited to participate in the interviews via a telephone call or email, and were selected on a first response basis.

The interviews were based on a semi-structured interview format, lasting between 40 and 50 minutes. In the interviews, students were asked questions on a number of topics, but with the flexibility and leeway for both the interviewer and interviewee to explore themes, patterns and tendencies as they emerged during the discussion. The interviewer in the first research cycle was an independent third party. In action research cycles two and three (when I had stepped down from my Head of Department role) I undertook the interviews myself.

4.11.1 Informant interview questions

Table 9 presents questions that I utilised in the informant interviews.

Table 9. Examples of key informant interview questions

What aspect of the design thinking project (curriculum) did you find the most enjoyable and why?
What aspect of design thinking was your most significant learning, and why?
What aspect of the design thinking project (curriculum) did you find the most challenging and why?
What was the most significant difference completing this project has made to your personal development as a design thinker? Why is this difference significant to you?
What was your most significant achievement from the design thinking project (curriculum), and why?
Reflecting on your experiences of design thinking methods and approaches, is there anything else that you would like to share with me to improve design thinking learning for students in the future?

The interviews were undertaken either on campus or via a phone call, and were electronically recorded. The audio file was transcribed into a written format for analysis by the researcher.

4.12 Student portfolios

A portfolio is an excellent way of capturing rich data, and is an especially relevant tool in design and design thinking education. A portfolio is either a physical or an electronic document that usually has both written and visual forms of information, and represents a process or task that has been undertaken.

For the purposes of this research, students who agreed to participate were asked to complete a detailed group portfolio. They were given instructions on the required content and the layout of the portfolio via an Adobe Indesign or Microsoft Word document template, with a teacher briefing. The content of the portfolios included selected documentation and written commentary on design thinking work that groups had undertaken in each stage of the design thinking process. In addition, an introduction and conclusion were also required. Student groups were also asked to include examples of practical work including images, diagrams, photographs and text to illustrate the process and outcomes.

It is important to note that as per the ethics approval conditions (see Section 4.17 Ethical considerations), I did not review the portfolios until they had been assessed by the teaching staff, and grades approved and returned to students.

SECTION FIVE: DATA ANALYSIS AND THEORISING

In this section, I describe the use of a critical realist theorising methodology, and the specific steps associated with data analysis and theorising are elaborated and illustrated.

4.13 Theorising Methdology

Figure 29 presents an overall model that I developed and used to undertake the data analysis and theorising process in each of the cases, across the three action research cycles.

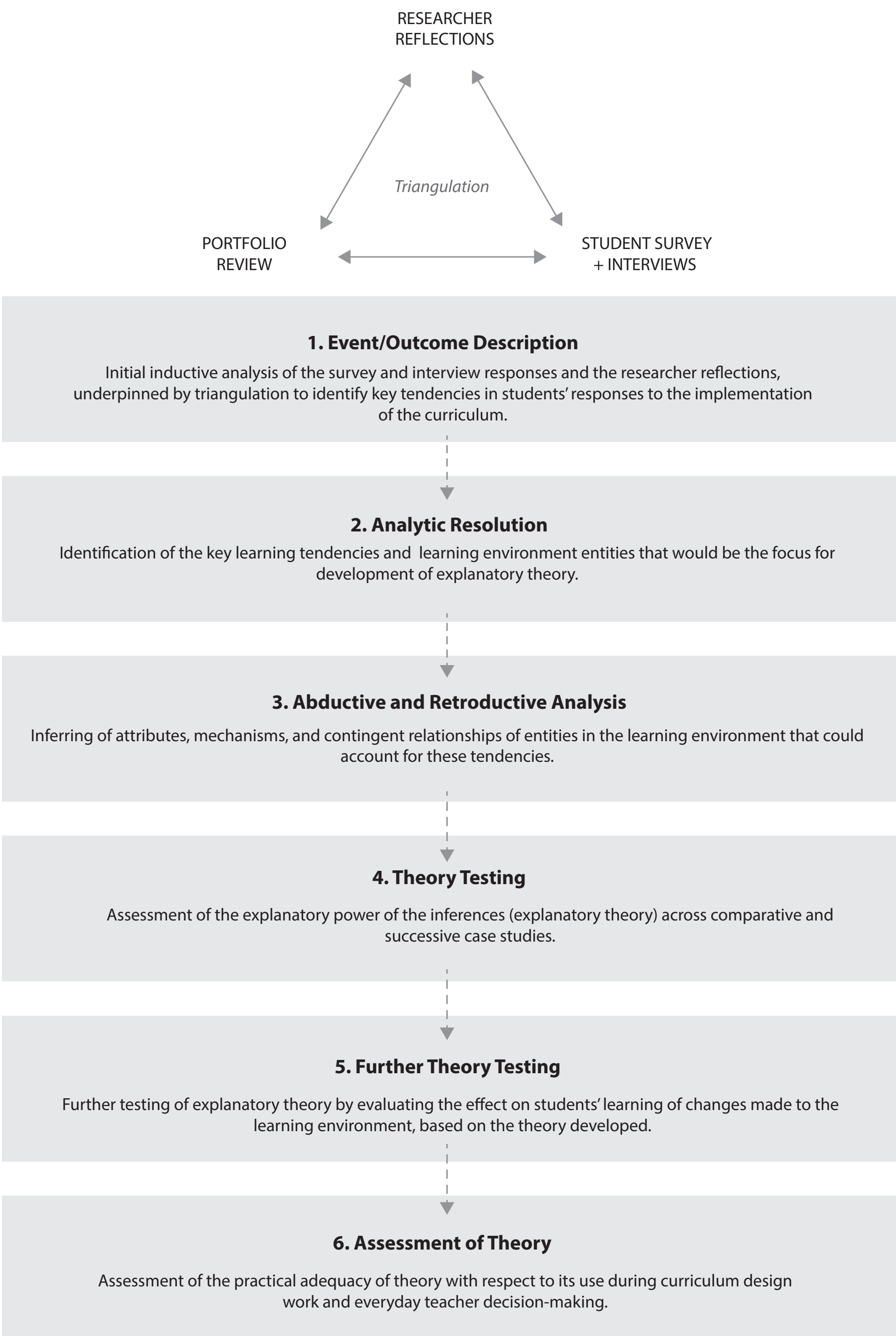

Figure 29. Overall data analysis and theorising model

Further details about the analysis processes for the survey interview, portolio and journal are now presented.

4.14 Data Analysis

4.14.1 Survey

The survey data were analysed using simple descriptive statistics and non-parametric correlational statistics (Bryman & Bell, 2007). The descriptive statistics included simple frequency counts, transformation of frequencies into percentages and the translation of numerical data into bar graphs. A correlational analysis was also utilised, using the Mann Whitney U Test (Mann & Whitney, 1947) to compare cases, such as comparing the response of the business design and product design students.

It is important to note that while each student completed the same survey on two occasions (i.e., pre-course/project and post course/project), given the limitation of the survey design administration, it was not possible to analyse changes in individual responses using a test such as the Wilcoxon Pairs Signed Ranks Test.

4.14.2 Informant interviews

The transcripts of interviews were initially reviewed and coded using a *comparative contrastive* method (Leech & Onwuegbuzie, 2007).

To apply this method, as I read transcripts, I marked off words and phrases that had a meaning that related to the specific interview questions. I labelled the meaning with a descriptive title or ‘code’. I continuously compared previous and succeeding chunks of text as I read, noting whether they had the same or new meanings. New codes were assigned when I noted a new meaning. During this process I tried to remain ‘open’ to new meanings and the process was essentially inductive. For each interview transcript, I also created a summary sheet of the codes or categories.

In this process, I also looked for patterns across categories, which included grouping possibilities (themes), and process links. To assist the analysis, categories and their relationships were further summarised and interactively mapped on large boards using post-it notes.

I actively engaged in a reflective and reflexive process throughout my analysis. As I worked through each transcript, I was able to continuously respond to emergent issues, my developing knowledge, understanding and confidence, and adjust my approach accordingly. For example, my use of post-it notes emerged after I struggled to see initial patterns and tendencies. The interactive approach enabled me to recognise and adjust categories and groups as I worked. I also noted when there was reoccurrence of categories across transcripts. It is important to note that to help check and moderate my own analysis approach, I asked one of my supervisors to code several interview transcriptions. I then compared them to my own analysis.

4.14.3 Reflections of researcher

The researcher reflections were analysed in a very similar manner to the informant interviews described above. Again, this involved the reading of my reflections and marking off words and phrases with specific interview questions in mind, assigning meanings and noting reoccurrence. As categories emerged, they were organised into taxonomies.

4.14.4 Student group portfolios

Both the text and visual content of the portfolios were reviewed. After an overall review, I utilised my expertise framework to identify specific evidence of students' achievements. Again, I mapped my findings for each portfolio on to large boards using post-it notes and then developed a map that summarised tendencies across the portfolios. The assessment grades were also recorded.

4.14.5 Triangulation

As noted, triangulation was an element of the overall data analysis process.

Triangulation is the use of "more than one method or source of data in the study of social phenomenon so that the findings can be cross checked" (Bryman & Bell, 2007, p. 733). "The objective is to increase confidence in the findings through the confirmation of a proposition using two or more independent measures used to determine the completeness of data" (Heale & Forbes, 2013, p. 98). Critical realists specifically believe that triangulation from many data sources is very useful in establishing confirmation and completeness of research findings (McEvoy & Richards, 2006; Sobh & Perry, 2005). According to Heale and Forbes (2013), combining methods to answer a specific research question may result in one of the following three outcomes:

- The results may be *convergent* and lead to similar or the same conclusions;
- The results may relate to different objects or phenomena but may be *complementary* to each other and used to supplement the individual results; and/or

- The results may be *divergent* or *contradictory*.

Converging results aim to increase the validity through *verification*; complementary results highlight different aspects of the phenomenon or illustrate different phenomena, and divergent findings can lead to new and better explanations for the phenomenon under investigation (Heale & Forbes, 2013).

My process of triangulation generally involved systematically pausing my individual analysis of each set of data (such as informant interviews) and reviewing the findings of other data, looking for convergence, or results that were complementary or contradictory. As Modell (2009) noted, triangulation is also useful in identifying context-based variations in the data. This was particularly useful for me when I undertook comparative analysis of different cases (product and business students) at the end of the third action research cycle.

4.15 Abductive and retroductive analysis

The key tendencies that I had identified were then further analysed using a combination of abductive and retroductive analysis. I also undertook some initial theorising, and recommended changes to the 'ideal' design thinking curriculum.

As noted previously, abductive analysis is defined as a further analysis, including "(re)description and (re)contextualisation of data to gain knowledge about the interconnected workings of complex social phenomenon" (Christ, 2013, p. 114), involving the analysis of data without using an initial theoretical frame or premise, to introduce new ideas (Meyer & Lunnay, 2013), and an *inference* to the best explanation (Curedale, 2013). In essence, abduction is a way of reinterpreting data and, when used in conjunction with retroduction, often leads to the development of a new conceptual framework or theory (Danermark et al., 1997).

Retroductive analysis, on the other hand, can be defined as the inferring of the circumstances without which something cannot exist. "Retroductive inference is built on the premise that social reality consists of structures and internally related objects, but we can only attain knowledge of this reality if we go beyond what is empirically observable by asking about and developing concepts that are fundamental to the phenomena under study" (Meyer & Lunnay, 2013, p. 3). This includes inferring the underlying structures and causal mechanisms that account for the phenomena involved, and which are not otherwise evident or obvious (McEvoy & Richards, 2006).

In addition to the abductive and retroductive analyses, I explored findings and theories from other related research[6] to help verify and extend my findings, and to help with initial theorising. This theorising focused in particular on the properties of entities in the learning environment and their associated mechanisms that could increase the likelihood of students' learning of design thinking.

SECTION SIX: QUALITY CRITERIA AND ETHICS

In this section, I describe the criteria that I used to evaluate the quality of my research, as well as key ethical considerations.

4.16 Validity and other criteria

I used the following criteria to evaluate the quality of the research, and the outcomes.

4.16.1 Validity

Validity is often referred to as the most important criteria for assessing the quality of research. Validity, however, is generally associated with a positivist paradigm and the prioritising of quantitative data. Given my critical realist position and use of both qualitative and quantitative data, I decided that I should use the alternative criterion of trustworthiness (Finlay, 2006; Lincoln & Guba, 1985).

4.16.2 Trustworthiness

"Research needs to be '*trustworthy*' (a term often used in place of 'validity' in the qualitative researcher's lexicon), in the sense of being able to demonstrate both *rigour* [process] and *relevance* [end product]" (Finlay, 2006). The following concepts explore key notions of *trustworthiness* in this research.

4.16.3 Credibility (replaces the concept of *internal validity*)

Rather than the idea of establishing the *truth* of their findings, with *credibility* researchers focus on the degree to which findings *make sense* (Finlay, 2006). This aligns somewhat with the critical realist concept of *truth* as *practical adequacy. "*Just how practically adequate different parts of our knowledge are will vary according to where and to what things they are applied." (Sayer, 2000, p. 43). Credibility is based on a researcher's prolonged engagement in the field, persistent observation and triangulation of the data (Finlay, 2006).

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[6] This occurred only in Action Research Cycles two and three, and not in cycle one.

To achieve credibility, this research used four data sets (both quantitative and qualitative), each with a different perspective on the same subject being studied (the design thinking curriculum), and with the research process effectively repeated three times, across three action research cycles. Each data set was relatively extensive (for example, one set of data includes 23 key informant interviews, each around 45 minutes long) and the findings were analysed using a process of triangulation.

4.16.4 Transferability (replaces the concept of external validity)

Transferability replaces the concept of external validity. Qualitative researchers are encouraged to provide a detailed description of the setting in which the research is conducted, with the aim of giving readers enough information for them to evaluate the applicability of the findings to other settings (Finlay, 2006).

To demonstrate *transferability*, the research documentation outlined a high level of detail regarding the background to research, the research setting and the research process. For example, Chapter Five: Learning, Learning Environments, and Curriculum provides a detailed outline of the curriculum design process, and Chapter Seven: Action Research Cycle One (Case Study One) provides a very detailed account of the curriculum enactment, as well as the data collection and analysis process.

4.16.5 Dependability (replaces the concept of external validity)

Dependability is related to how well researchers provide an audit trail (the documentation of data, methods and decisions about the research), which is open to external review and scrutiny (Finlay, 2006). Dependability also correlates to the ability of others to replicate the research.

To demonstrate dependability, the research documentation provides the reader with a detailed description of the methodology and research methods, and with examples from the data for review (for example, images from the curriculum development process, quotes from participants, examples of group portfolios and graphs of the survey results), and examples from the analysis process.

4.16.6 Confirmability (replaces the concept of objectivity)

Confirmability is the relationship between external audit of the research (see above), and the researcher's reflexivity (a self-critically reflexive analysis) of the methodology used in the research (Finlay, 2006).

To demonstrate confirmability, my ongoing reflexive analysis was outlined as part of the researcher's reflections. As an example of reflexivity, I gave attention to my role in the curriculum development process in relation to the teaching staff, and the impact that it has had on my choice of research methods, and on co-construction of curriculum. I also acknowledged that my understanding of the implications of my critical realism positioning developed and changed through the project.

4.17 Ethical considerations

As the research would be undertaken in a university context, very careful consideration was given to ethical considerations.

Hammersley and Traianou (2012), identified that researchers undertaking projects in educational contexts should consider a range of key ethical principles during the planning of research. This includes: minimising possible harm to participants; respecting autonomy, i.e. ensuring that participants can make decisions for themselves including voluntarily consenting to participate; protecting participant privacy; offering reciprocity; and treating people equitably, i.e. that no participants would unjustly favoured or discriminated against.

In planning my research design, I noted that there were a number of potential conflicts of interest, specifically relating to my roles as both researcher and teacher, and as Head of Department. To ensure that the research adhered to the ethical principles identified above, and responded to the conflicts of interest, a number key ethics protocols were put in place. This included:

- Employing an independent third party to meet and brief possible student participants, and to invite them to participate. This would include detailed discussions with students about the research process, what possible participation would mean for them, the proposed benefits of the research, discussing the ethics protocols that were in place to minimise any potential risks, to ensure their privacy, and to ensure that understood the consenting process. In addition, the third party would emphasise that the academic work of student participant's was not under scrutiny in the research.

- Employing an independent third party to undertake data gathering, and transcribe the interviews.

In addition:

- No AUT teaching staff were able to participate in the research. I.e. no data was to be gathered in relation to teachers' perceptions and experiences concerning either their own teaching or their students' learning. I noted however that their views could be taken into account during the continuing development of the curriculum, but were not to be reported as formal data.
- Student confidentiality was to be maintained at all times and as researcher, I was not to play any role in the assessment and grade approval processes for student participants.
- The student portfolios and reflective documents were to be collected as a source of data only after the lecturers who taught the course papers had assessed them, a final grade had been given for the work, and this had been approved by the relevant programme exam board.

After careful consideration and some negotiation, the AUT University Ethics Committee granted ethical approval to the research[7].

The Participant Information Sheet and Consent Form, as approved by the AUT Ethics Committee for use in the research, are included in APPENDIX VII.

4.18 The next chapter

In the next chapter I explore, discuss and develop my own conceptualisation of curriculum, and present a curriculum design framework that I developed. This framework is subsequently utilised in the design of the initial 'ideal' design thinking curriculum described in Chapter Six, and provides the foundation for Action Research Cycle One, the enactment and evaluation of the curriculum described in Chapter Seven.

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[7] AUT Ethics approval number 12/140.

CHAPTER FIVE: CURRICULUM DESIGN

In this chapter, I present the curriculum design framework that I developed and the curriculum that I designed for the first cycle using this framework. This includes a brief description of institutional considerations and requirements, key curriculum considerations, learning theories that influenced my decisions about these considerations, and selected examples of the curriculum documentation.

SECTION ONE: CURRICULUM DESIGN FRAMEWORK

Ornstein and Hunkins (2009) observed that curriculum design encompasses how a “curriculum is planned, implemented and evaluated, as well as what people, processes and procedures are involved” (p. 14). As noted previously, curriculum design is the process of making decisions about the entities within an environment that will potentially influence students’ learning. This section identifies and discusses some curriculum design frameworks and approaches relevant to this research.

5.1 Curriculum design and evaluation models

Haigh (2013) proposed that the challenges in curriculum design and development derive from several distinctive features of learning environments. These include the “complex relationships between factors that have both cumulative and simultaneous impacts on learning”, “the ‘endemic uncertainty’ that teachers inevitably experience when they try to identify all of these factors”, “their relationships and impacts”, and the “uniqueness of each student” (p. 2).

Development frameworks are very useful in working through these challenges in curriculum design and development. The following curriculum development models have been identified by Parsons and Beauchamp (2012).

- *Instrumental*: Involves systemic development processes based on thorough analysis. Clear measurable objectives for the development process are formulated (i.e., the step-by-step planning process allows for the formulation of clear, measurable objectives for the development process).
- *Communicative*: The development process is primarily a social process that emphasises the importance of relational strategies (i.e., to build relationships with stakeholders and solicit input, starting with the subjective perceptions and views of developers and various stakeholders, including students). Deliberation and negotiation are central to this orientation.
- *Artistic:* This holistic systemic-aesthetic approach assumes that the developer is an

artist, who creatively anticipates from his or her own vision, intuition, taste and experience, the identification of what is educationally relevant. There are no objective criteria or fixed processes to follow.

- *Pragmatic:* Curriculum development requires close interaction with local practice and those who actually use the product (Parsons & Beauchamp, 2012).

Haigh (2013) provided a useful, and pragmatic model (Figure 30) of curriculum design based on the following concept of a curriculum.

> A set of views about (a) intended learning outcomes, (b) learner activities that will enable achievement of those outcomes and provide evidence of their achievement, (c) teacher activities that will facilitate the learning and assessment activities of learners, (d) the people who will be involved in particular learning, teaching and assessment activities, (e) the location, timing and duration of learning, teaching and assessment activities, (f) the tools and resources that learners and teachers will use, and (g) the *interrelationship* and required *alignment* of these components of a learning environment (p. 1).

These views are influenced in turn by the curriculum designer's views about such considerations as the purposes of education and training, the nature of learning and teaching, the possible future worlds and lives of students. Haigh (2012) identified the key considerations and decisions that need addressing in the design of a course or individual unit of study, as illustrated in Figure 30.

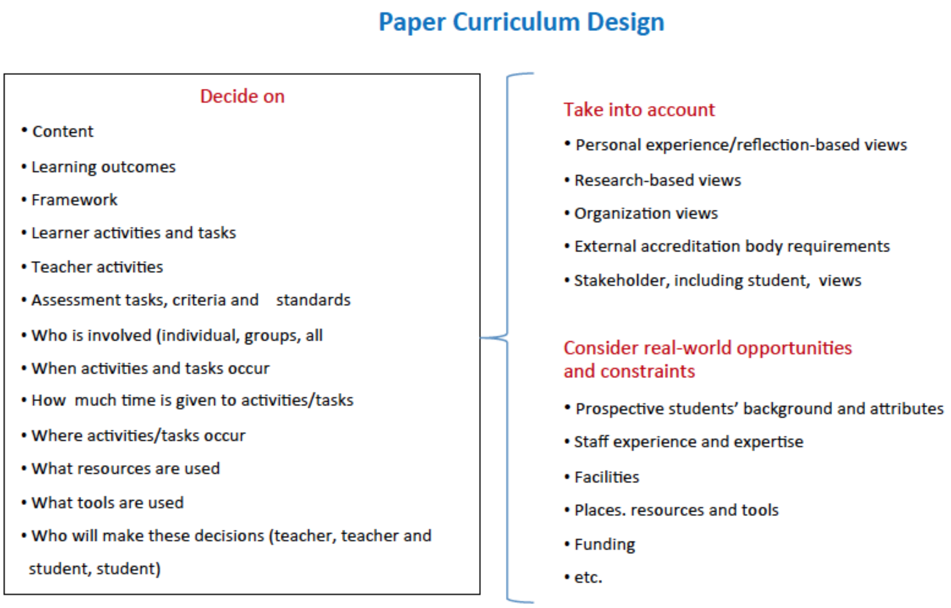

Figure 30. Course design considerations (Haigh, 2012)

I also identified the need to align the arrangement of elements of a learning environment to ensure that they formed a coherent and well-designed system: constructive alignment was a key criterion for a well-designed curriculum.

5.2 Constructive alignment

The concept of constructive alignment, which was developed by Biggs (1996), has roots in both constructivism and curriculum theory and represents a connection between a constructivist understanding of the nature of learning, and an 'aligned' design for an outcomes-based teaching education. "Constructive comes from the constructivist theory that learners use their own activity to construct their knowledge through its own schemata" (Biggs & Tang, 2011, p. 97).

Constructive alignment provides a principle for identifying and aligning all the elements of the learning environment, and the balancing of desirable learning outcomes, learning activities, with assessment (C. Jones, 2006). "Alignment is the principle in curriculum theory that assessment tasks should be aligned to what is intended to be learned, as in criterion referenced assessment" (Biggs & Tang, 2011, p. 97). Biggs and Tang also noted that when using constructive alignment, it is important to state the intended learning outcomes as activities, as well as topics. For example, outcomes may include, to *explain,* to *construct*, to *communicate*. From a critical realist perspective, these activities could be described as mechanisms.

Aligning with my conceptualisation of curriculum described previously, constructive alignment can also be perceived as a more systemic theory that regards the total learning and teaching context as a whole and as a system. "To understand the system, we need to identify and understand the parts of the system and how they interact and affect one another" (Brabrand, 2007, p. 2). In this sense, constructive alignment encouraged me to consider, more holistically, all aspects of the design thinking curriculum, and associated learning environment during the design process.

5.3 Curriculum design: My model

As noted, I conceptualised a design thinking curriculum as a plan that informs and guides decisions about a learning environment that is intended to optimise students' learning of design thinking. Using the Haigh (2012) framework, and the concept of constructive alignment (Biggs, 1996), I developed my own initial process model to help me to make these decisions. This model is presented in Figure 31 below.

The process model included two key steps. The first step involved making decisions about the disciplinary and professional knowledge concerning design thinking that I wanted students to acquire (the subject matter) and the student groups who would experience the curriculum. I also took into account university regulations and requirements that would influence the learning environment (such as timetabling of teaching sessions, the allocation of teaching rooms, and course credit values). The second step involved making decisions about the various elements of, and considerations for, a curriculum, including their alignment. These decisions were influenced by theories on learning and teaching that I subscribed to.

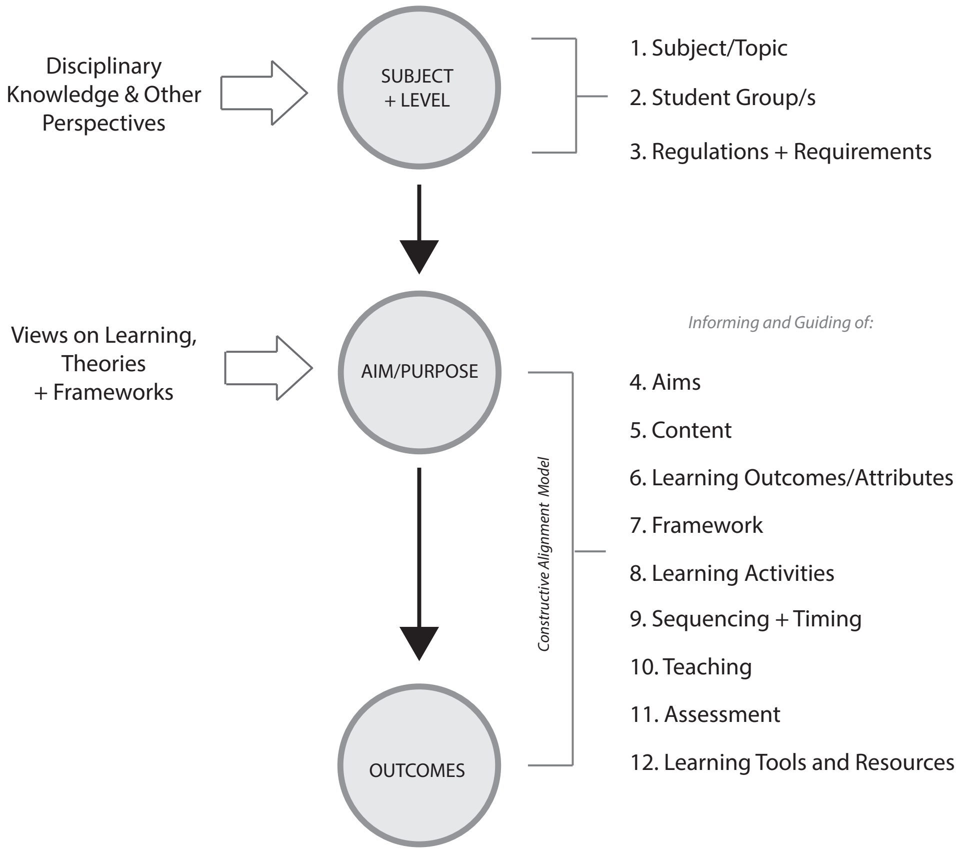

Figure 31. My curriculum design model

Table 10 provides a summary of the key considerations for the curriculum design.

Table 10. Curriculum considerations

Considerations (decisions about)	Description
Aims	The aims, or purposes of the design thinking curriculum.
Content	The aspects of design thinking that students are intended to acquire knowledge about.
Outcomes	The knowledge and associated capabilities/mechanisms that students are intended to develop for specific aspects of design thinking.
Framework	The sequence in which particular outcomes will be addressed during the course, the weighting of time and credit value given to specific outcomes and the designation of

	outcomes as compulsory or elective.
Learning Activities	The learning activities that students will engage in to achieve each of the learning outcomes.
Sequence and Timing	The sequence and timing of learning and teaching activities associated with particular outcomes.
Teaching	The activities that teachers engage in to guide learning activities (as above).
Assessment Events, and Criteria	The tasks that students will undertake to provide evidence of their learning and 'measures' that are used to represent evidence of the degree to which particular learning outcomes have been met.
Learning and Teaching Resources and Tools	The resources and tools that will be used to enable and support learning and teaching activities.

SECTION TWO: DESIGN OF THE INITIAL 'IDEAL' DESIGN THINKING CURRICULUM

In this section, I describe the design of the initial 'ideal' design thinking curriculum, based on application of the curriculum design framework outlined above. In addition to a description of the two student groups who experienced the curriculum, and a brief description of institutional considerations and requirements, the chapter is structured around the key curriculum considerations identified in the framework. I also review learning theories that influenced my decisions about these considerations. Selected examples of the curriculum documentation are presented to illustrate the design process and decisions. It is important to note that while these considerations are presented in a sequential order, in reality many of these were developed in a parallel and iterative manner.

5.4 Student groups

The curriculum was designed for the following student groups:

1. *First-year, Bachelor of Design students.* The Bachelor of Design is a three-year, undergraduate degree programme with approximately 700 students studying across six major discipline areas. At the time of the curriculum development, the Product Design major had approximately 90 students. The curriculum was to be enacted with students as a 12-session, six-week project within a course titled *Product Design Studio II*.
2. *First-year, Bachelor of Business students.* The Bachelor of Business is a three-year, undergraduate degree programme with approximately 2000 students studying across six major discipline areas. The curriculum was to be enacted with students across a 12-session, 12-week course titled *Design Thinking*.

Given that two contrasting groups would experience the curriculum, some aspects needed to be able to be modified, if required, when enacted. However, the overall learning outcomes, key learning activities and assessment tasks and criteria would remain the same.

5.5 Institutional considerations and requirements

The Bachelor of Design, Product Design major, and Bachelor of Business are both New Zealand university approved programmes of study, and are subject to the rules and regulations governing all university programmes. They also need to take account of the university's policies and plans for learning and teaching and are overseen by the Boards of Studies and Examination Boards of the respective schools.

To fulfil the requirements of these bodies, I needed to ensure that:

- Learning outcomes aligned with those prescribed for university undergraduate level programmes and attributes within the university graduate attribute profile. Both courses were level five.
- Taught and independent learning hours for both versions of the curriculum did not exceed 360 learning hours.
- Assessment, moderation and student feedback processes followed university processes.
- Timetabling and room requirements could be fulfilled and where appropriate, learning resources be accessed from the university online learning system.

5.6 Curriculum aim

The aim of the curriculum was to develop the design thinking expertise of first-year, undergraduate design and business students.

5.7 Curriculum elements – first thoughts

As a first step in the design process, I developed the following mind map of elements of the curriculum, and their potential relationships. This map is presented in Figure 32. This exercise surfaced my initial thoughts that were then considered more rigorously using the design framework.

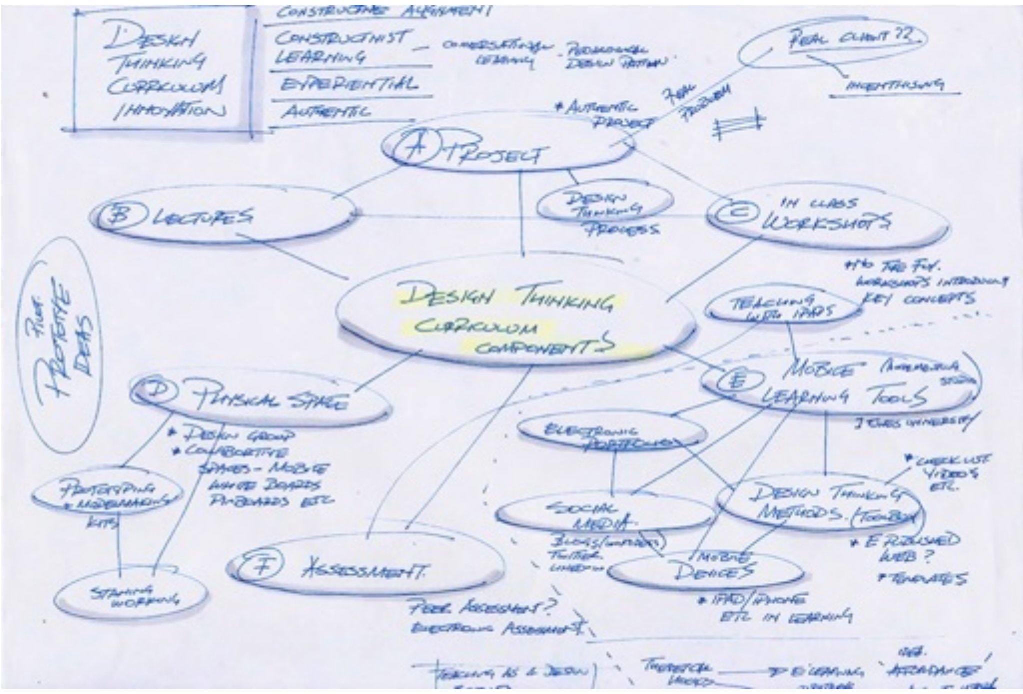

Figure 32. Mind map of curriculum elements

5.8 Content

Drawing on my previous experiences and the findings of the literature review, I formulated a concept of design thinking which was summarised in the following definitions:

> Design thinking is a methodology, underpinned by an interrelated set of mindsets, cognition and reasoning processes and practices, which can be utilised across a range of situations and contexts, to frame and creatively solve problems that may be complex and ill-defined.
>
> The 'designed' outcomes from design thinking are diverse and generally defined as the best solution or idea for the problem and the related context. Outcomes can include, but are not limited to, products, spaces, graphics, services, business ideas, systems, organisations and experiences and processes. Outcomes can often be referred to as an *innovation*.

On the basis of this concept, I elaborated key aspects of design thinking that the curriculum would focus on. These aspects represented personal attributes that someone would require to engage effectively in design thinking. These are presented in Table 11.

Table 11. Attributes of the design thinker

Attributes of the Design Thinker	
Mindsets	**Practices**
Motivated *Optimistic* *Empathic* *Inquisitive* *Emancipatory*	*Collaboration* *Empathic Research* *Problem Reframing* *Creative Practice* *Sketching/Drawing* *Concept Development* *Concept Testing* *Communication* *Reflective Practice*
Cognition and Reasoning Processes	
Analytical Thinking *Intuitive Thinking* *Abstract Thinking* *Creative Thinking* *Synthetic Thinking* *Reflective Thinking*	

Each of these attributes was further defined, as presented in Tables 12 to 14.

Table 12. Design thinking mindsets

Mindsets	Definition/ Attribute (Has)
Motivated	The personal drive and motivation to utilise design thinking practices and cognitive processes
Optimistic	An optimistic outlook when approaching design thinking problems
Empathic/Human-centred	Sensitivity to the needs of others
Inquisitive	A motivation to be inquisitive and ask questions
Experimental	A personal drive to explore, try and test new ideas and concepts
Emancipatory	A motivation to improve the lives of others

Table 13: Design thinking practices

Practices	Definition/ Attribute (Can)
Collaborative Practices	Collaborate with others in team situation/context.
Empathic Research Practices	Undertake empathic research, including observing people, interviewing and roleplaying
Problem Reframing Practices	Reframe ill-defined and complex problems into manageable and workable problems
Creative Practices	Create a broad range of ideas and possible solution in response to reframed problem
Concept Development Practices	Iteratively develop ideas using drawing/sketching and 3D prototyping
Communication Practices	Communicate ideas through verbal and visual means, process, ideas and concepts
Reflective Practice	Reflect on own learning

Table 14: Design thinking cognition and reasoning

Cognitive Processes	Definition/ Attribute (Can)
Analytical Thinking	Spot patterns, and articulate findings using available information.
Abstract Thinking	Develop concepts from ideas.
Creative Thinking	Generate new ideas and concepts.
Abductive Reasoning	Logically infer from observation and other data (best guesses) opportunities, directions and solutions.
Synthetic Thinking	Combine one or two or more entities that together form something new.
Concrete Thinking	Resolve ideas and concepts so they become increasingly logical, coherent, appropriate and meaningful.

Another key aspect of the content was an overall design thinking methodology, which involved a series of design thinking practices. This was a framework for integrating and sequencing the aspects identified above when undertaking design thinking. This is elaborated in Section 5.10.1.

5.9 Learning outcomes

A widely adopted way of conceptualising and stating learning outcomes involves identifying:

(a) An attribute or property that can be developed or changed (e.g., knowledge concerning methods of reframing).
(b) A new capability that the learner is intended to become able to exercise in relation to this attribute (e.g., apply reframing methods).
(c) A context in which this capability can be used (e.g., apply reframing methods when solving ill-defined design problems).

This approach has some parallels with a critical realist perspective on learning outcomes (effects). Learning outcomes represent changes in someone's personal attributes, such as the development and acquisition of knowledge that can be attributed to their exercise of learning mechanisms (capabilities). When these attributes change, students may acquire new mechanisms or improve their ability to activate existing mechanisms effectively. My view about appropriate learning outcomes for the curriculum was also influenced by literature on learning taxonomies and the development of expertise.

5.9.1 Learning taxonomies

There are several taxonomies of learning, which identify domains of attributes that may change as an outcome of learning. Curriculum designers have utilised learning taxonomies to help them conceptualise learning outcomes. The most widely known and used taxonomy, which was developed by Bloom (1965), differentiates three domains and related capabilities (mechanisms).

- Cognitive Domain. The cognitive domain concerns the development of knowledge. Mechanisms exercised in this domain include *remembering* and *recognition* of knowledge comprehension, *application, analysis, synthesis, and evaluation*.
- Affective Domain. The affective domain concerns development of feelings, values and emotions. Mechanisms exercised in this domain include *receiving, responding, valuing*, and *organising* through to *characterising*.
- Sensorimotor Domain. The sensorimotor domain concerns the development of manual or physical capabilities. Mechanisms exercised in this domain include *moving, exercising*, through to *touching* and *sensing.*

Within each domain, more specific mechanisms have been identified. For example, within the cognitive domain, *analysing* subsumes *discriminating, distinguishing, focusing, selecting, integrating,* and *outlining.*

There have been several revisions of Bloom's taxonomy. For example, Anderson et al. (2001) redefined the cognitive domain as the knowledge/cognitive domain, added a social domain, and differentiated process, content and purpose for the respective domains. Dettmer (2006) subsequently added a 'unified' domain to the taxonomy. This is presented in Table 15.

Table 15. Developing human potential in four domains with unification for learning and doing (Dettmer, 2006, p. 73)

Domain	1. Affective	2. Cognitive	3.Sensorimotor	4. Social	Unified
Process	Feeling	Thinking	Sensing and moving	Interacting	Doing
Content	Emotional	Intellectual	Physical	Sociocultural	Holistic
Purpose	Enhance feeling	Expand Thinking	Cultivate senses and movement	Enrich relationships	Optimise potential
Goal	To develop self	To gain knowledge	To nurture self-expression	To cultivate socialisation	To realise self-fulfilment

L. Anderson et al. (2001) further differentiated the knowledge domain into four types of knowledge:

1. *Factual knowledge:* Knowing the basic elements that students must know.
2. *Conceptual knowledge:* Knowing the interrelationships between basic elements.
3. *Procedural knowledge*: Knowing the steps of procedures needed to do something.
4. *Metacognitive knowledge*: Awareness of one's own cognition.

Biggs (1999) provided a similar taxonomy, which included the concept of *functioning knowledge*. His taxonomy included:

1. *Declarative knowledge*: Knowing what, or knowing about the content of knowledge, sometimes called conceptual knowledge.
2. *Procedural knowledge*: Knowing how to do things.
3. *Conditional knowledge*: Knowing when to do things.
4. *Functioning knowledge*: Knowing why as well as when to employ the first three types of knowledge to solve problems and function as an effective professional.

5.9.2 Levels of learning and expertise

Given the curriculum enactment was confined to 12 sessions, I needed to consider a level of design thinking expertise that it would be feasible for students to develop in this timeframe. When considering this, I also needed to consider the level of expertise that students might already have at the beginning of the programme. The design students had encountered some relevant design concepts and processes already that business students would be unfamiliar with. I drew on three frameworks, (a) Anderson et al. (2001) and Biggs (1999) as described above, (b) Biggs and Collis (1982), and (c) H. Dreyfus and Dreyfus (1986), when making these judgments.

Associated with learning taxonomies is the assumption that cognitive activities can be differentiated along a continuum from simple to complex and that experts are able to engage in the more complex activities. Therefore, specific cognitive activities associated with evaluating and creating are more complex than those required for remembering and understanding.

The Biggs and Collis (1982) SOLO taxonomy conceptualises learning as a progression through surface, deep and conceptual levels and classifies learning outcomes in terms of their level of complexity. The five levels of learning are summarised in Table 16.

Table 16. Summary of the SOLO taxonomy (Biggs, 1996, p. 352)

Level	Description
Pre-structural	The task is not attacked appropriately; the student hasn't really understood the point and uses too simple a way of going about it.
Unistructural	One or a few aspects of the task are picked up and used (understanding as nominal).
Multistructural	Several aspects of the task are learned but are treated separately (understanding as knowing about).
Relational	The components are integrated into a coherent whole, with each part contributing

	to the overall meaning (understanding as appreciating relationships).
Extended Abstract	The integrated whole at the relational level is reconceptualised at a higher level of abstraction, which enables generalisation to a new topic or area, or is turned reflexively on oneself (understanding as far transfer, and as involving metacognition).

The H. Dreyfus and Dreyfus (1986) expertise framework identifies five levels of expertise: novice, advanced beginner, competent, proficient and expert. These levels are presented in Table 17.

Table 17. Levels of expertise (H. Dreyfus & Dreyfus, 1986)

Expertise Level	Basic Description
1. Novice	Behaviour is detached and rule-governed with no exercise of 'discretionary judgment' about what is significant in situations
2. Advanced Beginner	Learns from reflection on experience but has limited 'situational perception'; takes limited responsibility for performance
3. Competent	Has an analytic awareness of what is involved. Develops goals, plans, points of view and formulates routines
4. Proficient	Is analytical, involved and has a holistic view of situations; uses maxims to guide decisions
5. Expert	Has an intuitive grasp of situations based on deep, tacit understanding.

In addition to the levels described above, Dorst and Reymen (2004) have described a 'visionary' level of design expertise which sits beyond the expert level. A visionary person consciously strives to extend the domain in which he or she works and "develops new ways things can be, defines the issues, opens new worlds and create domains" (Dorst & Reymen, 2004, p. 3).

Several authors have explored the use of the H. Dreyfus and Dreyfus (1986) model in defining design expertise (Ahmed, Wallace, & Blessing, 2003; Cross, 2004; Dorst & Reymen; Lawson & Dorst, 2009), which further validates the use of an expertise framework in this research.

Based on the frameworks described above, I developed my initial thoughts regarding expertise levels in relation to the learning and teaching of design thinking. This is presented in Table 18.

Table 18. My initial thoughts regarding a design thinking expertise framework

Level	Expertise levels in relation to the learning and teaching of design thinking
1. Novice	• No experience or limited experience of design thinking practices. • Not sure what to attend to when engaged in design thinking. • Design problems should be relatively simple, and well defined. • Needs a well-defined, but relatively simple design thinking methodology, and associated process model. • Needs to be given 'getting started' rules for a limited number of design practices. • Very detached from the problem or situation.

	• Needs close support, including highly structured learning activities and teaching, and access to learning resources.
2. Advanced Beginner	• Has developed basic conceptual, procedural and conditional knowledge of design thinking practices. • Design problems can be more complex, but need to be well defined. • Continues to need a well-defined and detailed methodology and set of practice rules to guide practice. • Begins to construct some rules for design practice by reflecting on experiences. • Still somewhat detached from the problem or situation. • Teaching needs to be relatively directive.
3. Competent	• Has developed extensive conceptual, procedural, conditional and functional knowledge of design thinking. • Has an analytic awareness of the knowledge required for design thinking. • Can adapt design thinking methodologies and practices to fit own needs and specific design problems. • Design problems can be ill-defined and complex. • Takes ownership, is emotionally connected to situation and feels responsible for the 'designed' outcomes. • Establishes goals and constructs plans for design thinking activities. • Teaching can be relatively 'hands off' but critique and some guidance is needed.
4. Proficient	• Draws on extensive conceptual, procedural, conditional and functional knowledge of design thinking using intuition. • Creates own practices, adapts methodologies and practices from other areas. • Design problems can be ill-defined and complex, and involve multiple contexts and situations. • Very limited guidance needed. • Further development of expertise facilitated by discussion of and reflection on design thinking case studies.
5. Expert	• Has an expert level of conceptual, procedural, conditional and functioning knowledge of design thinking. • Design problems can be ill-defined and very complex across multiple contexts and situations. • Works very holistically, intuitively, and relatively unconsciously, and with deep understanding. • Takes full ownership, is emotionally connected and feels responsible for 'designed' outcomes. • No guidance needed. • Continuing development facilitated by encounters with critical incidents.

5.9.3 Learning outcomes

Given the curriculum enactment timeframe, I decided to place most emphasis on design thinking attributes associated with the knowledge and affective domains. The latter was important given the significance of empathy, which involves mechanisms from both domains. While there were other domains and related mechanisms (e.g., sensorimotor domain – drawing mechanism), time was too limited to focus on them adequately. I wanted to avoid overloading the cognitive capabilities of students who were at the novice or advanced beginner levels of expertise.

I also concluded that the Biggs (1999) taxonomy would be helpful given that four forms of knowledge could be associated with most aspects of design thinking. For example, when students acquire conceptual knowledge about collaboration, they may be able to *define* and *describe* collaboration. When procedural knowledge about collaboration is acquired, they may be able to *order* steps involved in establishing a collaboration. With conditional knowledge, they may be able to *select* collaboration processes and tools that fit particular stages in a design thinking project. Functional knowledge may enable them to *select* and *integrate* conceptual, procedural and conditional knowledge required for collaboration during a design thinking project. The development of students' functional knowledge concerning key design thinking practices was a primary aim of the curriculum.

I developed the following goals with respect to level of expertise development.

(a) Biggs (1999) Taxonomy: By the end of the programme, students would be able to *remember*, *understand* and *apply* declarative, procedural and conditional knowledge about the attributes of design thinkers.
(b) Biggs and Collis (1982) SOLO Taxonomy: By the end of the programme, all students would be at a multi-structural level and some would be at a relational level.
(c) H. Dreyfus and Dreyfus (1986) Expertise Framework: By the end of the programme, all students would be advanced beginners with respect to their ability to apply a design thinking methodology and associated practices.

Based on the frameworks described above, I developed the following key learning outcomes for the curriculum. These outcomes explicitly place the emphasis on students' development of specific design thinking practices and their ability to apply them using a design thinking methodology. To utilise these practices effectively they need relevant conceptual, procedural, conditional and functional knowledge.

I anticipated that at the end of the curriculum enactment, students would be able to:

1. Define, provide examples of, select, sequence, and apply specific practices involved in design thinking.
2. Define and apply cognitive and reasoning processes required to undertake specific design thinking practices.
3. Describe and apply key steps involved in a design thinking methodology.

4. Describe and demonstrate the features of key design thinking mindsets.

5.10 Framework

Constructing a framework for the curriculum involved making decisions about the sequence in which content and related outcomes would be addressed, the time that would be allocated to areas of content and whether students would have opportunities to make decisions about content and outcomes.

5.10.1 Sequence

There are a number of criteria that can be used to make decisions about sequencing. Some of the criteria identified by Haigh (2013) include logical, psychological, whole to parts, parts to whole, procedural, personal theory to academic theory, and academic theory to personal theory.

I decided that following a brief overview of design thinking, the programme structure would have a procedural basis: it would be based on the sequence of processes and practices that may be engaged in during a design thinking project; that is, a design thinking methodology. The methodology that I adopted was based in part on two existing models: (a) the Stanford University, d.school process model (d.school, 2010) and (b) the Beckman and Barry (2007) model.

The Stanford University, d.school process model identified key stages in a design thinking process, each comprised of a number of key design thinking methods. This is presented in Figure 33.

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Figure 33. Design thinking process model (d.school, 2010, p. 3)

The Beckman and Barry (2007) model, on the other hand, described a cyclic process that linked four stages to cognitive thinking styles and modes. This is presented in Figure 34.

Image removed due to copyright restrictions.

Figure 34. Cyclic design thinking process (Beckman & Barry, 2007, p. 30)

Drawing on these models, I first developed a 'hybrid' methodology that I considered appropriate for a university undergraduate level curriculum. The model represented design thinking as a four-stage, cyclic process, with each stage potentially involving a number of specific design thinking practices and their associated processes. This model is presented in Figure 35.

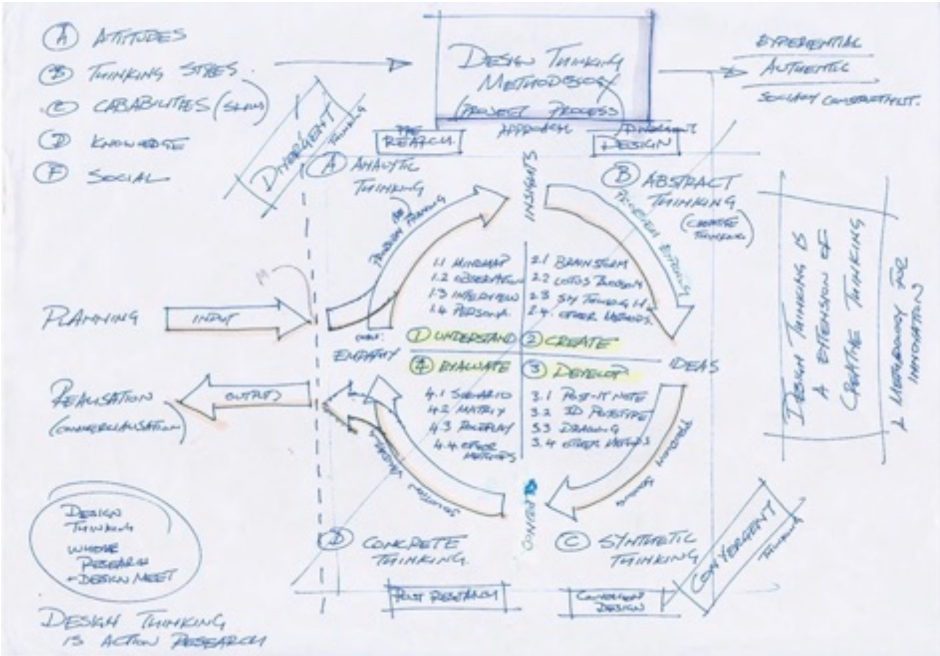

Figure 35. Sketch of design thinking process model

Figure 36. Design thinking methodology

Based on this model, I then conceptualised a design thinking methodology, which included two more stages (Initiate and Communicate stages) presented in Figure 36. Each stage was named and associated practices listed.

This methodology was further modified as I continued to review other models. I selected and adapted individual practices from other design thinking curricula including the d.school *Bootcamp Bootleg* method guide (d.school, 2010). I also developed some new practices that I believed were important for the curriculum. New practices included teamwork practices, reflective practice, and knowledge gathering. This methodology became the sequence aspect of the curriculum framework. The key stages and associated practices of my methodology are presented in Figure 37.

1. Initiate	2. Investigate	3. Generate	4. Ideate	5. Evaluate	6. Communicate
COLLABORATION	KNOWLEDGE GATHERING	OPPORTUNITY DEFINING	IMPOSE CONSTRAINTS	CONCEPT CRITIQUING	STORYTELLING
BEGINNERS OUTLOOK	OBSERVATION	BRAINSTORMING	SKETCH IDEATE	CONCEPT MATRIX	FINAL MODEL
ASSUMPTION MAPPING	ROLEPLAYING	LOTUS BLOSSOM	QUICK-FIRE PROTOTYPING	SCENARIO BUILDING	PRESENTATION BOARD
REFLECTIVE PRACTICE	INTERVIEWING	IDEA HARVESTING			
PORTFOLIO	PERSONAS				
	EMPATHY MAPPING				
	POINT-OF-VIEW (POV)				

Figure 37. Summary of design thinking practices

Through a process of further consultation and negotiation with the teachers for the first cycle of curriculum enactment, I finalised a detailed summary of the content for each week for both in-class and out-of-class learning. This is presented in Figure 38.

	Hour 1	Hour 2	Hour 3	Self-Directed Time
Monday 24th Sept	**General Briefing** **Intro to Design Thinking** *Nick*	Design Thinking in 2 Hours (Workshop) *Steve*		Review Design Thinking Methods in own time.
Tuesday 25th Sept	**Project Briefing** **Intro to Initiate** TEAMWORK *Nick*	BEGINNERS OUTLOOK REFLECTIVE PRACTICE ASSUMPTION MAPPING *Steve*	**Intro to Investigate** KNOWLEDGE GATHERING *Steve*	Continue KNOWLEDGE GATHERING+ Continue Blog and Portfolio *Nick*
Wednesday 26th Sept	OBSERVATION INTERVIEWING ROLEPLAYING *Nick*			Reflect on OBSERVATION + Continue Blog and Portfolio *Steve*
Monday 30th Sept	OBSERVATION INTERVIEWING ROLEPLAYING *Nick*		PERSONAS *Steve*	Continue INTERVIEWING and Roleplaying + Continue Blog and Portfolio *Nick*
Tuesday 1st Oct	EMPATHY MAPPING *Steve*	INSIGHT GENERATION *Steve*	Group Presentation *Nick*	Fine Tune PERSONAS and OPPORTUNITY STATEMENT + Continue Blog and Portfolio *Steve*
Wednesday 2nd Oct	**Intro to Generate** POINT-OF-VIEW OPPORTUNITY STATEMENT *Steve*	BRAINSTORMING *Steve*		Continue BRAINSTORMING + Continue Blog and Portfolio *Nick*
Monday 8th Oct	LOTUS BLOSSOM *Nick*		**Intro to Ideate** IMPOSE CONS TAINTS IDEA HARVESTING *Steve*	Continue SKETCH IDEATE + Continue Blog and Portfolio *Steve*
Tuesday 9th Oct	SKETCH IDEATE *Nick*	QUICK-FIRE PROTOTYPING *Steve*		Continue QUICK-FIRE PROTOTYPING + Continue Blog and Portfolio *Nick*
Wednesday 10th Oct	Group Presentation *Steve*	QUICK-FIRE PROTOTYPING *Steve*		Continue QUICK-FIRE PROTOTYPING + Continue Blog and Portfolio *Steve*
Monday 15th Oct	**Intro to Evaluate** MATRIX EVALUATION *Nick*		QUICK-FIRE PROTOTYPING *Steve*	Continue QUICK-FIRE PROTOTYPING + Continue Blog and Portfolio *Nick*
Tuesday 16th Oct	SCENARIO TESTING		STORYTELLING	Continue STORYTELLING + Continue Blog and Portfolio

Figure 38. Final plan of learning activities

Given that I needed to provide the teachers with more detailed guidance about the sequence of content and learning and teaching activities, I also developed more detailed plans for each class session. While these plans reflected my own teaching philosophy and approaches, I acknowledged that some aspects of their philosophies and approaches might differ from my own. With this in mind, I defined them as ‘prototype’ plans that they could provide feedback on and amend. Out of this process, a final set of session plans was developed collaboratively. An example is presented in Figure 39.

Session 2: Tuesday 25th Sept (afternoon)				
Intro	This session aims to introduce the students to the first stage of the Design Thinking process (Initiate), get students into teams, introduce the project brief and get started on the project through some first research.			
Targeted Learning Goals	1. Values: Be empathic; 2. Attitudes: Be open, curious, inquisitive, and collaborative; 3. Knowledge: Be knowledgeable in Design Thinking theory, principles, examples and case studies; 4. Cognitive thinking: Be able to think effectively in a range of ways including analytical/abstract/synthetic and concrete thinking; 5. Creative thinking: Be able to think creatively; and 6. Practice: be able to effectively apply Design Thinking methods and processes.			
Time	Key Points	Comments	Facilitator Presentation	Structured Learning Activity
Hour 1	Project Briefing - 20 mins...	Hand out project brief and discuss key points.	Yes	
	Intro to Initiate Stage - 10 mins.	Introduce and review the Initiate stage - where it sits in the methodology - why it is important in getting project off to a good start.	Yes	
	Intro to TEAMWORK - 30 mins.	Get students to meet in their groups - elect a leader - set some basic group goals (use template)	Yes	Yes
Hour 2	BEGINNERS OUTLOOK 30 mins.	Introduce BEGINNERS MINDSET method. Get students to meet and discuss in groups (use template)	Yes	Yes
	ASSUMPTION MAPPING - 30 mins.	Introduce ASSUMPTION MAPPING method. Get groups to map basic assumptions i.e immediate travel problems / ferry travel / waiting etc. at (brief).	Yes	Yes
Hour 3	Intro to Investigate Stage - 10 mins.	Introduce the Investigate stage.	Yes	
	7. KNOWLEDGE GATHERING - 20 mins.	Introduce KNOWLEDGE GATHERING method. Get students started on quick internet search on ferrry terminal / history / travel problems / Auckland city etc.	Yes	
Self-Directed	Continue KNOWLEDGE GATHERING + Continue Blog and Portfolio	Remind students to continue to gather relevant knowledge - emphasise that this is quick scanning of the internet - maybe a couple of academic papers - youtube may be useful. There are some useful forums blogs i.e. joelcayford.blogspot.co.nz/2011/03/aucklands-ferry-dis-service.html. Groups should also update their blogs and undertake their first entry in the portfolio.		

Figure 39. Example of an individual teaching plan

5.10.2 Weighting of stages

The six stages of the design thinking methodology mapped relatively well onto the 12 sessions of the course. As a starting point, I developed a teaching plan that distributed each of the stages, and associated design thinking practices, relatively evenly across the 12 sessions (e.g., Investigate = two sessions).

5.10.3 Student choice

Students did not have any choices with respect to the content and specific learning outcomes for the class sessions. However, they could make some limited choices about what practices they could undertake in the design thinking project.

5.11 Learning and teaching activities

Before I made decisions about the learning and teaching activities, I reflected on my previous experience of teaching product design and design thinking and reviewed several research-based theories, principles and approaches about tertiary learning and teaching. The latter included:

1. Constructivism/Constructionism
2. Experiential Learning
3. Reflective Practice
4. Authentic Learning
5. Workshop Learning
6. Other Learning Approaches: Cooperative Learning, Problem-Based learning, Project-Based Learning.

I took these perspectives into account when deciding on learning and teaching activities.

5.11.1 Constructivist learning

Design thinking has been defined as a *constructive* activity and Oxman (1999) proposed that design education should therefore be based on a constructivist approach, which emphasises knowledge acquisition through a process of learning in which knowledge is *constructed*. She also noted that the designer learns the cognitive processes of design thinking, by *constructing* cognitive models.

"Constructivism dominates contemporary learning theory" (Morphew (2009, p. 418), and has its origins in learning theories developed by Dewey (1916), Piaget (1972), and Vygotsky (1978). Learning that is based around constructivist pedagogical principles can be defined as “environments, activities, and methods that are grounded in a constructivist theory of learning, with goals that focus on individual students developing deep understandings in the subject matter of interest and habits of mind that aid in future learning” (Richardson, 1997, p. 1627). It is important to note that *constructionism* is closely related to *constructivism* and is founded on the view that the individual learner constructs mental models to understand the world around them. The constructivist and constructionist approaches to learning and teaching emphasise the development and empowerment of student-centred or student-directed learning.

It is also important to note that given critical realism’s *relativist* epistemology, it can incorporate constructivist notions regarding the construction of knowledge about reality (Al-

Amoudi & Willmott, 2011; T. Newton, Deetz, & Reed, 2011). When commenting on the realist/constructivist divide, Elder-Vass (2012) argued that critical realism is not in conflict with some forms of constructionism: “on the contrary, I argue that a realist constructionism can be more coherent” (Elder-Vass, 2012, p. 9). On reflection, constructivist principles, such as the empowerment of students, also aligned with my own values as a teacher.

With respect to specific implications for learning and teaching activities, I drew on constructivist-based learning principles proposed by Papastergiou (2006). She stated that a constructivist-based learning experience should be characterised by:

> “(a) negotiation of learning objectives; (b) student control over his/her learning; (c) authentic, purposeful and contextual learning; (d) problem solving; (e) collaborative learning; (f) multiple, alternative perspectives; (g) knowledge construction and validation through action and discourse; (h) authentic, contextual assessment; and (i) development of metacognitive skills” (p. 594).

And, with respect to specific learning activities, students should also be able to “articulate ideas, negotiate meaning and collaboratively construct shared knowledge” (p. 602). 6.7.2 Experiential learning

Experiential Learning Theory (ELT), which draws on theories of human learning and development, notably, Dewey (1933), Lewin (1935), and Piaget (1970), offers a holistic and integrative perspective on learning that combines experience, perception, cognition and behaviour (Kolb, 1984). ELT emphasises the process of learning, not the outcomes of learning.

The learning process that is endorsed involves 'reflection on doing’ that can be contrasted with rote or didactic learning. It is a process whereby knowledge is created through the transformation of experience (Kolb, Boyatzis, & Mainemelis, 2000) or “the combination of grasping and transforming experience" (Kolb, 1984, p. 41). Kolb offers a model of experiential learning that differentiates two dialectically related modes of grasping experience (Concrete Experience and Abstract Conceptualisation), and two dialectically related modes of transforming experience (Reflective Observation and Active Experimentation – see Figure 40). He also proposed that “individual learning styles are determined by an individual's preferred way of resolving these two dialectics” (Eickman, Kolb, & Kolb, 2002, p. 1).

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Figure 40. Experiential learning model (Kolb, 1984)

The concept of experiential learning aligns closely with constructivist views of learning and design has traditionally been taught through experiential learning approaches that usually involve project-based learning in studio contexts (Brandt et al., 2013). It is an approach that I have adopted previously when teaching product design and I observed that the model underpinned the d.school design thinking programme. The Kolb model highlighted categories of learning activity that I should emphasise and the potential value of having students undertake a design thinking project that provided an opportunity for active experimentation. The latter would also provide students with the opportunity to develop functional knowledge.

5.11.2 Workshop learning

Workshop learning is often associated with professional learning. In general, a workshop is a short (i.e., 45 minutes to two full days), tightly structured educational programme designed to teach participants practical skills, techniques, or ideas (*Conducting a workshop*, 2013). Workshop learning is intended to be:

- *Participatory*: Participants are active, both in that they influence the direction of the workshop and also in that they have a chance to discuss and practice the techniques, skills, and other materials that are presented.
- *Informal*: Participation involves informal discussion in addition to attending to a teacher's presentation of material.
- *Time limited*: Workshops are often limited to a single session, although some may involve multiple sessions over a period of time (e.g., once a week for four weeks, or two full-day sessions over a weekend).
- *Self-contained*. Although a workshop may end with handouts and suggestions for further reading or study for those who are interested, the presentation, discussion and

practice is generally meant to stand on its own (*Conducting a workshop*, 2013).

I incorporated these features, including the forms of learning and teaching activities, in class sessions.

5.11.3 Reflection and reflective practice

As noted previously, experiential learning emphasises active reflection during the learning process. Reflection involves deliberate thinking about experience in order to learn from it (Atkins & Murphy, 1995). While Schön (1983) introduced related concepts such as 'reflection on action' and 'reflection in action', the notion of reflective practice is much older. Dewey (1933) was among the first to write about reflective practice with his exploration of the relationship between experience, interaction and reflection. Dewey defines reflection as "the active, persistent and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it and the further conclusions to which it tends" (p. 9).

According to Schön (1983), *reflection-in-action* involves tacitly drawing on a knowledge base as we engage with practice tasks. Schön describes it as 'thinking on one's feet' about practice, which goes beyond random thought or 'common sense'. In contrast, *reflection-on-action* involves a higher-level activity, reflecting on the design process itself which "involves 'standing back' and asking if the process is going well, or might be steered differently"(Lawson & Dorst, 2009, p. 299). Schön (1988) others subsequently explored reflection as a key part of the design process (Cross, 2011b; Currano, Steinert, & Leifer, 2011; Reymen, 2003; Roozenburg & Dorst, 1998). The utilisation of reflective practice has been encouraged in design thinking educational programmes (Bruton, 2010; Cassim, 2013; Koria et al., 2011).

I considered that both forms of reflection were relevant to the development of design thinking expertise, and developed learning activities that would prompt students to engage in reflection, as a learning mechanism. The main activity was the requirement that students formally self-reflect in an online blog or written journal, after experiencing the curriculum enactment. A series of questions were posed to help students self-reflect on their learning (see Section 5.12.2). I also explored the development of a model to assist students to self-reflect on their learning. An early sketch of the diagram is presented in Figure 41.

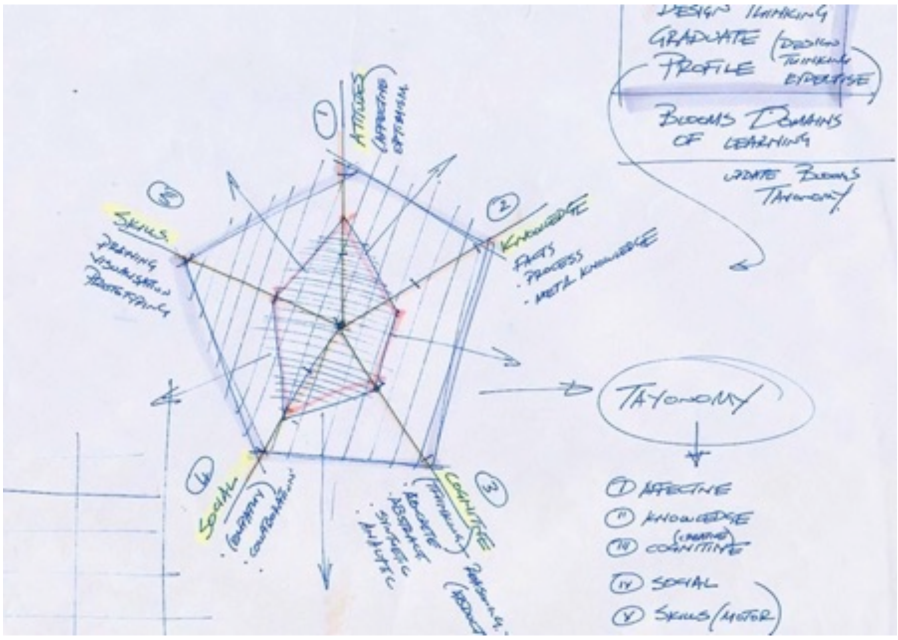

Figure 41. Sketch of student self-reflection diagram

The model prompted students to self-reflect on the extent to which some of their design thinking attributes had extended and improved, i.e., their expertise had developed. Students were asked to draw the position of their expertise a total of three times, before, during and after the curriculum enactment.

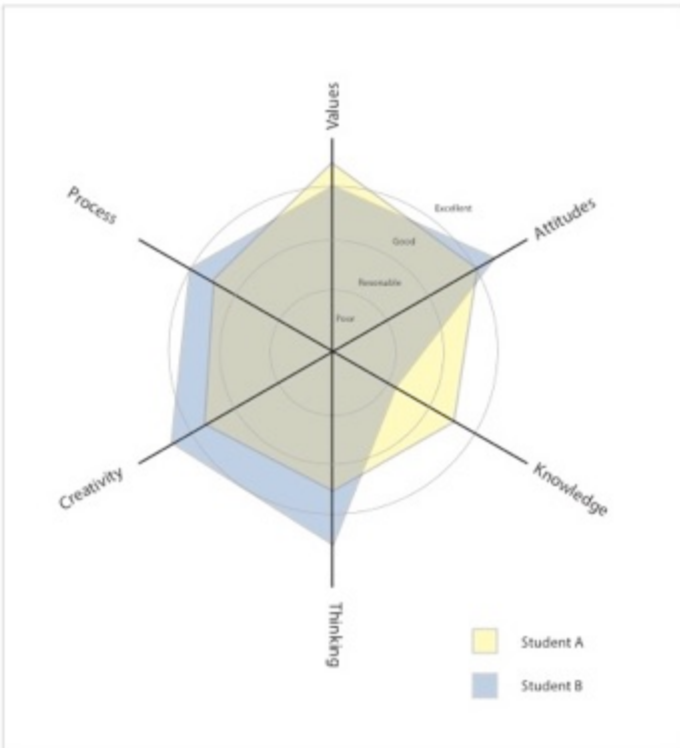

Figure 42. Refined student self-reflection diagram

5.11.4 Authentic learning

While design thinking has emerged from the study of design, it is currently situated within and across a range of disciplines and professional areas and contexts (Bell, 2008; Friedman, 2003; Gloppen, 2009; Howard & Davis, 2011; Stickdorn & Schneider, 2011; Szabo, 2010)Howard & Davis, 2011*authentic*; (Reeves, Heerington, & Oliver, 2002, p. 564)Szabo, 2010). Being cognisant of these contexts, as well as situating the curriculum within appropriate (multiple) *authentic* contexts, is important. Authentic learning can be described as learning activities which "match as nearly as possible the real-world tasks of professionals in practice rather than decontextualized or classroom-based tasks" .

As a central feature of the curriculum, I decided that students should undertake an authentic design thinking project that had the following features. It required students to address a human-centred problem (topic) that:

- Could be understood, but was not completely defined.
- Students could relate to.
- Had rich and accessible ethnographic data available. Students needed to be able to undertake empathic research, such as observation of people in outside environments.
- Could be undertaken collaboratively by groups of three to six students.

I worked with the teachers to define an appropriate design thinking problem.

5.11.5 Other learning frameworks and approaches

I also drew on literature concerning three more learning approaches when making decisions about learning and teaching activities. These approaches are defined in Table 19.

Table 19. Definitions of other learning models and frameworks

Learning approach	**Summary explanation**
Cooperative Learning	The concept of a cooperative learning model emerged in the 1960s. "The cooperative learning model involves structuring classes around small groups that work together so that each group member's success is dependent on the group's success. … There are three basic ways students can interact with each other as they learn. They can compete to see who is best, they can work individualistically toward a goal without paying attention to other students, or they can work cooperatively with a vested interest in each other's learning as well as their own" (Johnson & Johnson, 1994, p. 1).
Problem-Based Learning	In a problem-based learning model, students engage with complex, challenging problems and collaboratively work toward their resolution. PBL is about students connecting disciplinary knowledge to real-world problems—the motivation to solve a problem becomes the motivation to learn (*PBL&UD*,

	2013).
Project-Based Learning	Project-based learning is a model that organises learning around projects comprising complex tasks, based on challenging questions or problems, that involve students in design, problem-solving, decision making, or investigative activities; give students the opportunity to work relatively autonomously over extended periods of time; and culminate in realistic products or presentations (Thomas, 2000). Other defining features found in the literature include authentic content, authentic assessment, teacher facilitation but not direction, explicit educational goals, cooperative learning, reflection, and incorporation of adult skills (Thomas, 2000).

5.11.6 Summary

I concluded that the overall learning approach would be constructivist and involve students in experiential, authentic and collaborative learning activities within workshops designed for each phase of the design thinking methodology. It would also involve students in a group design thinking project that would address a design problem. The approach and related learning and teaching activities is summarised in Figure 43. Table 20 presents the main learning and teaching contexts and activities.

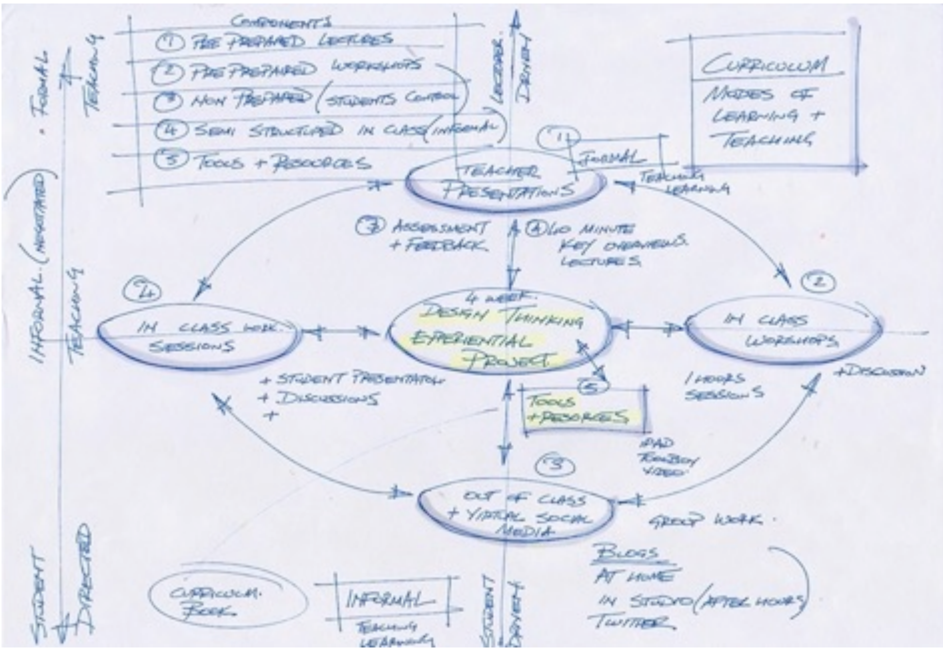

Figure 43. Model of learning approach and activities

Table 20. Description of learning activities

Table of learning and teaching activities	
Group Project Work	A design thinking project undertaken collaboratively by student groups, and with all work documented in a group prepared portfolio. Approximately half of the project undertaken in class time - the other half undertaken independently; teacher direction and guidance as required.
Facilitated Class Workshops	Teacher-facilitated three-hour sessions, which include teacher demonstrations and other hands-on activities, project group meetings, informal interactive discussion between students (groups) and the teacher, and field research involving observation, roleplaying and interviews.
Teacher Lectures/Presentation	Short, but relatively formal, teacher presentations and invited talks focusing on design thinking principles, theories and case studies.
Facilitated Class Discussions	Facilitated discussion between students and teachers, and students and students, often following lectures and presentations.
Student Presentations	Formal presentations by students of their group work for feedback and discussion.
Reflective Practice	Ongoing self-reflection by students on their learning, with reflections recorded in an online blog or journal.

When I had finalised the learning and teaching activities, I prepared a visual model to check whether the relative weighting of time to be given to each of these contexts and activities was compatible with an approach intended to emphasise constructivist, experiential learning principles. This is presented in Figure 44.

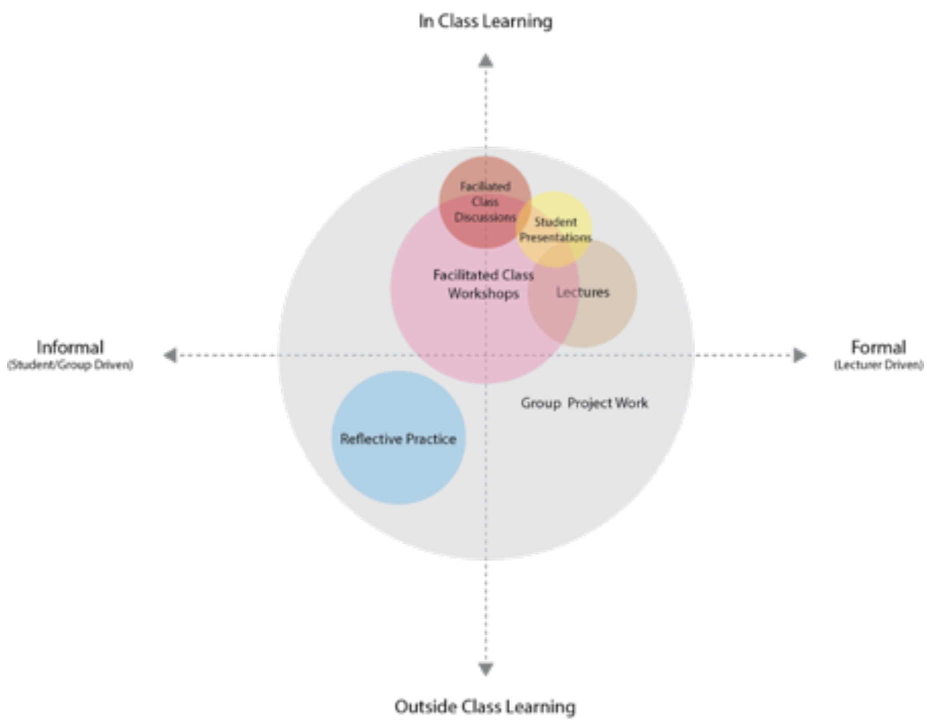

Figure 44. Diagram of weighting and location of learning activities

5.12 Assessment tasks and criteria

I developed two achievement-based assessment tasks: a group design project portfolio (80% of end of course grade), and an individual, reflection-based, self-assessment portfolio (20% of end of course grade). The assessment standards for these tasks took into account the goals I had set for level of expertise development.

5.12.1 Collaborative assessment (Portfolio)

In the portfolio, students collated a range of different forms of evidence of their learning processes and outcomes for the design project. This provided a basis for an assessment of their collective functional knowledge of design thinking. It was decided that the group grade would be awarded to each member of the group.

The types of evidence that they were asked to provide included written text outlining each stage of the design thinking methodology, descriptions of specific practices that their group undertook, and selected photographic images of the practices, such as photographs of research, drawing and 3D prototyping. A template was also developed to assist student groups to develop and manage the portfolio documentation process. An assessment criteria matrix was developed and provided to students when they were briefed on the project. The assessment matrix is presented in Figure 45.

Names:

Design Thinking Project
Group Assessment 80%

You are assessed on your group's portfolio throughout the Design Thinking project. Assessment is based on evidence of your group's achievement in the following stages of the design thinking methodology. Your group is assessed on your definition, description and application and of design thinking practices, and the application of an overall design thinking methodology. You are also assessed on your collaborative practices.

	High Level of Achievement (A Range)	Medium Level of Achievement (B Range)	Low Level of Achievement (C Range)	No Achievement
INITIATE STAGE	Excellent definition, description, and application of DT practices in the Initiate stage.	Good definition, description, and application of DT practices in the Initiate stage.	Reasonable definition, description, and application of DT practices in the Initiate stage.	Poor to no achievement in the definition, description, and application of DT practices in the Initiate
INVESTIGATE STAGE	Excellent definition, description, and application of DT practices in the Investigate stage.	Good definition, description, and application of DT practices in the Investigate stage.	Reasonable definition, description, and application of DT practices in the Investigate stage	Poor to no achievement in the definition, description, and application of DT practices in the Initiate
PROTOTYPE STAGE	Excellent definition, description, and application of DT practices in the Prototype stage.	Good definition, description, and application of DT practices in the Prototype stage.	Reasonable definition, description, and application of DT practices in the Prototype stage	Poor to no achievement in the definition, description, and application of DT practices in the Initiate
EVALUATE STAGE	Excellent definition, description, and application of DT practices in the Evaluate stage.	Good definition, description, and application of DT practices in the Evaluate stage.	Reasonable definition, description, and application of DT practices in the Evaluate stage	Poor to no achievement in the definition, description, and application of DT practices in the Initiate
COMMUNICATE STAGE	Excellent definition, description, and application of DT practices in the Communicate stage.	Good definition, description, and application of DT practices in the Communicate stage	Reasonable definition, description, and application of DT practices in the Communicate stage	Poor to no achievement in the definition, description, and application of DT practices in the Initiate
OVERALL DESIGN THINKING METHADOLOGY	Excellent definition, description, and application of an overall DT methodology	Good definition, description, and application of an overall DT methodology	Reasonable definition, description, and application of an overall DT methodology	Poor to no achievement in the definition, description, and application of an overall DT methodology
COLLABORATIVE PRACTICE	Excellent definition, description, and application of group collaborative practices	Good definition, description, and application of group collaborative practices	Reasonable definition, description, and application of group collaborative practices	Poor to no achievement in the definition, description, and application of group collaborative practices
		Final Group Grade	**%**	

General Feedback

Figure 45. Group portfolio assessment matrix

5.12.2 Individual assessment (Reflection on learning)

At the end of the curriculum enactment, students were asked to individually reflect on their learning development. Their reflections were guided by the following questions which they recorded using an online blog format:

- How did your understanding of key design thinking concepts develop throughout the course (i.e., describe how your understanding of the design thinking practices and the overall methodology developed)?
- How did your ability to apply individual design thinking practices develop? Describe individual design thinking practices that you most enjoyed, and those you found most difficult or you were most challenged by.
- How did your own design thinking attitudes (mindsets) develop? For example, refer to:

- Your motivation for tackling the design thinking problem that you were given.
- Your empathy for and understanding of other people through the research that you and your group undertook.
- Your inquisitiveness and willingness to experiment through creativity.
- Any other attitudes.
- What aspects of design thinking do you think you could apply to your other courses or future work?

Students received an overall letter grade based on these two assessments.

5.13 Learning and teaching resources

I developed a comprehensive set of learning and teaching resources that were intended to support students' independent and group learning. For each practice, a PDF document was compiled for students that included an introduction to the topic, background about the practice, and key instructions, as well as examples of students' work and links to videos, articles and other methods. Careful consideration was given to the visual design and layout of the learning resource to enhance usability and achieve a consistent appearance for all curriculum materials. Figure 46 presents an example of a page from the learning resource.

HARVESTING IDEAS

image sourced from informedfarmer.com

What is it? Harvesting Ideas is the process of selecting ideas from the generate phase of your project for further consideration and development.

Why do it? During the generate phase of your project you will likely come up with a lot of ideas. Some good, some not so good. The idea behind Idea Harvesting is to select the best ones to carry forward into the next phase of your project. You need to consider your ideas carefully in order to choose the one(s) with the most potential. Pick the wrong one(s) and you may hit roadblocks later on in your project.

Methods Make a list of all the ideas generated in the creative phase of your project. Consider the pros and cons of each idea. Pick the idea(s) you think have the most potential and play devil's advocate. Put your best ideas through their paces and find their associated weak points. Refer back to your Opportunity Statement. Keep in mind that as the project moves forward, your investments in time and energy increase rapidly. Choose wisely!

(+) (-) The related benefits of this stage of your project cannot be overemphasised. Choosing ideas with the most potential to move forward can make or break your project. The drawbacks of this process are that often times you need to let go of your personal feelings towards an idea and proceed with the idea(s) best suited to the end user.

Tips Sometimes the quietest, simplest ideas can be overlooked in favour of "wow" factor ideas. Give these simple ideas careful consideration. They can often represent the best solution for the end user.

"Keeping it simple is the best guide for Harvesting Ideas. Look back at your Opportunity Statement and ask which idea best meets the goals of your project."
- Andrew Withell, AUT

DESIGN THINKING METHODS

Figure 46. Example of the design thinking learning resource

Further resources were developed for the teachers, including Microsoft PowerPoint files. More examples are presented in Figure 47.

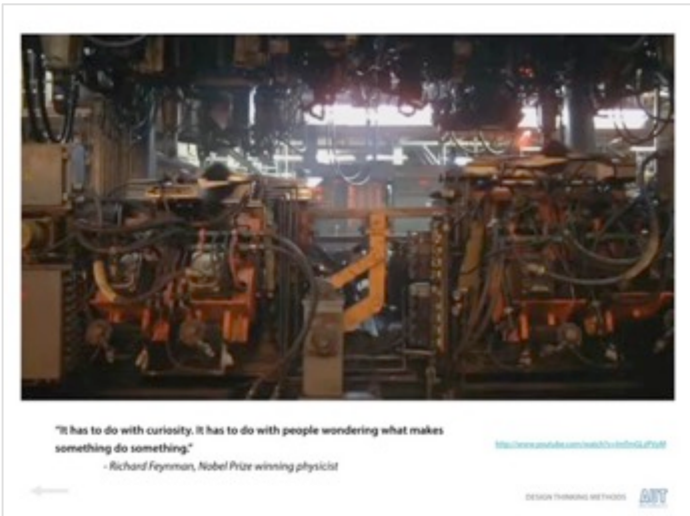

Figure 47. Examples of PowerPoint slides

5.14 The next part

In this chapter I have described the design of an initial 'ideal' design thinking curriculum. As noted in Chapter Five, the concept of an 'ideal' curriculum, sometimes referred to as *intended* or *planned*, is the curriculum that has been *envisioned* and *designed*, but has yet to be put into effect or implemented. I noted that an 'ideal' curriculum was an aspirational concept, which aligned closely with my own personal values as a teacher, curriculum designer and senior academic leader, and my intention as a designer. While I was realistic that a curriculum could never be 'perfect', I strongly believed that a curriculum could be continuously evaluated and improved, to optimise the potential for students' learning.

In the following section of the thesis (Chapters Six to Eight), I provide a detailed description and discussion of the iterative enactment and evaluation of the design thinking curriculum to four groups of students, through three action research cycles. This includes the identification of emergent tendencies, and opportunities for curriculum development and improvement. The outcome of each cycle is a new 'ideal' design thinking curriculum. The action research cycles are presented as case studies.

PART TWO: ACTION RESEARCH CYCLES

CHAPTER SIX: ACTION RESEARCH CYCLE ONE (CASE STUDY ONE)

6.1 INTRODUCTION

In this chapter, I describe the first enactment of the curriculum with a group of product design students (case study one), present outcomes of the utilisation of initial steps in the theorising methodology applied to data gathered from three sources, and summarise opportunities for improving the curriculum for the next action research cycle. These took account of my first attempt to develop explanatory theory. At the conclusion of the chapter, I also present the outcomes of an initial application of a critical realist ontological lens when developing explanatory theory concerning the curriculum enactment and its overall outcomes with respect to student development of design thinking expertise.

It is important to note that while I utilised a critical realist perspective in my research, my knowledge and application of critical realism was emergent. For example, in this cycle, although I completed a qualitative analysis of the data to identify themes and tendencies, my first attempt to utilise abductive and retroductive analysis to identify and map various design student-related thinking mechanisms in operation in the learning environment was limited. At the conclusion of the chapter, I also present some of my reflections on the research process and the implications for the use of critical realist frameworks and methodologies in future action research cycles.

The curriculum was enacted in semester two, 2012, with 24 first-year product design students in a course titled Product Design Studio II. The project was enacted over 4 weeks, three sessions per week, for a total of 12 sessions. Of the 24 students present in the class, 22 agreed to participate in the survey. Figure 48 illustrates examples of images from the learning environment during the curriculum enactment.

Figure 48. Photos of the learning environment during curriculum enactment

As this was my first application of the theorising methodology, there was necessarily some 'learning on the job' and as noted at the conclusion of the chapter, I present some of my reflections on the methodology and implications for its in future action research cycles.

Succeeding sections of the chapter focus on data gathered from three sources:

(a) My reflections as the researcher.

(b) Students' self report data from the survey and interviews.

(c) Student portfolio assessments.

SECTION ONE: RESEARCHER REFLECTIONS

When I analysed my record of reflections on the first enactment of the curriculum, I identified what appeared to be significant features of the enactment, as well as the outcomes with respect to observed tendencies in students' response to the learning environment (i.e. description of event and effects). The analysis was inductive. At the end of the section, I present a 'map' that summarises features of, and possible relationships between, the curriculum, the learning environment, and students' responses that I concluded were significant and that it would be helpful to develop explanatory theory about. This represented application of analytic resolution. While I recognised that I was also moving to abductive reasoning, this was limited in time and depth and I was not intentionally using a critical realist ontological lens when doing this. Possible relationships between some of features are suggested in the map. It should be noted that some theorising spontaneously occurred as I talked with the teachers after classes, and this proved to be a productive context for this work.

I cover the pre-enactment, enactment, and post-enactment periods. Examples of my reflections (in italics) are used to illustrate key points[8].

6.2 Pre-enactment

The pre-enactment period included gaining research ethics approval, the briefing of teaching staff, some negotiation of final curriculum details and subsequent adjustments to the curriculum, and the recruitment of student participants. The final negotiation and adjustments to the curriculum were made during the two weeks leading up to the curriculum enactment.

6.2.1 Briefing, negotiation and agreement

One of the most crucial aspects of the enactment of the curriculum was the need for an agreement from staff to enact (teach) the curriculum as part of their teaching load. During briefing, I was very careful to be mindful and upfront with the staff members about the power relationships involved, and the overall commitment required. I found the process relatively straightforward, with a small amount of negotiation and adjustment in teaching plans and other curriculum details.

From my briefing and discussions with the teaching staff, I noted that they had a genuine interest and desire to explore design thinking within the programme curriculum, to improve teaching methods and approaches, and enhance the learning outcomes of students. It also became apparent to me how much of a commitment teaching this course as part of my research was for teaching staff, even though they were not participants in the research.

> *They are on board, but I'm beginning to realise more about the implications of the curriculum i.e. how much work it will be, what they will need to do, and how organised they will need to be.*
>
> *I think they are realising that they will have to 'give up' some of their own thoughts and approaches to teaching to run with my curriculum. It will really make me question how*

[8] Note: Teachers are referred to as Teacher One and Teacher Two.

easy it will be for someone to enact 'my' curriculum when so much has been prepared by me.

I also noted how important it was to get a good understanding and 'buy-in' from the teaching staff regarding the curriculum philosophy and teaching approach.

This is an important (and ongoing) process for me to get their 'buy-in' and also get their feedback before they enact the curriculum.

Developing a curriculum for others to implement is a careful process of negotiation (what/when/how etc.). Many factors are at play including power relations, philosophical approaches to teaching and to the views on content.

I also noted how important it was that I responded as much as possible to the needs of teaching staff during negotiation and planning. This required a careful balancing of my overall vision (in relation to my concepts of design thinking, and approaches to teaching), with the needs/wants/requests of the teaching staff. For example, I needed to negotiate the roles of the two teachers, and how they would share the teaching load.

The lead teacher will give presentations and run the session while the other works more closely with students. I have mapped a lead/support plan onto the overall plan. Hopefully this will be manageable, and will allow the teaching load to be shared a bit and hopefully will be quite productive.

This resulted in good clarity around roles, with one teaching staff member being able to plan and 'gear-up' to lead a session, then take more of a back seat in the following session. Roles were then reversed in the following teaching session.

6.2.2 Need for flexibility

It also emerged through the negotiation process that there were some differences in teaching approaches and philosophical understandings of design thinking between the two teaching staff.

Both facilitators have some philosophical differences around the concepts of design thinking. Maybe we should have talked this through more…

For example, one staff member was very comfortable with delivering the presentations and structure relatively verbatim, while the other wanted to have the presentations earlier, so that they could amend and add/change material and content as desired. While this added some pressure, I was realistic that the different approaches to teaching reflected a normal spectrum of teaching approaches, and that a level of flexibility in response was the key to meeting everyone's needs.

It was also apparent that the different philosophical understandings and teaching approaches could, if handled well, add a richer (more diverse) context to the curriculum. It did raise for me a concern about how well defined or constrained the curriculum should be, and how much opportunity for flexibility in teaching approach, structure and content should be built in.

6.2.3 Participant briefing

Students were briefed as per requirements of the ethics approval by an independent third party. One of the teaching staff elected to be at the beginning of the briefing session to help present an overall context to the programme of study from a department perspective, and provide some background to the project.

> *This does remind me that the 'pitch' to students to be part of the research will be important – remind them of the aims of research, benefits.*

Feedback indicated that this was a very successful session with good questions and discussion from students, and a high level of voluntary agreement to participate (22 of the 24 students agreed to participate).

6.3 Curriculum enactment

The curriculum was enacted with the students over four weeks (three sessions a week for 12 sessions).

6.3.1 Initial teaching

Given the build-up and negotiations concerning the first session, I noted that this was quite a stressful time for all involved. A quick debrief with the teaching staff after the enactment of the first session indicated a slight disappointment in the reaction and overall engagement of the students to the project briefing, and the two-hour design thinking exercise. Expectations had been built quite high, so in hindsight this was probably not too surprising. We concluded that it was also a very different approach from what the students had been used to, and maybe they were not able to respond as quickly and effectively to the curriculum as we had anticipated. It was evident from our discussions that the teaching staff were also very drained from the intensity of the teaching.

I think it went 'alright' – not a 'stellar' result but not a disaster. I think that both teacher one, and teacher two felt pretty drained – and probably a little underwhelmed by the students' engagement – in particular the two-hour workshops. They struggled to get past simple ideas and engage at a higher level.

Following from the first session, a routine however seemed to quickly develop in the teaching enactment, and the debriefing process after each session. I noted that it was interesting to meet up with the staff at the end of each session to get feedback and to debrief about the success or not of the session. Discussion focused on the level of engagement of students, enthusiasm, interactions and discussion and the quality of work produced.

It was good to see, however, that after the initial build-up and disappointment, the feedback after the second session was much more positive.

Caught up with both teacher one and teacher two after today's session. Both felt much more positive about today's session – students were more engaged and seemed to get into it. The teams formed well and worked through each of the methods.

Teacher 1 mentioned he thought the mix of video, presentation, workshop activity, and discussion was good.

6.3.2 Group selection

The process of selecting and allocating students to their working groups was an early talking point, and included the pros and cons of different approaches. After discussion, a decision was made to carefully orchestrate the teams, with high performing students grouped together, and likewise for the other end of the spectrum.

Organising students into groups of three will be very important for the dynamics and success of the 4 weeks – wondering what will the best way to manage be – self form or predetermine.

6.3.3 Emergent issues

The patterns of teaching preparation, briefing of staff, enactment, debrief and teacher/researcher response soon became routine.

I think it is good that teacher one is playing a little with my presentations before he delivers. It helps prepare and gives him some ownership – I would be like him.

Given the evolving nature of the teaching process, I noted that it was important for both staff and myself to be responsive to emergent pragmatic and teaching considerations on an as-needed basis. In many ways this reflects an action research process in itself. Some examples:

> *Some comments about yesterday. Music could have been better in workshop – will need to consider music and be sensitive around this. Will look at this tomorrow.*
>
> *Session 4 went pretty well up to the point that teacher two had some technical problems trying to show video. It always reminds us that we are often at the mercy of technology. When this happens it does seem to slow down the class momentum.*
>
> *I thought I would also add in a quick 'time-out' for the students to collectively in groups take some time to reflect on learning goals. This will help them focus and help with blog writing.*

Overall, the enactment process was relatively straightforward, and anecdotal feedback from staff indicated that students were enjoying the project, were well engaged and working well overall. There was one significant moment in the teaching process when the class did unravel slightly.

> *Session six went well up to the point until teacher two got a little rattled over 'what is a need' – some challenging by students. Doing teaching for the first time is hard – anyway with teacher 1 away I ended up helping out – shouldn't have, but felt needed to jump in to the class to help out…*

6.3.4 Teaching journey

It emerged from the ongoing debriefs and discussions how the 'journey' of the teaching was quite a 'rollercoaster' of emotions for the teaching staff, especially in their reactions to the success (or not) of each session. This varied quite widely from one session to the next.

> *It seems to be up and down on a daily basis – students still have been turning up ready to go at 9.00*
>
> *If Monday's session was a little negative, Tuesday's session swung the other way and was positive, yesterday was somewhere in the middle!*

This was probably partly related to the added expectation of the research, but also generally reflected the nature of the teaching process such as the daily outlook of the staff or general mood/feeling of the students.

6.3.5 Momentum through final stages

The four weeks of curriculum enactment through each stage of the design thinking model were followed by two weeks of relatively independent work by the group to refine the concepts that they had developed, make final 3-dimensional models, prepare a final presentation and complete group process portfolios.

> *The students certainly slowed down when came to 3D prototyping and model-making – this is something we need a strategy on in the future – how to get them into 3D quickly.*

It was clear that when the tight workshop style structure was removed, the momentum of the class noticeably slowed. Both of the teaching staff reported that students were not showing up on time, and were not particularly proactive in seeking help and feedback.

6.4 Post-curriculum enactment

On completion of the curriculum enactment, I conducted two informal debriefing sessions with the teaching staff to review the project enactment, and to reflect on issues and opportunities. I noted a number of key outcomes that were evident from these discussions.

6.4.1 Overall success of the approach and structure

While there was clearly an up and down, 'rollercoaster' ride for staff delivering the curriculum, the teachers' overall feedback on the approach and process, and final results from students, was positive, with both very keen to continue the approach again.

> *Teacher two was pretty upbeat and thought it went pretty well. Teacher one though was a bit more reserved. He thought it was a solid outcome – final models could have been better, as with the presentations.*

I took this as a general endorsement of the curriculum approach. The two staff did wonder how the intense level of preparation and teaching would be able to be maintained if all projects and courses were like this.

6.4.2 Student engagement and impact

From my own observations and the debriefing with the teaching staff, there seemed to be a strong level of engagement with students through the whole project, with motivation having stepped up from the previous studio design project. The project appeared to have a positive impact on the students' engagement, as was evident from students' attendance and enthusiasm and overall attitude to the design thinking project. I noted that the students' engagement did lessen when the tight structure was removed towards the end of the project.

6.4.3 Role of the teacher

It became increasingly evident to me as researcher that, although a great amount of work and effort went into developing and refining the structure, approach, content and associated materials of the curriculum, much of the success (or not) came down to the motivation, drive and ability of the staff who taught it.

> *I reflected on how I can only do so much when preparing the curriculum – so much of the success is down to how it is taught.*

6.4.4 Assessment

The teaching staff noted some difficulty in assessing the work using the criteria provided, which was complicated by the two components of group assessment and individual self-reflection. They also noted that some of the student self-reflections were very lengthy (up to 10,000 words), while others were very short. They did comment that they enjoyed reading the reflections, and how insightful they were in providing insights into students' thinking and their experiences of learning.

6.4.5 Shared reflection

I noted that one of the more enjoyable parts of the teaching and curriculum enactment process was the unique collaboration, and ongoing dialogue, critique and general discussion between the teaching staff and me during the curriculum planning and enactment.

> *Anyway teacher 1, teacher 2 and I have been debriefing quite a bit each morning, if anything this project has given us a mechanism to engage with our teaching programme, content, how we teach etc. Very useful in this regard!*

In addition, one of the positive outcomes of the ethics approval conditions was the need to remove myself from the teaching process, which allowed me to have a more objective view of the teaching process. It also provided a framework and platform to help to discuss the curriculum enactment and the outcomes.

6.4.6 Longer-term planning

Given the relative success of the curriculum enactment, there was some discussion regarding the need for extending the use of design thinking in product design studio projects in the second year of the product design programme, and beyond.

> *This work makes me (and us) realise how important looking at the students' first project will be in the next semester (year). It will be important to pick up some of what we have taught and integrate into the next project to continue with the curriculum.*

Discussion included how to brief other staff members, and make available the overall structure and design thinking resources. I also noted that it would also be important to encourage students to take more ownership and control of their own learning process, and to enable them to adapt what they have learnt for application in other contexts.

6.5 Themes and tendencies

I used a mapping process to categorise tendencies and to show possible relationships between them and features of the learning environment. Key tendencies were grouped around a number of emergent headings, as illustrated in Figure 49.

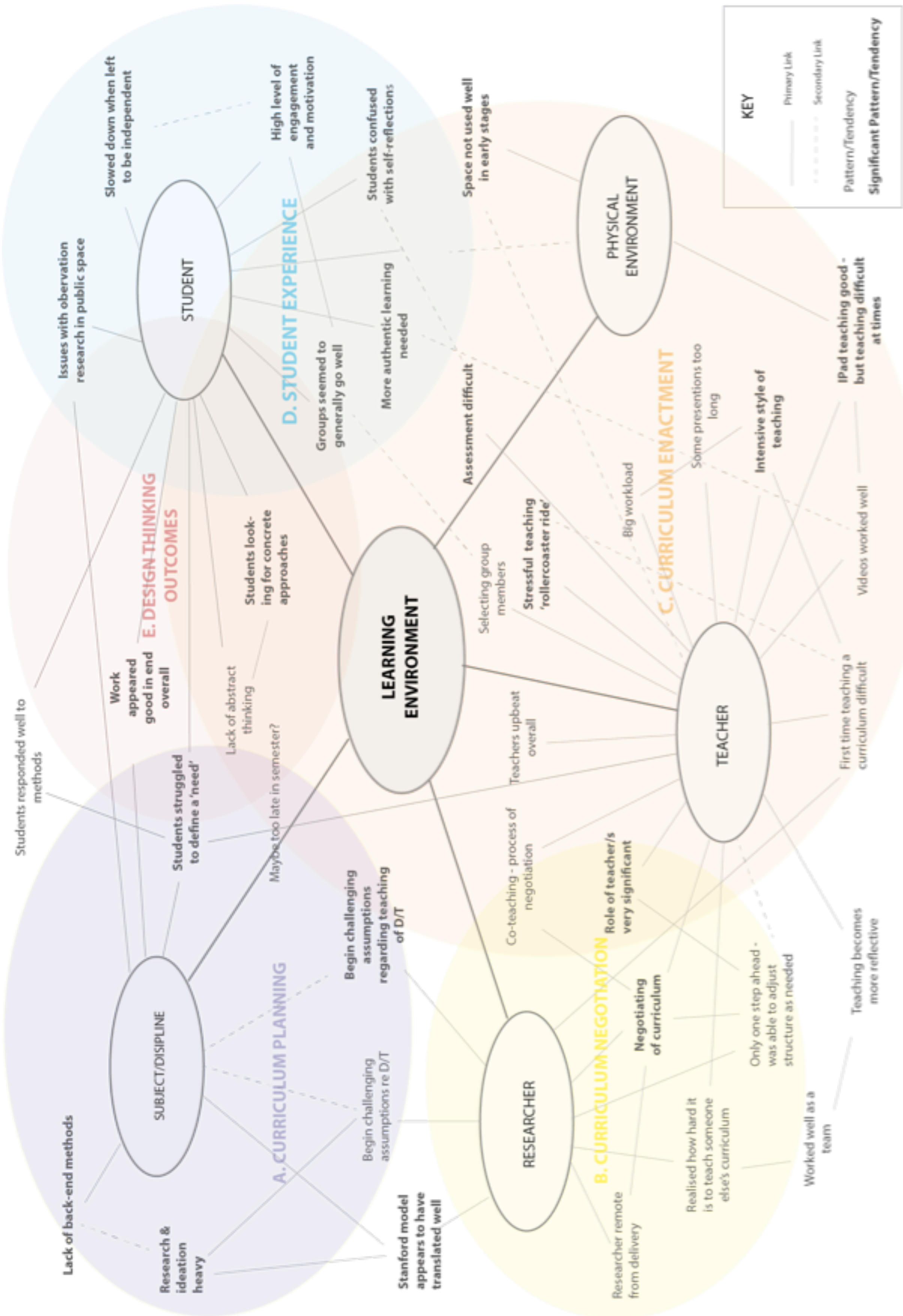

Figure 49. Key tendencies from the curriculum enactment

6.6 Opportunities for curriculum enhancement

Using this analysis, and associated theorising about several relationships between tendencies and features of the learning environment, I identified a number of key opportunities for enhancing the curriculum in the next action research cycle. Opportunities were categorised using my curriculum development framework.

6.6.1 Content

- Increase students' knowledge and understanding of authentic ('real-world') applications of design thinking, and provide authentic design thinking examples and case studies.

6.6.2 Framework

- Revise overall structure to allow more time at the end of the design thinking process for concept development
- Move the project to earlier in the calendar year (for example, to the beginning of the semester) for the product design students.

6.6.3 Learning activities

- Develop a framework for planning and negotiating students' observational and other field work activities to improve their experiences in public spaces, especially with observation and interview practices (methods)
- Develop learning activities that help students develop knowledge of, and ability to define, categorise, and spot human needs
- Create learning activities that better support concept development and communication practices
- Improve the students' knowledge and use of reflective blogging. This may include providing better reflection frameworks and models.

6.6.4 Teaching

- Shorten key presentations
- Simplify the use of presentation technologies (such as Apple iPads as primary teaching device) used in the teaching process
- More actively facilitate concept development practices towards to end of the process

- Encourage increased (and more effective) use of the studio space and walls earlier in the project. Set the room up better at the beginning of the process.

6.6.5 Teacher support

In addition to the opportunities identified above:

- Enhance the teaching negotiation, agreement and briefing process to streamline and enhance understanding and buy-in. This may include better documentation outlining background and overall philosophy.
- Enhance the overall journey of staff through delivering the curriculum, and develop ways to better support staff, especially if they are teaching for the first time. This may include a better plan, more resources, suggestions, and photos.
- Reconceptualise the teaching template to be more flexible so teaching staff can respond to, and more effectively engage with, a wide range of teaching approaches. This may include exploring a better balance between providing an effective structure (and content), and allowing more freedom for teacher agency, including to drive their own approaches, personalities, viewpoints, and conceptualisations.
- Enhance the staff debriefing and shared reflection process. This may include identifying how staff reflections can be better captured, analysed and responded to.

I also identified that it would be important for myself (as the researcher) to teach the curriculum, so that I have a deeper understanding of the curriculum enactment process, and to enhance my empathy with the experiences of the teaching staff. This would provide an excellent set of deep researcher reflections from a different perspective.

In addition, we all agreed that it would be good to find ways to integrate design thinking principles and approaches into the broader product design programme, and to continue building on the plan for future product design projects.

SECTION TWO: ANALYSIS OF STUDENT SURVEY

In this section I present an analysis of data gathered through the student survey and interviews. This analysis contributed to the description of the outcomes of the curriculum enactment, provided a further basis for analytic resolution (e.g., students identified and rated the relative helpfulness of features of the learning environment) and prompted further, if limited, theorising.. Please note that the term ‘project’ was referred to with students, rather than ‘curriculum’. I therefore use the term project through the next sections.

6.7 Participants and data

Although 22 of the 24 students agreed to participate at the initial research briefing session, 24 students completed the post-project survey during the second survey briefing[9]. Data from the survey sheets were translated into table format, with percentages rounded up or down to nearest whole number analysed, and presented in bar graph format.

6.8 Students' ratings of overall experience and impact on learning

This section of the survey specifically requested feedback on students' perceptions of their overall experience, the impact that the curriculum had had on their learning, and whether they believed they could apply their learning to future studies and work (Figure 50). This section of the survey was completed after the students had participated in the project.

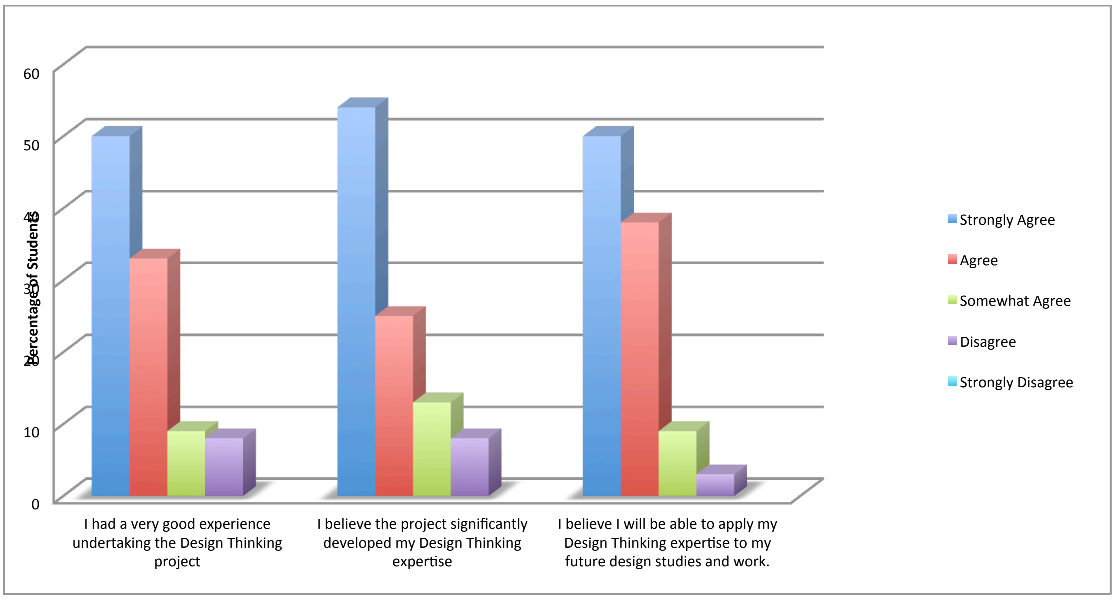

Figure 50. Students' ratings of their experiences of the design thinking project, and the impact that it had on their learning

This section of the survey indicated that:

- Most students had a very positive learning experience. For example, 83% agreed or strongly agreed that they had a very good experience when participating in (undertaking) the project. In contrast, 8% disagreed that they had a very good experience.
- A majority of the students believed that the project impacted on their learning. For example, 79% of students believed that the curriculum significantly contributed to the

[9] When approached by an independent third party to participate in the second questionnaire survey, all 24 students in the class subsequently wanted to, and agreed to participate.

development of their design thinking expertise. In comparison, only 8% disagreed that the project significantly developed their design thinking expertise.

- A majority of the students also suggested that the learning was useful for their future studies and work. For example, 88% indicated that they would be able to apply their learning to future design studies and their future work. In comparison, 4% indicated that they disagreed they would be able to apply their learning to future studies or work.

The findings of this section of the survey indicated that a majority of students had a very positive experience, and suggested that the project had developed their current and future learning and expertise. These findings provided an initial validation and general endorsement, from the students' perspective, of the overall value of the design thinking project.

6.9 Students' ratings of key aspects of the project

This section of the survey specifically sought feedback on the students' ratings of key aspects of the learning and teaching approach utilised. This section of the survey was also completed after the students had participated in the project. The outcomes are presented in Figure 51.

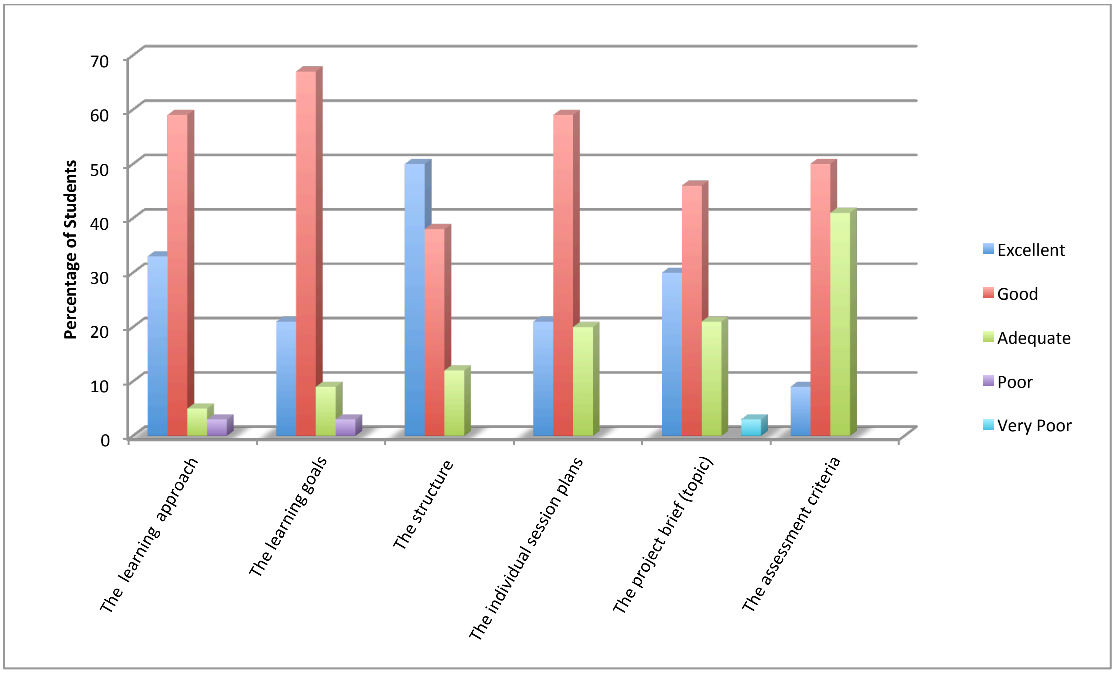

Figure 51. Students' ratings of key aspects of the design thinking project

This section of the survey indicated that students generally rated highly the excellence of the key aspects of the project, with only a very small number of students rating any aspect as poor. For example, 92% of students rated the overall learning and teaching approach as either good or excellent. On the other hand, only 4% rated the overall learning and teaching approach as poor or very poor; and 88% rated the project structure as good to excellent. Most notably, 50% rated the structure as excellent and no students rated the structure as poor or very poor.

While most aspects seem to be rated very positively, feedback on the assessment criteria was somewhat less positive, although not poor. For example, 92% of students rated the assessment criteria as adequate or good. In comparison to other rankings, it is notable that only 8% ranked assessment criteria as excellent.

As with the previous section, these findings provided an initial validation, and general endorsement of the project from the students' perspective.

6.10 Students' ratings of curriculum components

This section of the survey provided feedback on the students' ratings of the helpfulness of various components of the project. The outcomes are presented in Figure 52.

Again, this section of the survey was completed post-project.

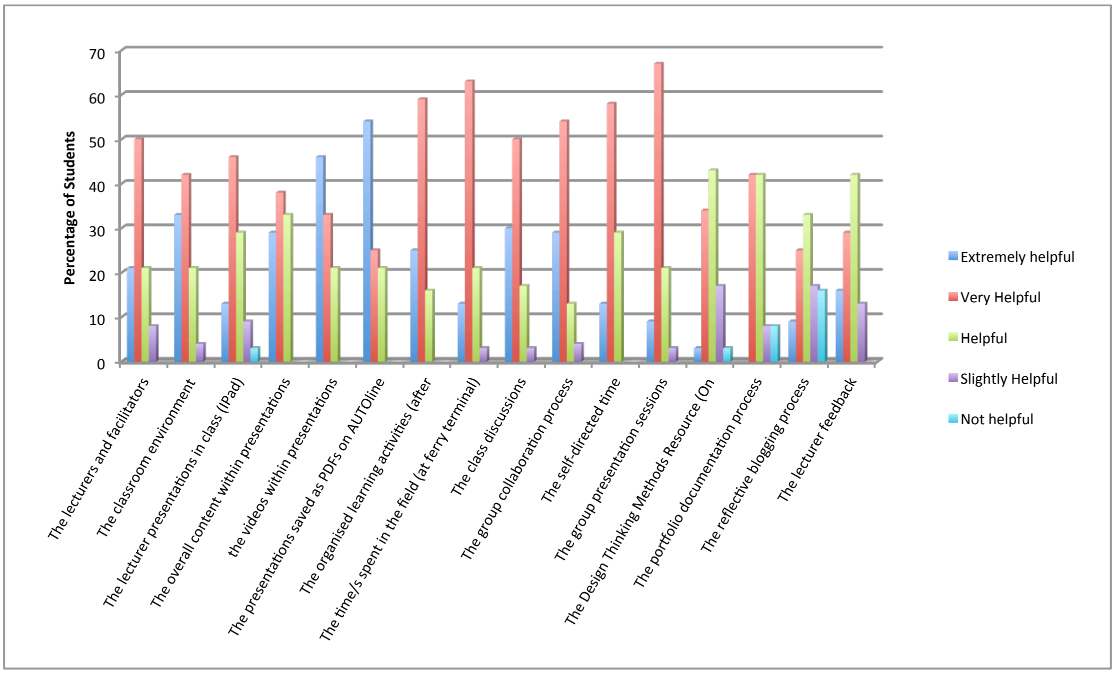

Figure 52. Students' ratings of key components of the design thinking curriculum

This section indicated that students generally had positive feedback for the helpfulness of most of the key components of the curriculum. Students rated a number of key aspects of the curriculum as particularly helpful for their learning. For example, 70% or more rated the following components as extremely helpful or very helpful:

- Lecturers and facilitators.

- Organised learning activities (after presentations).
- Classroom environment.
- Videos within presentations.
- Presentations saved as PDFs on the online learning tool.
- Class discussions.
- Time/s spent in the field (at ferry terminal).
- Group collaboration process.
- Group presentation sessions.

In comparison, a number of key components of the project were rated as less helpful. For example, although 73% students rated the Design Thinking Methods Resource (on AUT Online, the university's online learning system) as very helpful or helpful, 20% rated the Design Thinking Methods Resource as slightly helpful or not helpful. Although 58% of students rated the reflective blogging process as very helpful or helpful, one out of three (33%) rated the reflective blogging process as either slightly helpful or not helpful.

These findings again provided further initial validation and general endorsement, from the students' perspective, on the overall learning approach of the project.

The next sections of the survey explored students' perceptions of the impact of the project on various aspects of their design thinking expertise. Students were asked to complete the same questions before (in the pre-project survey) and after (in the post-project survey). Perceived impact is conceptualised as the shift between the students' pre- and post-project ratings.

6.11 Design thinking mindset development

This section of the survey explored students' ratings of the impact of the project on various design thinking mindsets. The overall graphs (showing a comparison of mindsets) are presented pre-project in Figure 53 and post-project in Figure 54.

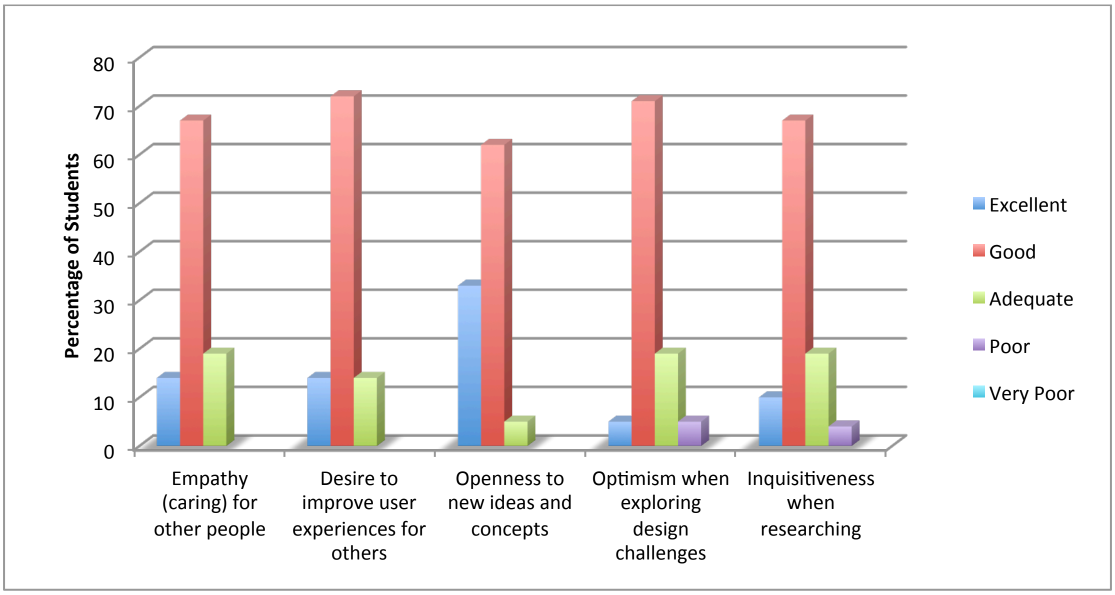

Figure 53. Students' ratings of their design thinking mindsets pre-participation in the project

This section of the survey indicated that a majority of student participants rated themselves as having a relatively high (adequate/good range) personal rating of their design thinking mindsets before their participation in the project. For example, 81% rated themselves as having strong (good or excellent) empathy for others and 86% rated themselves as having a strong (good or excellent) desire to improve user experiences for others, and 71% as good.

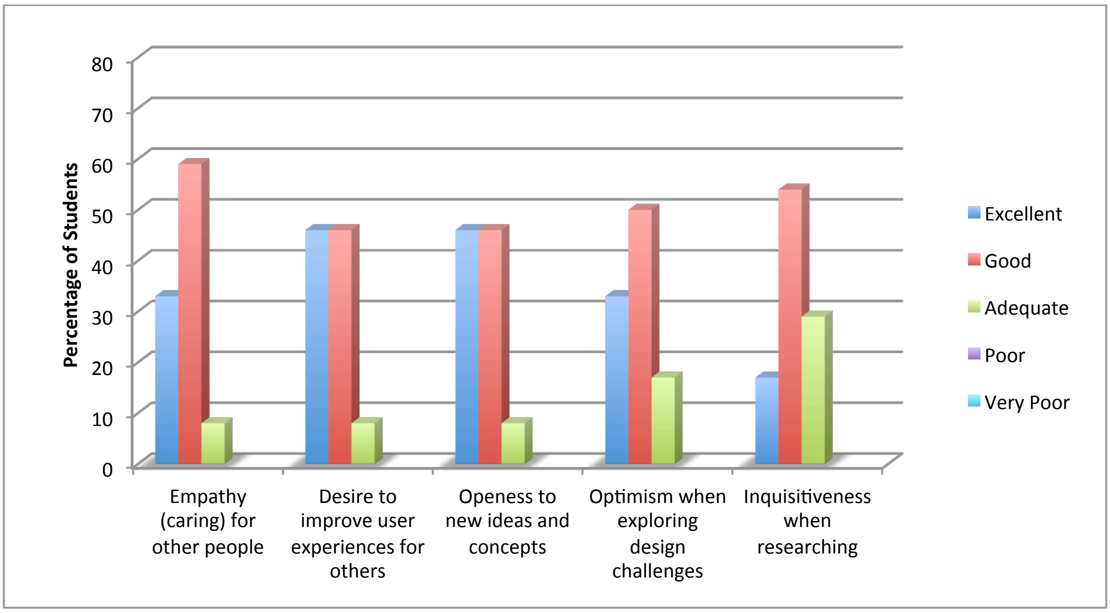

Figure 54. Students' ratings of their design thinking mindsets post-project

As indicated in the graph above (Figure 54), the students' ratings of their design thinking mindsets generally increased after the project, particularly in regard to the good/excellent range. The following two examples (Figures 55 and 56) represent changes in student ratings of their mindsets pre- to post-participation in the project.

6.11.1 Development of empathic mindsets

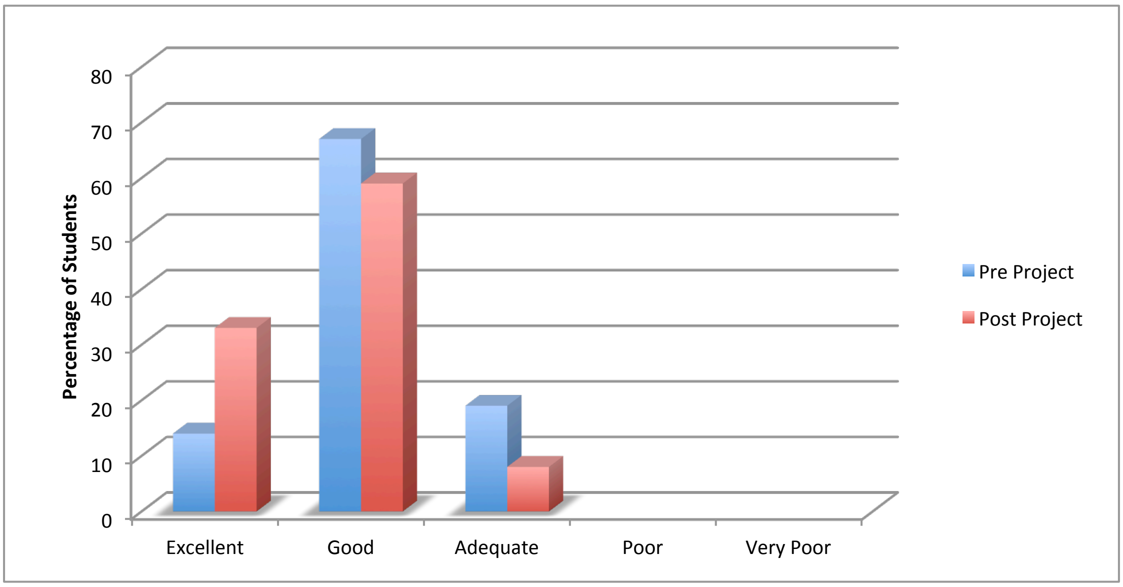

Figure 55. The change in students' ratings of their empathy for other people, pre- and post-project

6.11.2 Desire to improve user experiences

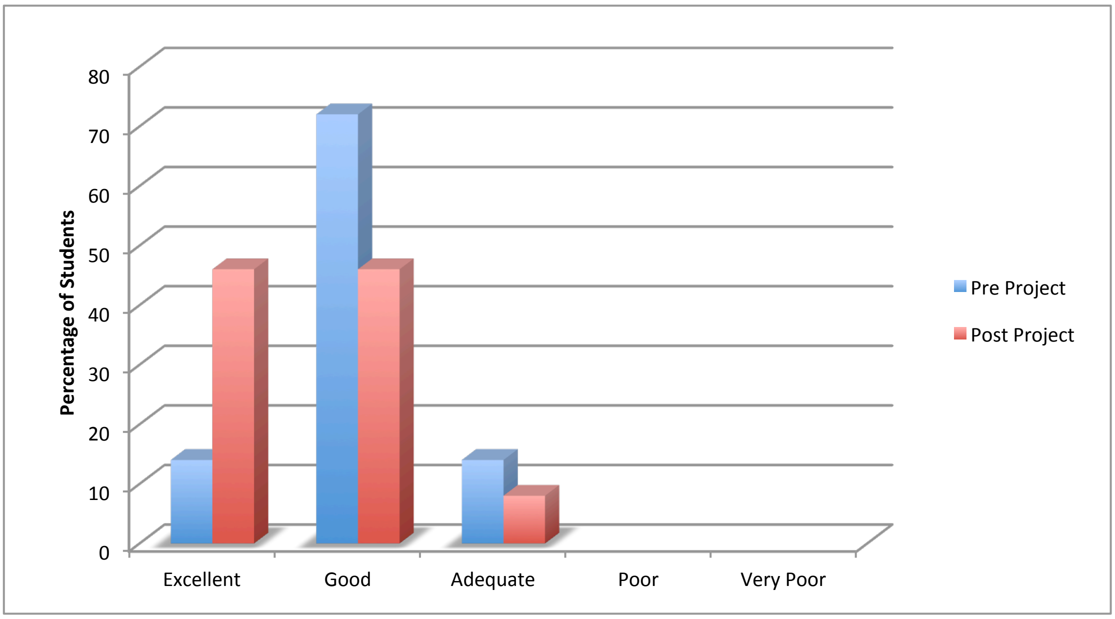

Figure 56. The change in students' ratings of their desire to improve the user experiences pre- and post-project

6.12 Development of design thinking knowledge

This section of the survey explored students' ratings of the impact of the design thinking project on various categories of design thinking knowledge.

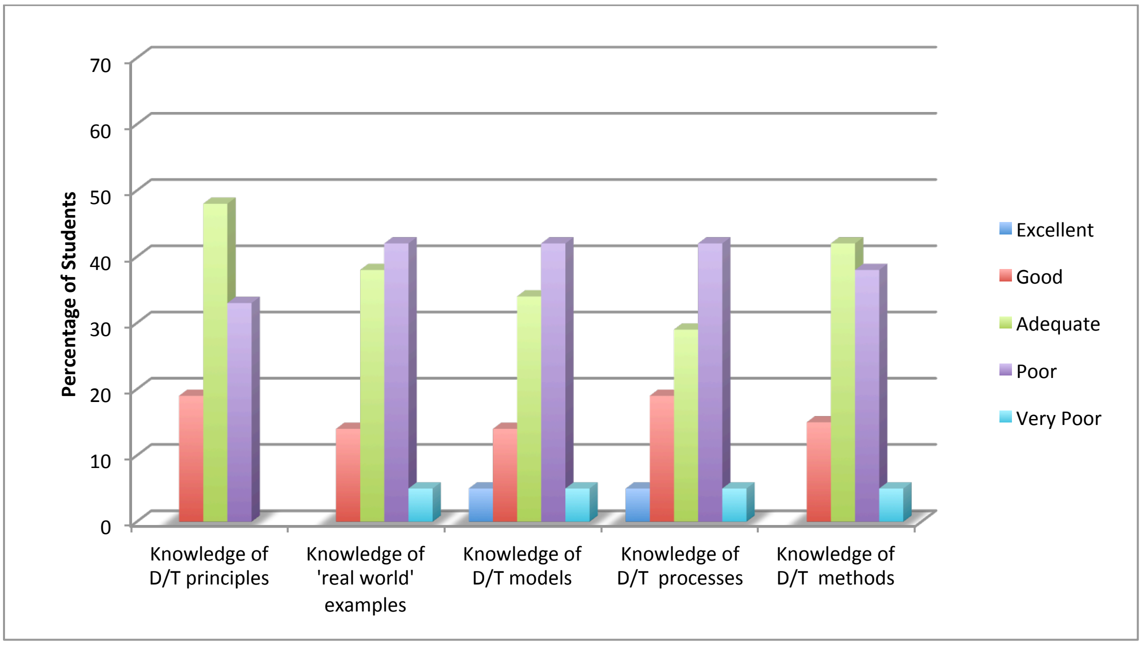

Figure 57. Students' ratings of their design thinking knowledge, pre-project

This section of the survey indicated again (as in the previous section) that the majority of student participants had a reasonably high personal rating of their design thinking knowledge, namely, in the adequate/good range - before participation in the project.

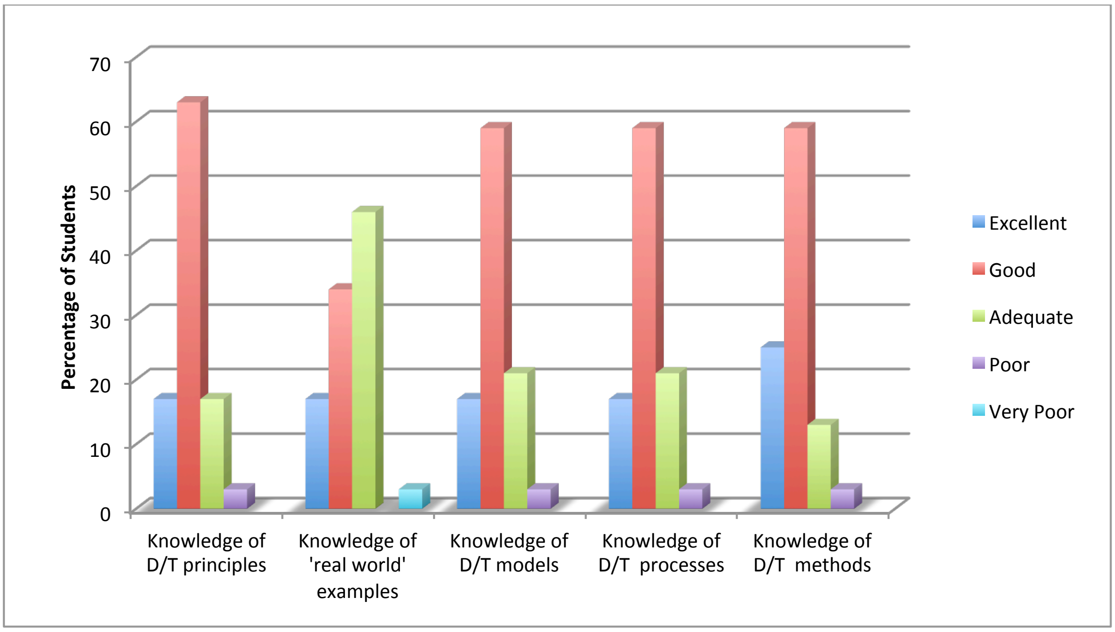

Figure 58. Students' ratings of their design thinking knowledge, post-project

As indicated in the overall graph above (figure), many students' ratings of their design thinking knowledge shifted to the good/excellent range post-project. Figures 59 and 60 show selected examples of some marked changes in student ratings.

6.12.1 Development of knowledge of design thinking principles

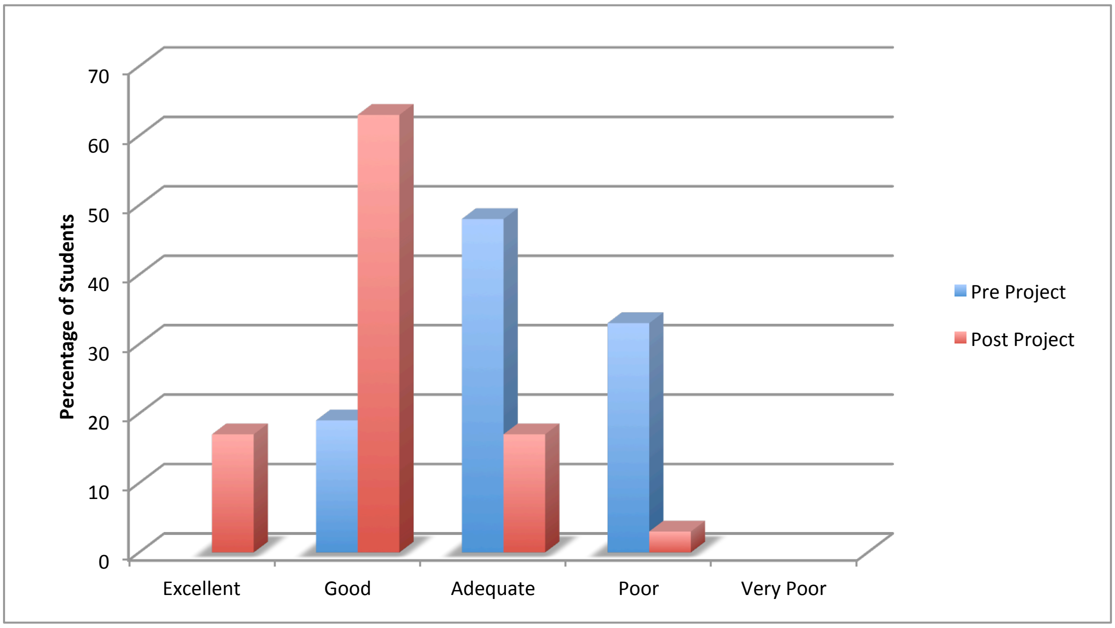

Figure 59. The change in students' ratings of their knowledge of design thinking principles pre- and post-project

6.12.2 Development of knowledge of design thinking methods

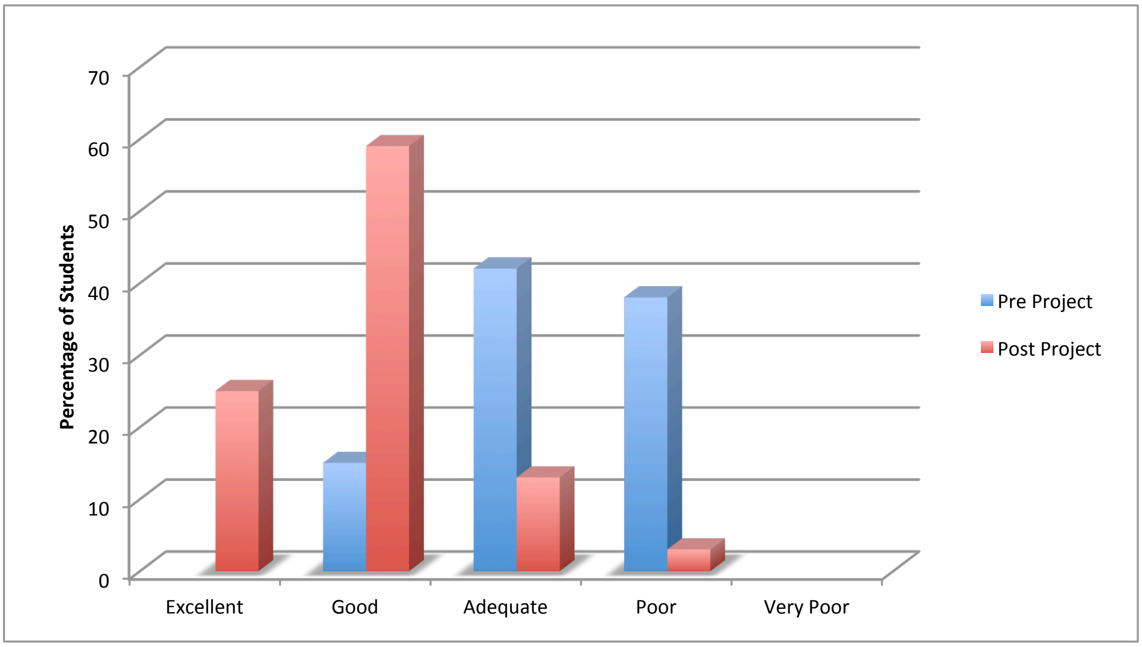

Figure 60. The change in students' ratings of their knowledge of design thinking methods pre- and post-project

Similar improvements were seen across the other areas, although students' knowledge of 'real-world' examples of design thinking (i.e., case studies) unexpectedly dropped from 14% (4 out of 21 students) to 13% (3 out of 24 students).

6.13 Development of design thinking practices

This section of the survey explored students' ratings of the impact of the project on their various design thinking practices. Graphs are presented pre- and post-project.

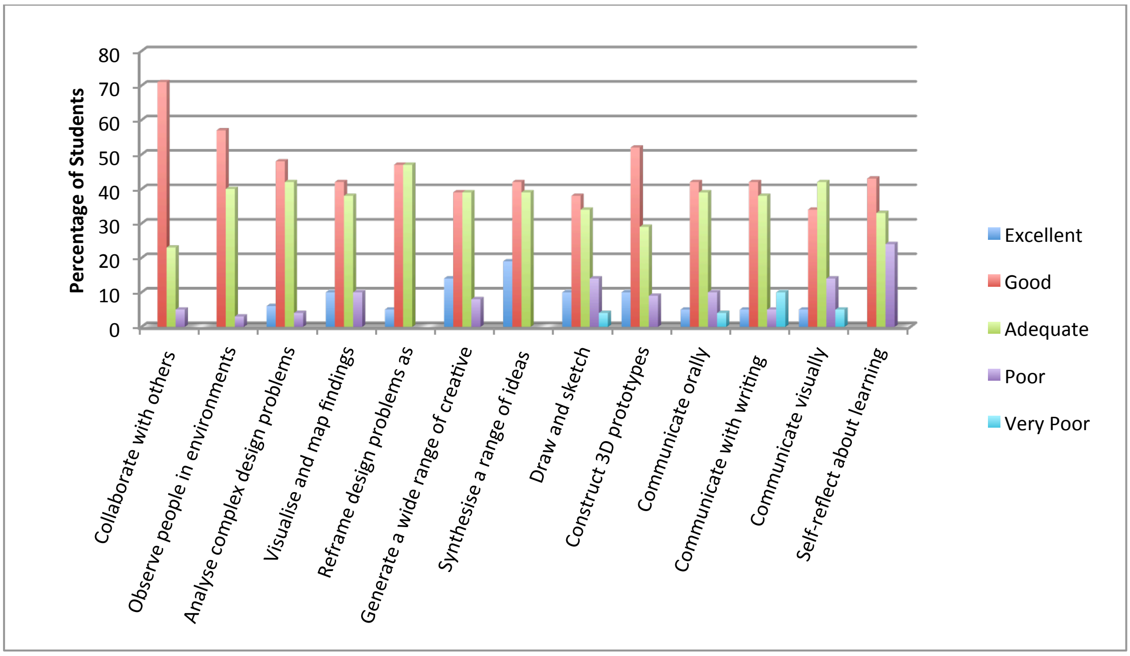

Figure 61. Students' ratings of their design thinking practices pre-project

Students appeared to have relatively high personal ratings of their capabilities to practice design thinking before participation in the project.

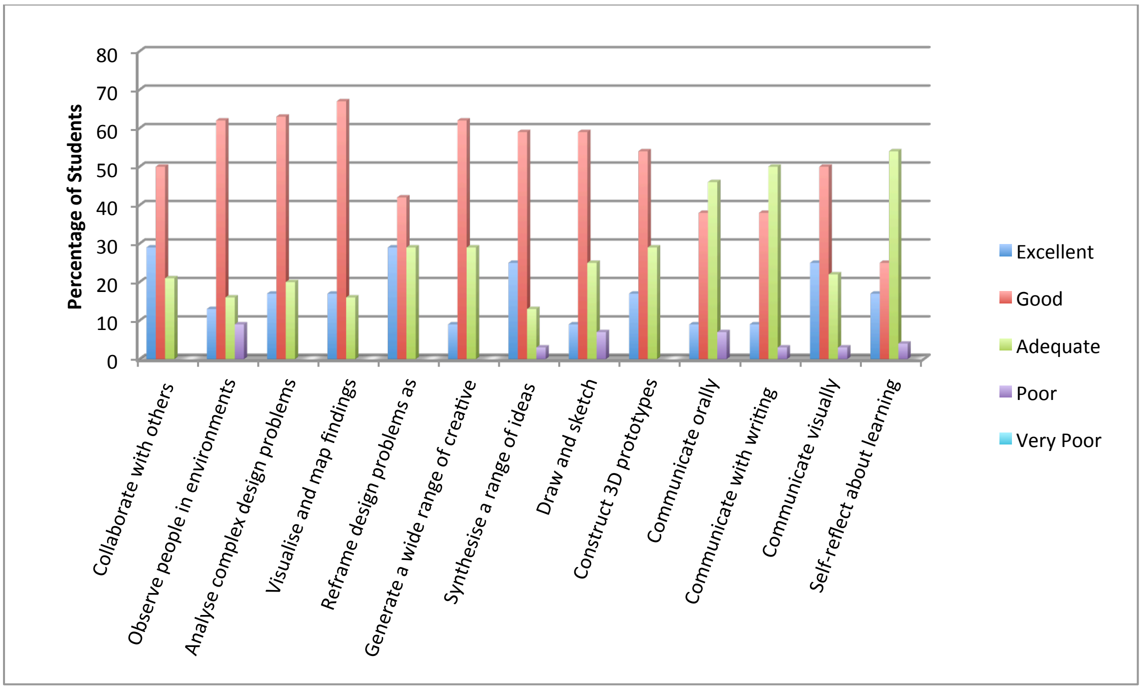

Figure 62. Students' ratings of their design thinking practices post-project

Students' personal ratings of their design thinking practices generally shifted into the good/excellent range after participating in the project. Figures 63 to 67 show selected examples of change in students' practice ratings pre- and post-project.

6.13.1 Development of collaborative practices

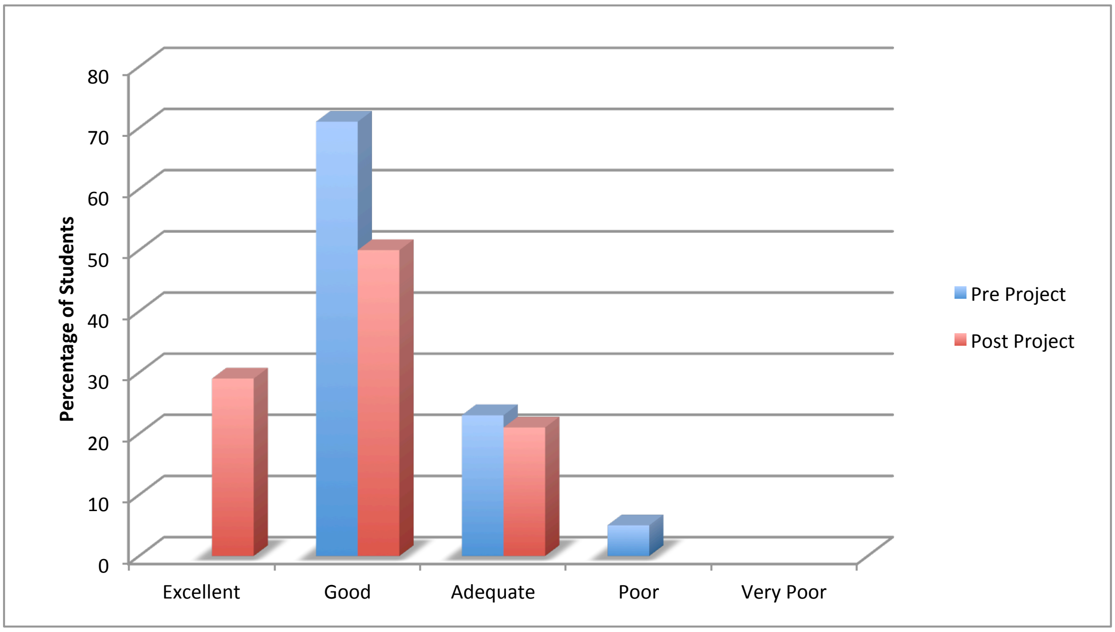

Figure 63.The change in students' ratings of their collaborative practices pre- and post-project

There was a shift at the top end, with just under 30% of students rating themselves as excellent (where before the project none had rated themselves as excellent), and no students rating themselves as poor or very poor post-project.

6.13.2 Development of observational practices

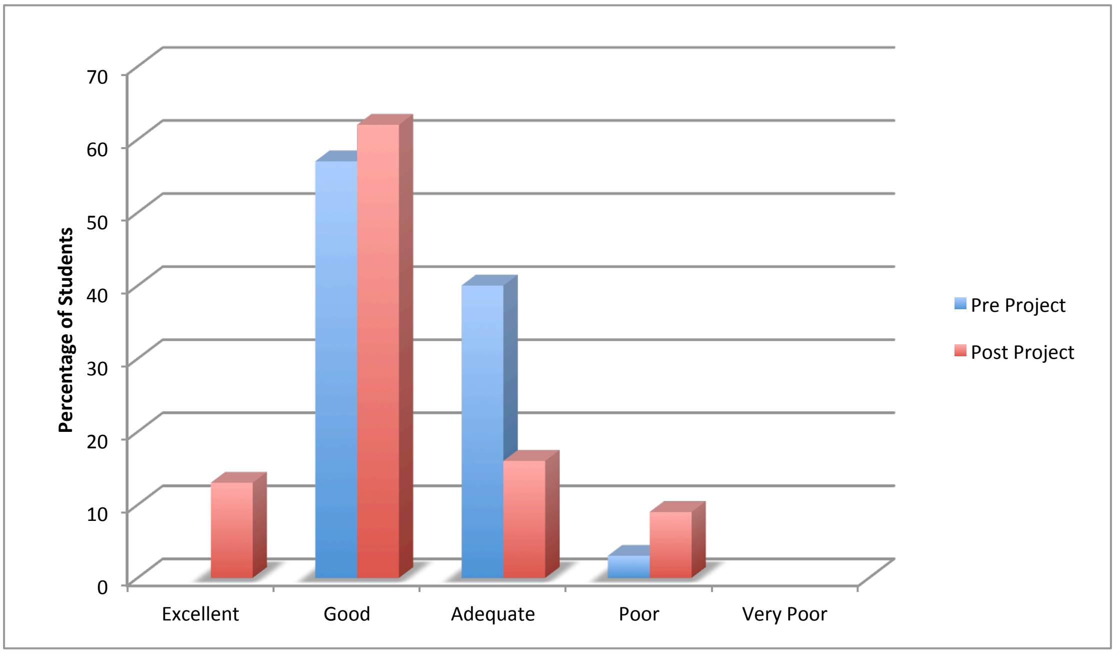

Figure 64. The change in students' ratings of their observational practices pre- and post-project

6.13.3 Development of problem (re)framing practices

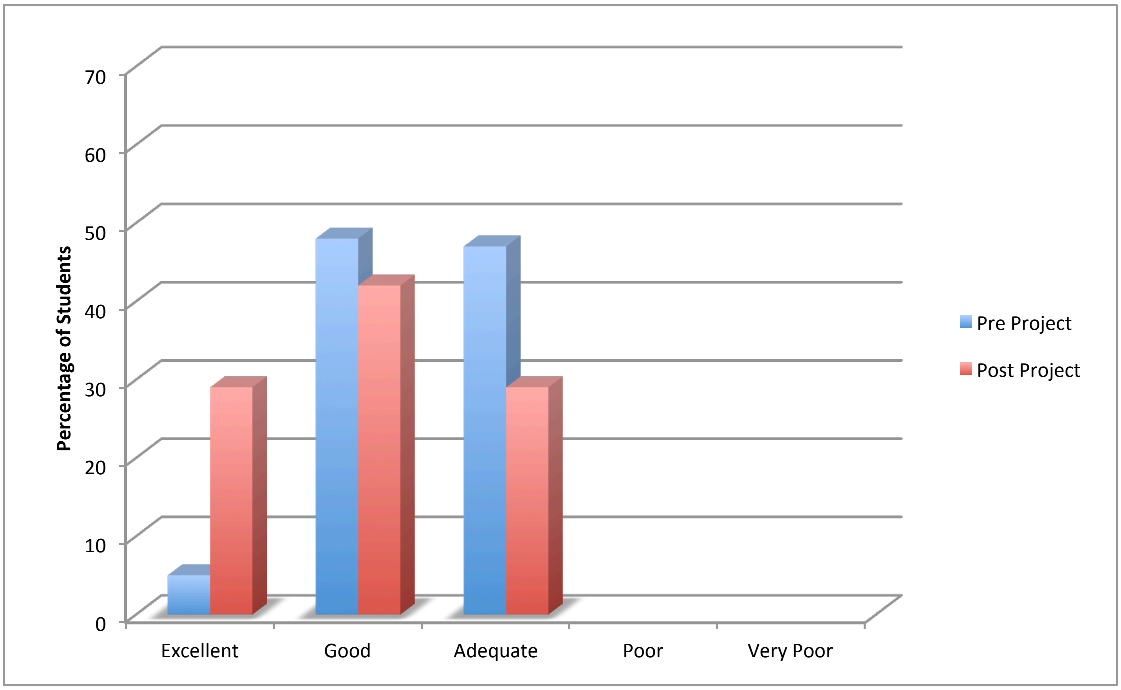

Figure 65. The change in students' ratings of their problem (re)framing practices pre- and post-project

There was a shift in students' perceptions of their development of problem framing capabilities (Figure 65).

6.13.4 Development of creative practices

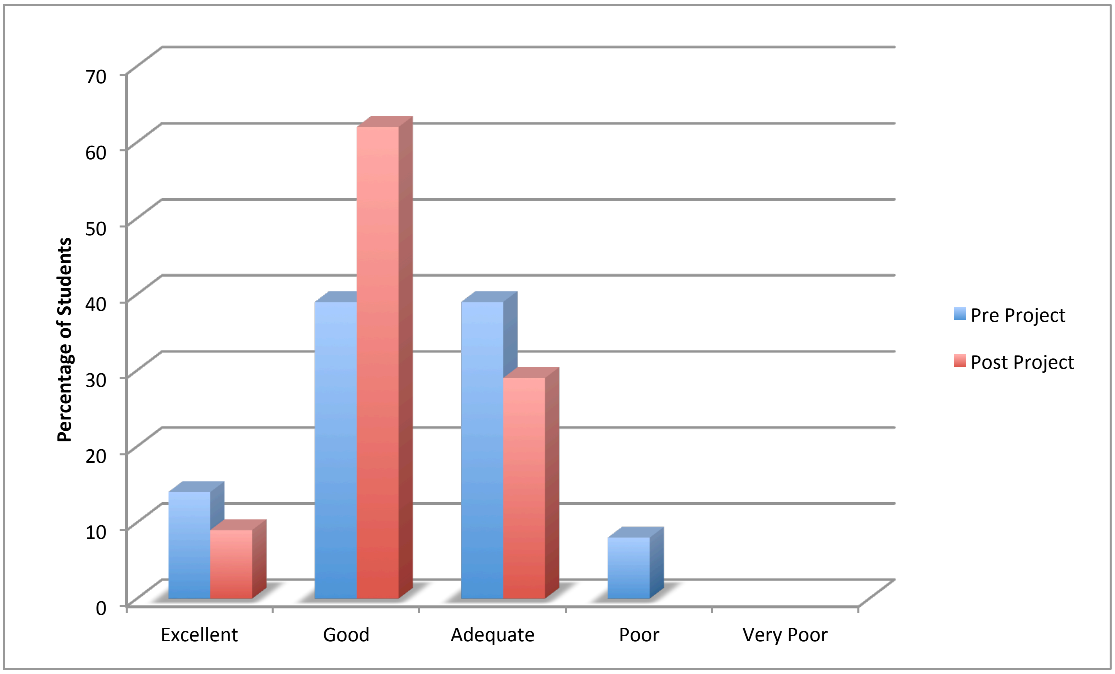

Figure 66. The change in students' ratings of their creative practices pre- and post-project

Relatively smaller shifts were noted with students' perceptions of their development of their creative capabilities (Figure 66).

6.13.5 Development of reflective practices

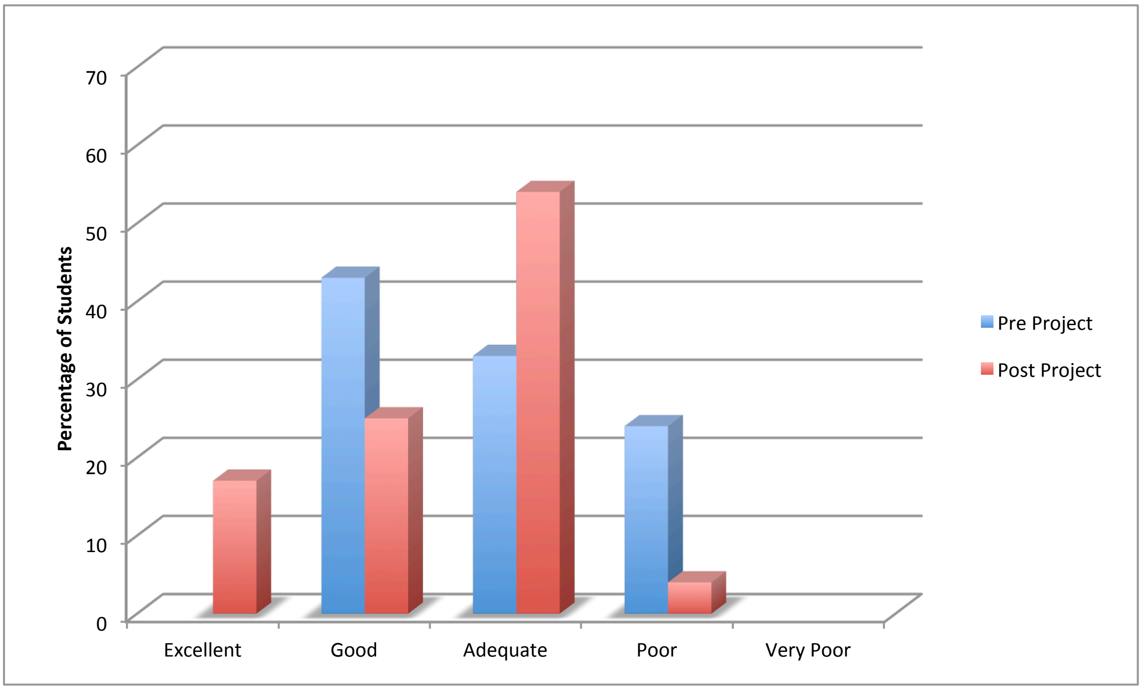

Figure 67. The change in students' ratings of their reflective practices (reflection on learning) pre- and post-project

As with the ratings of creative capabilities, relatively smaller shifts were noted with students' perceptions of their development of capabilities in reflective practices (Figure 67).

6.14 Summary of learning tendencies and their relationship with the learning environment

6.14.1 Student experience

A majority of students indicated that they had a very positive experience, and suggested that the project positively impacted their learning. A majority also indicated that they believed the learning could be applied to their future studies and work. These findings provide a validation and endorsement of the design thinking project.

6.14.2 Aspects of the learning environment

The student feedback provided a similar endorsement for the overall approach and individual components of the project. In particular, a majority of students rated the project goals and the tight structure very highly (in the excellent/good range). The assessment criteria and approach were rated lower (mostly in the good/adequate range). Components that were rated markedly highly (in the extremely/very helpful range) included:

- Lecturer presentations and videos.
- Class discussions.
- Field learning.
- Group collaboration.

While students positively rated the curriculum components overall, a number of components were rated somewhat lower than other components (in the helpful/slightly helpful or not helpful range). Components that were rated lower included:

- Design thinking online resource.
- Portfolio documentation process.
- Reflective blogging process.
- Lecturer feedback.

I noted however that students rated highly the teacher presentations, and that they were posted online for students review.

6.14.3 Design thinking expertise development

A majority of students had a relatively high rating (in the good/adequate range) of their design thinking expertise before their participation in the project, including high ratings of empathic mindsets. I noted that the high ratings overall were not too surprising given that the students had been accepted into the product design degree programme based on previous design and technology experience at high school, and had already undertaken a number of more traditional design projects before the design thinking project.

Overall students indicated that they perceived that their design thinking expertise improved from pre- to post-project. This is particularly evident where students perceived there were significant improvements in their design thinking knowledge, and practices overall.

6.15 Opportunities for curriculum enhancement

These key tendencies and relationships suggested opportunities for enhancing the curriculum. Opportunities were categorised using my curriculum development framework.

6.15.1 Content

- Build content (and associated learning activities) and areas of learning that were identified as having smaller shifts in students' expertise development (as perceived by the students). In particular, find ways (mechanisms and conditions) that may increase the shift in students' development of design thinking expertise across the following practices:
    - Creativity.
    - Drawing.
    - Oral and written communication.

6.15.2 Learning activities

- Develop learning activities along with content across the areas of creativity, drawing, and communication.
- Enhance the student portfolio documentation process, in particular clarify expectations for students, increase the use of case studies and models, and enhance how they are communicated to students.
- Enhance reflective blogging process and associated assessment.

6.15.3 Teaching

- Enhance feedback (formative and summative) provided by teaching staff, namely what, how and when feedback is given.

6.15.4 Resources

- Enhance the design thinking online resource, and evaluate how students are using it in relation to their work.

SECTION THREE: ANALYSIS OF INTERVIEWS

In this section I present an analysis of data gathered through key informant interviews with six student participants, based on their experiences of the project. Selected excerpts from transcripts (in italics) are included to illustrate selected themes and tendencies. The analysis served the same purposes with respect to the theorising methodology: description of outcomes and analytic resolution ('what counts' from student perspectives). The analysis included inductive and deductive approaches. As noted in the research design chapter, for the latter I developed an analysis framework that included the following analytic categories: teaching and learning 'structures' (in the learning environment), outcomes/effects, causal mechanisms, and conditions/contextual factors in play. I engaged in initial, although limited, theorising about student critical realist-based descriptions of the curriculum/learning environment and outcomes that provided a basis for curriculum decisions. In relation to the latter, students were also asked for their suggestions about curriculum changes in the interview.

6.16 Student experiences

Three of the six students clearly indicated that they had an excellent learning experience.

> *It was genuinely great. It's hard, because I had such a good experience with it.*

> *On the whole I was really pleased with it. I guess I felt like I really got good value for the time that I spent and good value, I don't know, value for money I suppose you could say with studying the course. I thought that was really valuable and I really enjoyed that and I really felt like it was excellent use of time and resources and well worth the effort. I felt like I really got a lot out of it.*

This is such a huge deal for us that, I don't know, I mean I'm sure there is something but I'd have to use this process for a while to, yeah, find something. But no, I think it's a great idea. Just under excellent because I mean I think there could be improvement but yeah, it was pretty good.

The remaining three were a little more circumspect, although all seemed to have positive feedback for parts/aspects of the project.

I actually liked the first half, like the first person was real good, it ran quite smooth and it was really fast-paced, and you only got four lots of information within a really short period of time, which I found was really nice.

The observation I think was good, and personas.

Very good (experience), but from the stuff I've said it can be improved in a few ways, but yeah it definitely helped.

Students mentioned that the project seemed to have a positive impact on the overall studio culture (in comparison to other projects).

We were always in the studio, and there was always stuff going on, laughing and things.

Everyone, the class, morale was like unbelievably improved.

Many of the students felt that they had a strong platform to develop in future projects.

But this time I felt, especially in the beginning part, we really got heaps and heaps of information that I can definitely take forward into the future.

It's like now I have a template for it we can take it and apply that if we get given the same projects. You can overlay this onto that if you need structure and you're able to.

6.17 Project structure and the pace of learning

Students were generally positive about the tightly structured workshop style approach to the project, and having a clear direction to follow. This was mentioned in comparison to previous project experiences and contributed to their overall enjoyment.

I'd say probably the structure of it. The way that it was laid out, very directed and we went to class every day and we got a lecture.

I really liked the structure of it and the fact that it was like a series of lectures with activities afterwards.

Just the whole project that we did, I liked the structure of it, it was really structured.

It was really fast-paced- they were quite quick and fast-paced and very structured.

I guess its structure would probably be the main thing (I liked), just that they had a set plan and each day we knew what we were going to have to do and what class we would be doing and the reason behind the class.

The workshop approach was mentioned as having a positive impact on the overall engagement of the class.

But because we were getting so much intensive attention and people were turning up because there were classes, it was sort of this rule for showing up from having actual information given to us. [In comparison to the previous project] whether you turned up to class every day, it really didn't seem to make much difference either way. You're very much sort of much more self-directed and kind of meandering your way through which I found quite difficult.

The overall pace of the project did appear to provide a lot of challenges to the students.

I guess the timeframe was, it was a very small timeframe so there was a lot to do.

The structure I found really difficult, like having such a strict timetable and not being able to go back to the previous exercises and change things if we didn't do it as well as we should've in the first place.

6.18 Impact on expertise

The students articulated a number of specific impacts on their design thinking expertise.

6.18.1 Mindsets

For example, two students specifically mentioned a general shift in their mindset and values.

It kind of made me realise that I'm not always that positive and I need to.

So I'd say my values completely improved.

The development of personal empathy featured prominently.

I guess the word we should probably use is empathetic – what you produce in the end will be a much more empathetic outcome.

The focus on empathy I think was really good because, like, it made the project more real.

6.18.2 Models

Learning practices (new methods, tools and processes), especially those that could be used in future projects (providing a template and model), was also mentioned as important.

It's definitely provided me with a strong base for a design process, which I can use in the future.

It was good getting, like, a really thorough beginning class of design process (model). I think the main thing was just learning lots of new tools that can be used again in other projects.

But this time I felt, especially in the beginning part, we really got heaps and heaps of information that I can definitely take forward into the future.

It's like now I have a template for it we can take it and apply that if we get given the same projects.

Just the design process to follow, coz up until now I've kind of just been making up my own design process really, just kind of like a modified version of the design process I used back in high school.

6.18.3 Practices

When prompted (and sometimes not), students did discuss a number of specific design thinking practices that they had some particularly strong feelings about.

A deeper understanding and engagement with research was another key impact that was mentioned.

> *Definitely, I just keep putting it under the research bracket; it's that investigation, like gathering the information in the beginning, all that part of it. I don't know, I guess it was different for me, but I found it really good.*

The importance of interviews in the research process came up a number of times, and how the practice was both challenging and rewarding.

> *And with the interviewing, I initially was really uncomfortable with that but I managed to get myself to do it in the end.*
>
> *And I've never done that before, and actually interacting with people. So seeing a problem through someone else's eyes was something that was very cool I didn't think we'd get as many people as we did.*
>
> *I think the interviewing was really good, and that observation part of the process, like actually hanging out on the field talking to people, coz that's something I hate doing usually.*

Observation was another method that students were quite challenged with, but found rewarding in their learning. One student again noted the relationship of observation and building of empathy.

> *I think it's just important that you keep the bit that makes you go out and see what, see what you're designing for and forces the focus [on] empathy.*

Brainstorming seemed quite a pivotal point in the process.

> *I thought the brainstorming stage was really good because it was very structured and as a group we came up with heaps of ideas. And over a period of three days we just produced a huge volume of ideas, which was great.*
>
> *It kind of tipped over the scale when we got into the brainstorming and we actually started picking around ideas and in brainstorming it's really important to not shoot down ideas. The comfort level (of group working) kind of grew, probably from the brainstorming session for me I think.*

6.18.4 Collaboration

All students were quick to articulate and discuss their experiences of group work in the interviews, which ranged from challenging to very rewarding (and both together). In fact, discussion of group collaboration dominated a good proportion of each of the interviews. It was clear that the success (or not) of group work was a very important part of students' overall experience. A number of key themes emerged. For example, most students articulated how they enjoyed the collaborative group aspects, but also seemed quite challenged at first.

> *We worked in groups and I found that really good, coz usually I'm not really a group work sort of person, I prefer to do things on my own.*

> *I think maybe making a group work, which I think we struggled quite a bit at the beginning but by the end everything kind of worked out.*

> *I found some of the teamwork side of it a bit challenging at the start. Working with people I hadn't worked with before and actually breaking that down and developing a team, we actually had quite a good team I think in the end.*

The emergent nature of collaborative group work was conceptualised by some students as a transition from an individual perspective, letting go and transferring responsibility to other team members.

> *Well it was just like coming out of my comfort zone in that I hate having to work with people.*

> *I kind of found that was probably the biggest challenge, just letting the group work, all the group kind of take control and actually work as a team. As soon as you kind of let everyone in the group to take responsibility for areas, suddenly the process takes a lot less time and everything begins to flow a lot quicker and ideas begin to generate quicker.*

Ideas of socialisation and friendship were also important aspects of students' conceptualisations of the emergent teamwork and collaboration.

> *I actually hadn't talked to the people so much, so to meet them and work with them and actually become friends and things, it was quite cool.*

Like once we got over, once we got through some of the later stages of the project I think we just got more comfortable with it and just got friendlier.

Well I made new friends. I knew them in the class but I hadn't really talked to them. Now we talk all the time.

Leadership emerged as a key issue for a number of students and groups, along with some frustration at the lack of motivation and agency of other students.

We were sort of told to select a leader but we didn't really do that.

Yeah what I didn't like about this process is that the group kind of left a lot of it to me, which was a bit unfair.

We had a lot of disagreements over what we were supposed to be doing with tasks, like agreeing what we were being asked to do. It felt that we didn't get anything done because we were trying to figure out what we were supposed to be doing instead of actually doing anything.

But overall the students found collaboration generally a very rewarding process that impacted the group's productivity.

I found it quite rewarding. I got along with the group, and we actually got stuff done. It was good in a way because we got things done faster than I probably would've left to my own devices.

6.18.5 Reflection

The reflection process also emerged as a key point of discussion in the interviews.

Some students were quite positive about their experiences with the self-reflection process, and how valuable it was for their learning.

Writing in there after every session. It was quite good I think in that it sort of forced you to sit back and reflect on what you had done.

I think the blogging actually helped a bit too coz I'm pretty sure there was a bit of reading of each other's blogs and knowing what people were thinking from that going on as well I thought.

But then I took a new approach later on, saying what's actually helpful for me. Obviously there are still some boundaries within that of what they want, but it's more important to actually have a valuable tool for myself.

Students also mentioned concerns and issues with not understanding the self-reflection method and process.

It didn't really benefit me to be honest, coz I'm quite new with that stuff and I didn't know how to read other people's blogs to see how they were going.

In terms of I think they only need to be very short, whereas some of us were writing very long.

The 'public' nature of the online self-reflection blog (in Wordpress), and how it was intimidating was mentioned.

I found having it on a web page as well, it was sort of more public, was a little bit intimidating as well I think.

Limitations with the writing process and not having an alternative method was mentioned by one student.

I'm dyslexic, and for me writing just takes far longer than most people, you know, just handwriting, reading in general a little more difficult.

6.19 Interaction with teachers

Students mentioned interaction with lecturers (teachers) as positive.

The students noted that the teaching staff seemed to be very interactive and engaged.

I think it was actually cool with all the lecturers coming round and talking with us as well, and all that stuff.

I think yeah, they maybe interacted a bit more.

Having two lecturers with different approaches was also mentioned as both different, but rewarding.

It's kind of hard with two lecturers - they've got a completely different style of teaching - It's definitely not a bad thing because I mean, whenever one would say something and the other would say something you'd kind of get twice the stuff out of that course.

6.19.1 Physical studio space

Students commented on the role of the physical space, especially the opportunity to start interactively displaying wok on the walls, something that happened about the end of the second week. It seemed to have a big impact on the groups' sense of cohesion and progress.

I loved it coz the idea was meant to go up on the walls and stuff.

They encouraged us a lot to put things up on the wall and that helped my group a whole lot, just making sure everything was really visual and you can just see it all the time.

6.20 Summary of themes and tendencies

The key findings of the key informant interviews are summarised below.

6.20.1 Learning experience

Aligning with the survey findings, the students interviewed indicated that they generally had a very good learning experience, and also described how the project positively impacted on their development of design thinking expertise. They noted that they thought the project lifted the overall morale of the class and motivation of students. It was evident that the project provided a strong template and model for future product design projects. A number of students believed they now had a very good design process model to work from.

6.20.2 Learning activities

In response to direct questions about the most enjoyable aspects of the project, the majority (five out of six) students focused almost exclusively on the collaboration and group work that was central to the project. In addition to the positive response to group work (even though students were quite challenged to begin with), students were able to describe key concepts of emergent group bonding, leadership, delegation, the development of friendships, being able to talk within the group and across the class, and other group processes. Overall, it appeared that the collaboration process dominated students' conceptualisations of design thinking, and was closely linked to a good (or poor) experience.

6.20.3 Structure and pace

The students indicated that they specifically enjoyed the tight teaching plan (workshop style approach, underpinned by a project undertaken through the design thinking process model) but some were challenged by the overall quickness of the pace, and lack of flexibility in the model (i.e., the ability to go back and revisit and repeat methods if needed etc.). A number of students felt that the curriculum was focused too much on the first half of the process model (i.e., the research/insights/needs/problem reframing methods), and there was not enough of a focus on idea development, testing, refinement and communication. In addition, the interviewees:

- Were very positive about learning new methods, tools and processes (and a process model) that were clearly transferable for future projects.
- Specially identified that observation, interviews, and brainstorming methods were significant and important in their learning experience.
- Specially mentioned that insights and needs were concepts and methods that weren't well communicated.

The students generally acknowledged the importance of self-reflection, however a number specifically identified issues with the self-reflection process, including the way expectations had not been clearly communicated, the public nature of the blogs, and lack of flexibility with self-reflection methods.

6.20.4 Teaching

The students generally acknowledged the role of the teaching staff and believed that they were both interactive and engaged. One student was slightly conflicted as to the benefits of having two teachers, which could be confusing, but also provided broader feedback. Students also generally acknowledged the importance of the physical space and the positive role that the active displaying of work in progress (when encouraged by the teaching staff) had in helping the collaboration and creative processes.

6.21 Opportunities for curriculum enhancement as suggested by students

Using the findings of the analysis, I identified a number of opportunities for enhancing the curriculum, as suggested by the students in the interviews. Opportunities were categorised using my curriculum framework.

6.21.1 Content

Define and communicate human needs and insights more clearly.

> *The one I remember specifically was when we were trying to generate negative insights and we didn't figure out what, exactly what he meant by insights, so we started, we were jumping to solutions rather than just broader insights.*
>
> *Or something to sort of show that this is the observation and this is how you then word it into an insight and just trying to get the difference.*

6.21.2 Learning activities

Improve the reflective blogging process and encourage other forms of self-reflection (in addition to written reflection).

> *They could have explained how to use the blog a bit more. I'm pretty sure other people would have figured it out, but I'm just not very good with that sort of stuff.*
>
> *In terms of I think they only need to be very short, whereas some of us were writing very long. And some of us were writing, I did at the start, like a diary where it was like a diary of unrelated things. I woke up and I walked out and there was a red car parked outside.*
>
> *I found having it on a web page as well, it was sort of more public, was a little bit intimidating as well I think.*

6.21.3 Sequence and timing

Move the timing of the curriculum enactment to earlier in the semester or year.

> *Yeah, that would have helped a lot at the beginning of the year.*
>
> *But probably the second half of the first semester, when we first started doing actual proper projects, that could have been a good opportunity.*
>
> *It'd be a cool introduction into the whole course.*

Enhance the second half of the project.

Like there wasn't a lot of time at the end for, like, evaluating the concept and coming up with as many concepts as you'd like to. But there was a lot of time at the beginning for research and then there was a lot of rush at the end.

From concept to, like, final design, that was all a bit wish-washy. Like we had all these weird and wonderful ideas, like make something that was practical and truly answered all the problems we found, that was quite difficult but I mean. It just, I don't know, we kind of got lost in that period.

In the last part of the stage I found it didn't really give you enough time to kind of incubate your ideas and really think them completely through.

6.21.4 Teaching

Create better and more seamless transitions between sessions to create a better sense of the overall learning flow for students.

I can't remember what we were doing at the time but we wanted to know what we were doing tomorrow.

More linking needed between sessions (what's coming up) clearer signposting - Clearer intent I guess.

6.21.5 Resources

Provide authentic examples and case studies.

I think some examples would have probably helped there. I think the lecturers were trying to come up with examples on the spot if they had some within their material that would have probably helped maybe for a different design problem.

6.21.6 Other student suggestions

Examine how the design thinking approach and structure can be applied to future projects for the students (i.e., in their second year of study).

I'd be very interested to see how they can develop it for, for example, like second year or something. Or if you could in fact apply this sort of style to every assignment.

6.21.7 Other opportunities identified

In addition to suggestions identified above, I identified a number of other opportunities from an analysis of the interviews.

- Upload presentations online more promptly after each teaching session.
- Integrate more structured (rather than impromptu and informal) class discussions, including potentially more at the end of each session.
- Enhance the roleplaying method. It was suggested that the teachers could allocate roles (personas) and give out props (i.e., crutches to roleplay someone with a broken leg) to encourage students to actually use this method (which many groups had avoided)
- Review both the timing and communication of the Lotus Blossom (idea generation and exploration method). Many students mentioned that this method wasn't too successful for them in the context of the project.

From my review of interviews, a number of other opportunities came to mind.

- Consider extending the overall timing and structure of the curriculum enactment to six weeks, instead of four weeks.
- Better support students who are struggling with the quickness of pace (related to the workshop style approach).
- Improve support for the student groups both at the beginning and throughout the curriculum enactment.

SECTION FOUR: REVIEW OF STUDENT PORTFOLIOS

In this section, I analyse data from a visual review of the portfolios produced from each group of students.

6.22 Analysis of group portfolios

I reviewed each of the student group portfolios, comparing the work produced (i.e., evidence of design thinking learning and expertise development) against the design thinking expertise framework. Tendencies in outcomes associated with key design thinking practices were summarised in the map in Figure 68, with emergent patterns and tendencies of groups associated with different stages of the design thinking process model.

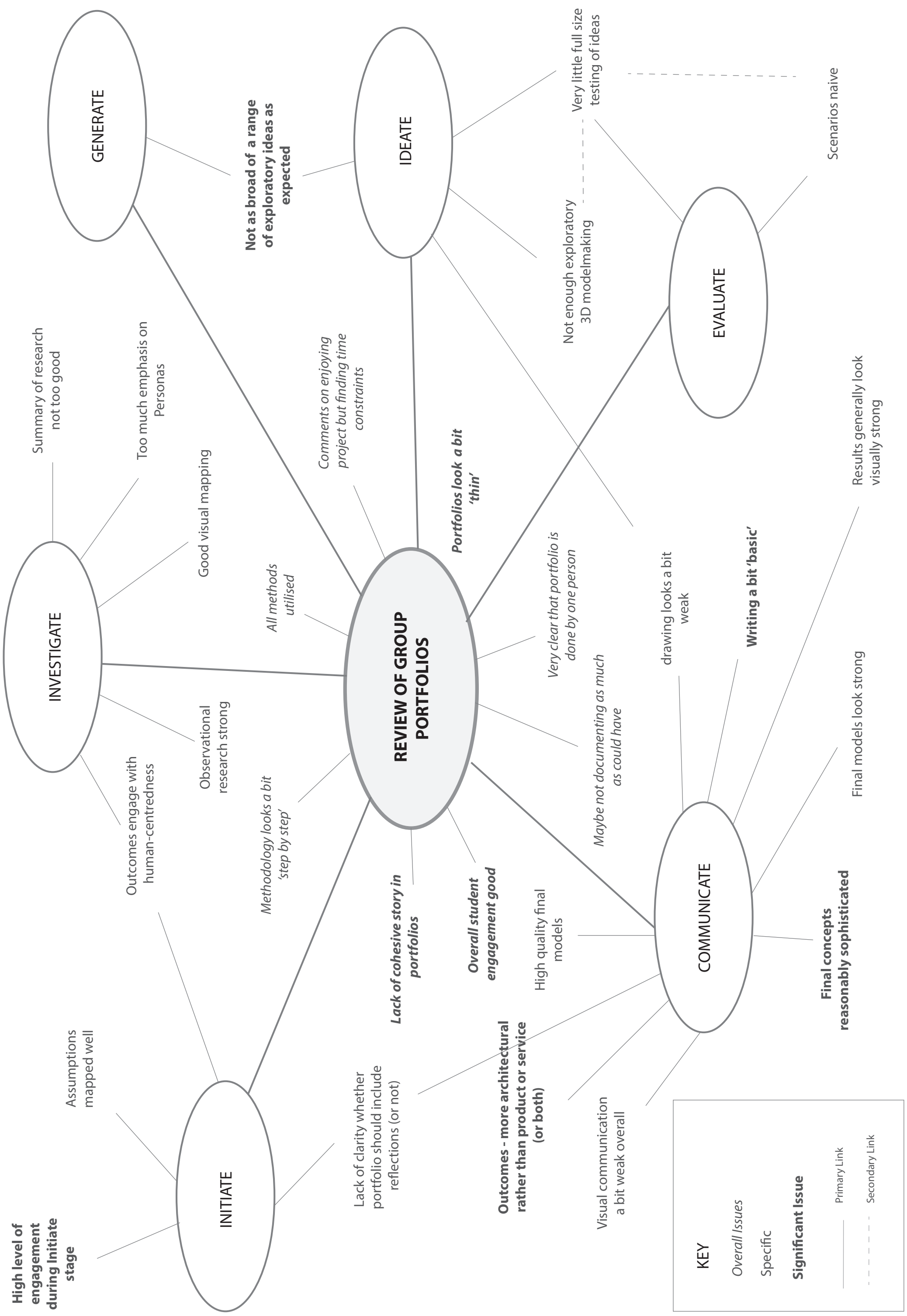

Figure 68. Findings from the analysis of the group portfolios

6.23 Themes and tendencies

Key themes and tendencies in the portfolio task outcomes are summarised below.

6.23.1 Designed outcomes

The overall outcomes (final design proposals) were generally strong, creative, innovative, well presented with clear evidence that the students (as represented by the group work) have engaged well with the key aims of the brief (improving the user experience and general human-centredness using design thinking). In addition, the final concepts, although generally interesting and innovative, were generally very architectural (i.e., very spatially focused - buildings, entrances, seating and signage). Surprisingly (given the human-centred focus), there were no service design outcomes. More surprisingly, given that these are product design students, there were very few specific product outcomes. Generally, all the outcomes, however, were underpinned by a good understanding of systems issues (i.e., a dynamic, changing flow of people etc.).

6.23.2 Process documentation

The documented process work in the portfolios generally seemed weak in comparison to the final designed outcomes. Overall, the documentation in the portfolios seemed a bit 'light'. There was, however, good evidence that the groups had engaged with all stages of the design thinking process model, and associated methods (practices). The portfolios also appeared relatively 'thin' with an overall lack of cohesiveness about the process and the journey through the design thinking project. For example, there were generally no introductions and conclusions to the portfolios. There also seemed to be a lack of clarity around the purpose of the portfolios, what they are used for, and how they should be structured. Process images were small, and perhaps not representative of the process work undertaken. There was also strong variation in the general layout and visual communication of the project.

6.23.3 Expertise development

A number of specific issues were identified with expertise development across student groups.

- The knowledge-gathering research (such as traditional research using the internet) that the students completed seemed to be quite weak, and the findings of this aspect of the research were poorly presented.

- The groups clearly engaged with observational research and interviews. These were well represented, and summarised, however there appeared to be little evidence of engagement with roleplaying method.
- The use of personas tended to dominate the research stage. This was evident in the overly large amount of space devoted to personas in the portfolios in relation to other methods.
- There appeared to be very good engagement with the problem (re)framing process and the mapping of exploring insights and needs. I noted that from this point onwards in the project, student groups started using the class space more effectively, especially a mapping and sorting of ideas on the walls.
- The exploratory drawing and 3D modelmaking was quite poor overall, i.e., the quality of drawing and modelmaking was generally weak. The range of ideas documented was not as broad as I had expected.
- There was very little evidence of the exploration and testing of full-size three dimensional concepts.
- Overall, the works looked visually strong with good final (almost professional level) presentation models. The portfolios were quite dominated by multiple images of the final concepts.

6.24 Opportunities for curriculum enhancement

Theorising with respect to the relationship between these outcomes and features of the learning environment suggested the following enhancements to the curriculum.

6.24.1 Content

- Redevelop the project topic to one that has less of a focus on (potential for) final design outcomes that are so architecturally orientated.
- Encourage students to explore a wider range of diverse project outcomes for the design thinking process.

6.24.2 Learning activities

- Review use of the personas method (as an associated learning activity), to de-emphasise it in relation to other methods. This may include being clearer with students about its overall role and value in the design thinking process, and providing better explanations of its use.

6.24.3 Teaching

- Encourage more effective drawing and idea exploration techniques and practices.

- Encourage better use of the studio space for displaying work earlier in the design thinking process.
- Encourage more use of 3D models and full-size testing through the later stages of the design thinking process. This may include developing or considering new methods.
- Improve communication regarding the overall approach that groups should take to constructing and collating the portfolios, and set benchmarks for the quantity of work on display, as well as quality text and imagery used. This may include providing better examples of portfolios.
- Improve clarity of communication regarding the use of reflections in the group portfolio. Reiterate that group portfolios should be relatively objective descriptions of the collaborative work process (illustrated with images).

SECTION FIVE: OVERALL FINDINGS AND OPPORTUNITIES FOR ENHANCING THE CURRICULUM

In this section, I present an overall summary of the findings of Action Research Cycle One (Case Study One). This includes:

a) A summary of key tendencies identified in the data concerning the curriculum enactment and its outcomes with respect to student learning.

b) A diagram that presents a summary of my initial theorising about key entities in the learning environment and their mechanisms that could provide an explanation for the outcomes.

c) A summary of overall opportunities identified for curriculum improvement including a summary (Table 19) that takes account of this theorising. In addition, I present a diagram that describes an initial analysis of key mechanisms operating within and across the learning environment.

6.25 Summary of key tendencies

Using a process of triangulation, I identified themes and tendencies across the findings of the analysis of each data set. There were many themes and tendencies that were convergent, with a small number that were complementary and/or divergent.

6.25.1 Endorsement

Both the students and the teaching staff generally endorsed the curriculum, including the learning goals, overall design thinking process model, the content and the approach. It was evident from the feedback that both staff and students particularly agreed with the tightness of the structure, quickness of pace, the clarity, and the workshop style teaching approach based on the Stanford University d.school model. Alternately though, a number of students did find the quickness of pace, and a lack of flexibility on the design thinking model challenging for them, which limited their engagement with the design thinking process model (see student experience below).

6.25.2 Student experience

The students indicated that they generally had a very good learning experience and thought that the curriculum impacted positively on their design thinking expertise development, and provided a good platform for their future study of product design. This was also reflected in my observations and reflections. The students also noted that they thought the design thinking process was very effectively laid out and communicated, and that they trusted a 'proven' model. They indicated that the curriculum was very different to what they had experienced before in their study. Students and staff also indicated that the class morale improved markedly (from previous projects) throughout the curriculum enactment.

As noted above, many students noted that the quick pace of delivery, while it was good, did challenge them a lot. Many students were clearly not used to this type of approach. A couple of students mentioned that the pace actually hindered their thinking, rather than enhancing it. Many agreed however that the quickness of pace enhanced the overall productivity of the groups.

The interviews were relatively dominated by the students' descriptions and reflections on the group collaborative process. The majority of students identified this as the most significant and enjoyable experience for them. Many students also found the group work very challenging at first, although thought that group collaboration improved over time. The students identified concepts of socialisation, bonding and friendship as important elements of successful group work. The students also commented on problems around leadership, delegation and issues with non-performing students.

Both the students and teaching staff indicated that they thought that the curriculum model should be taught again, and that it provided a good model for future product design projects.

6.25.3 Design thinking expertise development

While the students had a relatively high rating of their design thinking expertise pre-project enactment, they clearly believed that they had developed significantly across their mindset and design thinking practice capability over the course of the project. This was also evident in the generally high standard of work and outcomes produced in the group portfolios.

The students articulated that they generally thought the biggest impacts of the curriculum were on their knowledge and understanding of new design thinking methods and processes, and many noted that it was good to have a template (model) that was applicable/useful for future design projects. I noted that this was not too surprising given that learning new methods and process are a relatively tangible outcome. Only a small number noted more intangible outcomes, including significant mind shifts in their personal values and outlook.

The overall design thinking work outcomes were strong, with final concepts innovative, relatively sophisticated and responding well to the brief. The final models were also very well presented. Even though the underlying work was generally strong, the process work was not documented nor presented effectively (i.e., concept drawing was generally weak), and the portfolios were generally 'light'. In addition, the portfolios did not necessarily represent the work undertaken, and the written component was also 'light'. The lower standard of drawing, and a lack of 3D models and prototypes, were also noted as issues.

The students' use and application of self-reflection was also identified as a key issue in the learning process. While some students thought the reflective process was a very important aspect of their learning, and enjoyable, a number found the process very unclear, problematic and not well communicated. These points were also noted by the teaching staff during the debrief process. Key issues also included some students not being comfortable with the public nature of the blog (using Wordpress, and a lack of alternate methods of reflecting). There also appeared to be some confusion regarding the use of reflection in the group portfolios.

6.25.4 Design thinking practices

The students generally identified a number of design thinking practices as particularly important to them and as having a lot of impact, including Observation, Interviewing and Brainstorming. Observation and interviewing did seem to challenge the students however, given that they were asked to work outside of the comfort of the student space and watch and interact with strangers, but they also seemed to find it very rewarding and confidence enhancing. For example, in reality, the majority of people, when approached for interviews, were more friendly and engaging than the students expected. The insights that students gained clearly helped them develop more empathy and understanding of people's perspectives, and helped identify unmet human needs.

In addition, a number of methods were identified as more problematic for students and worthy of redevelopment/improvement. This was confirmed to some degree in the portfolio review. They include:

- *Lotus Blossom* (particularly the timing and relevance of the method)
- *Insight Development* (lack of clear definitions and lack of clarity of communication)
- *Roleplay* (content not good and there is a need for mechanisms to get students using the method).

Students also noted a lack of authentic (real-world) case studies and examples of professional design thinking in teacher presentations and in the resources provided.

In addition, a number of other issues were identified with the curriculum including its timing (a bit too late in the year), and too much emphasis on the 'front end' of the design thinking process (the research and insight development), with not enough emphasis on concept development, refinement and communication.

6.25.5 Teaching

The teaching staff were generally enthusiastic about the curriculum, and were keen to support the teaching of design thinking and the research. It was evident, through a process of ongoing discussion and negotiation, that both teaching staff members had differing teaching approaches and conceptualisations of design thinking, but the curriculum did however provide a solid backbone for the collaborative teaching process. I noted that it was very important to consider underlying power relationships when planning and negotiating staffing.

My observations and reflections indicated that the development and teaching process was intensive and stressful for the teaching staff and for me as the researcher. The enactment process could be conceptualised as a 'rollercoaster' ride for staff, with some of the sessions clearly more effective and better than others. Students, on the other hand, generally thought that the teachers engaged and interacted very well with the students. Overall (other than the first session), the students generally responded very well to the curriculum enactment.

The stress felt by the teaching staff during delivery may be related to the newness of the curriculum (it was a very different approach to the previous projects), the intensity of the workshop teaching style, the collaboration needed between the two teachers, and the extra expectations relating to the underlying research. A process of ongoing debriefing (between the teaching staff and me as researcher) was useful, however, in unpacking the 'journey', and for identifying issues and useful insights.

Many students noted in their feedback that they thought the lecturer presentations, videos, class discussions, and the learning in the field (observational research/interviews) were particularly helpful in their learning. On the other hand, the online resource, the portfolio documentation process and reflective blogs were noted as relatively less helpful. The staff, and a number of students, also noted the assessment criteria and process was not well communicated. In addition, a number of students noted that the transitions between each session could be improved.

Overall, the curriculum was generally enacted effectively, with a solid collaborative teaching model operating between the two staff members.

6.26 Initial theorising of entities and mechanisms operating within the learning environment

Figure 69 summarises the outcome of my first attempt to use abductive and retroductive analysis to help identify examples of mechanisms operating within and across the learning environment. The purpose was to help me develop a broad understanding of the type, variety and the number of possible mechanisms operating, and those that may be open to influence.

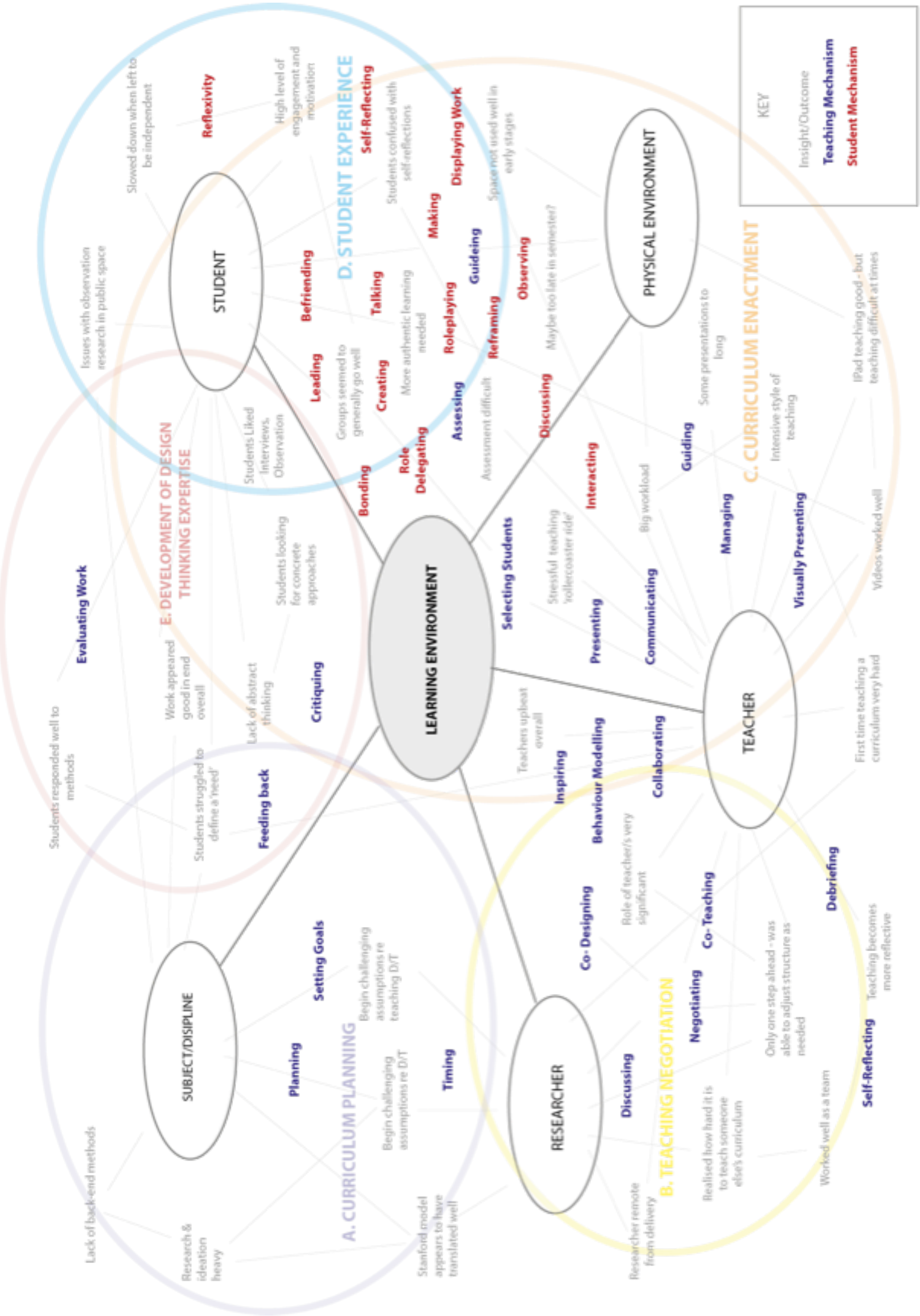

Figure 69. Overall summary of mechanisms operating in the learning environment

6.27 Opportunities for curriculum enhancement

Table 21 presents a summary table of the potential opportunities I identified for enhancing the next iteration of the curriculum. Opportunities were categorised using my curriculum development framework.

Table 21. Summary of opportunities for curriculum development

Curriculum consideration	Description of potential response
Content	
Empathic Mindsets	Identify ways to enhance the students' development of empathic mindsets. Teaching responses may include an increased focus through content, learning activities, teacher presentations, and discussions and improved design thinking methods associated with this area.
(Human) Needs Practice	Develop a new practice to help students understand and identify latent/unmet human needs. For example, develop better definitions of what human 'needs' are, how needs can be identified, understood and categorised. Adjust learning activities, teaching, and resources as needed.
Roleplaying Practice	Enhance the roleplaying practice. This may include the teacher allocating roles and supplying props (i.e., crutches or a wheelchair) and generally encouraging students to use this method.
Lotus Blossom Practice	Review both the timing and communication of the Lotus Blossom idea generation and exploration practice. This may include bringing it earlier in to process.
'Personas' Practice	De-emphasise the personas practice, and its use in the research process, especially at the expense of other methods.
Framework	
Duration of the Curriculum	Increase project length from four weeks to six weeks (but keep 12 sessions). This better aligns the structure to the university semester length of 12 weeks.
Flexibility of Structure	Explore ways of providing a better balance between providing an effective structure (and content), and allowing more freedom for teachers to add in own personalities, viewpoint, conceptualisations etc.
Timing of the Project	Move the curriculum project earlier in the first year (to the beginning of the semester) for the product design students.
Process Alignment	Develop a better balance between the first and second halves of the design thinking process. In particular, emphasise the second half of the design thinking process more (the last few weeks), to improve concept development and communication and reflection. This may include enhanced methods, learning activities and associated content and resources (see below).
Learning Activities	
Project Brief	Redevelop the project topic to one that has less of a focus on (potential for) final design outcomes that are so architecturally orientated.
Introduction to Collaboration	Develop more focus on the first few days, and support students better with the group bonding, and the alignment of each team. This may

	include the development of methods to support collaboration and group work.
Frameworks for Observation	Develop a framework for planning and negotiating students' observational and other field work activities to improve students' experiences in the public spaces, especially with observation and interview practices (methods)
Teaching Technologies	Simplify the use of presentation technologies (such as Apple iPads as primary teaching device) used in the teaching process
Portfolio Documentation	Develop better communication about expectations, and develop models, and/or examples or case studies.
Student Self-reflection process	Develop better models for the self-reflection process, including finding existing model/theories and frameworks that would provide a good structure.
	Develop journal document style approach to self-reflection rather than online blog.
	Develop student briefing sessions or workshops on self-reflection.
Teaching	
Authentic Learning Case Studies	Develop and provide appropriate case studies in relation to above and other areas. Given that there is a general lack of case studies available, these may need to be developed by the researcher.
Teacher Presentations	Shorten, and improve presentation layout and communication.
Presentation Upload	Upload presentations online more promptly after each teaching session.
Teaching Pace	Identify and support students who are struggling with the quickness of the workshop style pace. Encourage students to better use resources available (i.e., access the Design Thinking Methods resource).
Session Transitions	Develop ways to improve the transitions between teaching sessions.
Encouraging Drawing	Encourage more effective drawing and idea exploration techniques and practices.
Prototyping/Testing	Encourage more use of 3D models/prototypes and full-size testing through the later stages of the design thinking process.
Class Discussions/Debriefing	Schedule time for class to discuss and debrief after each session.
Teacher Support	
Teaching Briefing	Develop better teaching documentation which outlines the background, overall philosophy, etc.
Teaching Guide	Reconceptualise the teaching template to be more flexible so teaching staff can respond to and more effectively engage with a wide range of teaching approaches.
Teacher Debriefing	Enhance the staff debriefing and shared reflection process. It may include identifying how staff reflections can be better captured, analysed and responded to.
Resources	
Design Thinking Resource	Evaluate how students are using the resource in relation to their work and look at ways of getting students to better engage. This may include better communication (briefing of students) and improving layout and content of the resource. Also may include improving existing methods, developing new methods and including more design thinking examples and case studies (see below).
Assessment	

Assessment Criteria	Revisit assessment criteria.
Assessment Process	Provide more clarity around measurement of achievement, especially as it relates to self-reflection. Communicate criteria and expectations better.
Physical Environment	
Physical Environment	Develop a new physical teaching environment, and associated resources, that are designed specifically for design thinking type activities.

6.28 Further reflections on the research approach

In this chapter I presented the first enactment of the design thinking curriculum. I believe that the analysis of data delivered a strong set of findings, and a good range of potential opportunities for curriculum enhancement in relation to the curriculum design framework. While I believe that the research process was generally effective, on reflection I identified a couple of important issues with regard to my research approach. These included:

- Having to continue to give a lot of time to curriculum development, including curriculum planning and negotiation and discussions with teaching staff, which compromised the attention I could give to research tasks.
- Being slightly overwhelmed by the breadth and extensiveness of the data, and the scope and complexity of the related phenomena that appeared to be significant and that I should develop explanatory theory about.
- Needing to learn 'on the spot' how to rigorously apply some of the steps in the theorising methodology.

6.28.1 Recommendations

Based on the above, and my emergent knowledge and understanding of critical realism, I identified a number of potential enhancements to my research approach for the following action research cycle. These included:

- Constrain the data analysis and theorising (analytic resolution) by focusing on (a) specific examples of students' expertise development, such as specific mindsets or practices, that I believed were important, and (b) student-related design thinking mechanisms, and the student attributes that influence (enable or constrain) the students' abilities to activate these mechanisms. The data analysis for this first cycle did suggest aspects of design thinking expertise and student mechanisms that merited close attention.

- More systematic use of triangulation across each data source to analyse these specific examples of expertise development, to identify themes and tendencies in expertise development.
- Give more attention and time to the use of abduction and retroduction theorising strategies.

6.29 The next chapter

The next chapter presents Action Research Cycle Two, which incorporates Case Study Two.

CHAPTER SEVEN: ACTION RESEARCH CYCLE TWO (CASE STUDY TWO)

7.1 INTRODUCTION

In this chapter, I present the second action research cycle, which includes a summary of the curriculum development undertaken in response to opportunities identified in the previous cycle, and an account of my application of the theorising methodology to the data gathered. I also present opportunities for further enhancement of the curriculum, and thus learning environment, which were based on emerging explanatory theory. With respect to analytic resolution, I decided to focus in particular on data concerning the learning mechanisms and related attributes of students that potentially influenced their development of design thinking expertise. In contrast to the previous chapter, which was structured around an analysis of each individual data set, this chapter is structured around an analysis of students' overall experiences, their development of various design thinking mindsets, conceptual and procedural knowledge, and their capability across a number of individual design thinking practices. This cycle represents Case Study Two.

In this case study, I began to utilise the theorising methodology in a more focused manner, which aligned with my deepening knowledge and understanding of critical realism. This included the use of extant theory presented in literature to assist my 'theoretical redescription' of the data through the use of abductive reasoning. As with the previous action research cycle, data were gathered from my reflections (as a researcher), students' self-reported learning experiences (from interviews and a survey), and student achievement from portfolios of work. The analysis was undertaken in relation to various design thinking practices. The overall findings of the analysis were then used to propose potential enhancements of the curriculum.

The second iteration of the curriculum, incorporating enhancements identified in Action Research Cycle One, was enacted twice in semester one, 2013 with a total of 72 first-year, Bachelor of Business students in a first-year course titled Design Thinking. The course was enacted over 12 weeks, one session per week, for a total of 12 sessions. Of the 36 students present in the class during briefing, 16 students initially agreed to participate in this part of the research, and completed the agreement forms. Of the 16 students, 12 completed both pre- and post-participation surveys. A further six students participated in key informant interviews.

SECTION ONE: ENACTMENT OF SECOND ITERATION OF THE CURRICULUM

In this section, I describe the enactment of the second iteration of the curriculum. It is important to note that in the chapter, the curriculum is often referred to as the *course*.

7.2 Overview

Two parallel courses were enacted, one that I enacted[10], and another course that was enacted by a teacher from the Product Design and Innovation Department. I worked closely with the other teacher in both the course planning and enactment process. For example, the other teacher was able to observe the teaching of my course in a morning session, before teaching the other course in the afternoon session. The break between the two sessions provided time for discussion, debriefing and co-reflection.

7.3 Summary of curriculum development

In addition to the modifications undertaken to accommodate the new group of students and the new enactment context, a number of changes were made to the curriculum based on the enhancement opportunities identified in Action Research Cycle One. It is important to note that due to the very limited time between the first enactment and the second, not all opportunities identified in the previous cycle were implemented. Curriculum developments are described below.

7.3.1 Content

- The project brief was reviewed and redeveloped. The goal was to reduce the complexity of the design thinking problem in comparison to the previous action research cycle. Students were asked to use design thinking to improve the experience of tourists visiting the Auckland Viaduct waterfront area. Each group was given a specific physical location in the Viaduct area to investigate and on which to focus their design[11].
- A new *Identifying Needs* practice was developed to assist students to develop enhanced conceptual and procedural knowledge in relation to identifying and categorising human needs as an outcome of the empathic research process.
- The *Persona* practice was revised, and the rationale for using the method (when, where and why) clarified. I noted that this practice would need more clarification by

[10] Based on a change of position within the School of Art and Design, I was no longer a line manager of teaching staff involved in the research and no longer involved in the assessment of work of student participants. This allowed me to be able to teach in this iteration of the course.

[11] While the focus of the brief was on improving the experience of tourists, the location did provide a range of contextual and situational opportunities to help the design process.

the teachers. Simplified templates for students to construct personas were developed, to help clarify the role and content of personas, and to better manage students' engagement, especially to help de-emphasise the practice in relation to other practices.

- *Reflective Practice* was developed, based on the Atkins and Murphy (1995) model, to provide students with a clearer model and structure for their reflections on learning.
- Three case studies were developed based on work done by UK Design Council and Air New Zealand. The goal was to provide students with an authentic contextualisation of design thinking to enhance their learning. The case studies were formatted into the teacher presentations.

7.3.2 Framework

- Reflecting the changes of context, a 12-week, one session per week structure was developed.
- The design thinking process model was further developed to better balance and align with the course structure. This included creating a *Reframe* stage, moving the *Generate* stage into the second half of the process, and merging the *Ideate* stage with the existing *Evaluate* stage and renaming these as the *Develop* stage. I also developed an enhanced set of practices in the *Communicate* stage.

7.3.3 Learning activities

- Learning activities associated with the new *Identifying Needs* practice were developed.
- Learning activities associated with the *Assumption Mapping* practice were revised and enhanced, as were collaboration resources and introductory activities. This included introducing some theoretical models related to successful teamwork.
- A new mini workshop was developed, in conjunction with the updated material on *Reflective Practice*.
- The format for student reflections changed to reflect the Atkins and Murphy (1995) model. The format was also changed from online blog to a written journal format.

7.3.4 Teaching

- The overall and individual session planning templates were translated into a new format (Microsoft Word document) and the layout was simplified. This template was shared with the other teacher for his own planning purposes (see Appendix III, Figure 114 for example of the template).
- Given that I was not only developing the curriculum, but also teaching one of the courses, I made a note to actively engage with the other teacher, so that we could

share experiences and reflections, and identify strategies for further developing the curriculum.

- All teacher presentations were reviewed, shortened and simplified.
- Teaching and presenting from Apple iPads was dropped, and laptops used instead.

7.3.5 Assessment

- A mid-project assessment event (half of the 80% group portfolio grade) was added for the group portfolio to provide more feedback, and help students with portfolio work.
- The portfolio template was simplified, and the instructions that were provided were refined for the business students. The format was changed from Adobe InDesign to a Microsoft Word format.

7.3.6 Resources

- Version two of the Design Thinking Methods resource was further developed to include the new material and updated practices. The layout was also improved to enhance readability. New examples, case studies and videos were added to provide more authentic contexts and to extend overall learning.

7.3.7 Physical environment

- A new learning space was developed specifically for the teaching of design thinking. This space was included in the development of a set of new learning spaces in the Industrial Design and Innovation Department. The goal was to develop a space that was adaptable, flexible, and best suited to the teaching of design thinking. The space included a set of mobile furniture such as mobile tables, whiteboards and presentation equipment.

SECTION TWO: STUDENTS' OVERALL EXPERIENCES

In this section, I present an analysis of data relating to the overall experiences of students, and their perceptions of the impact of the course on their development of design thinking expertise. Data are drawn from the survey and interviews with students, comparisons between survey and interview data are made (triangulation) and some comparisons between the data from case study one and this case are also noted (case comparisons).

7.4 Overall student experience

The majority of students reported in the survey that they had a very positive experience, as presented in Figure 70 below. These views aligned with the findings of the previous action research cycle, and the findings provided further validation and endorsement of the course.

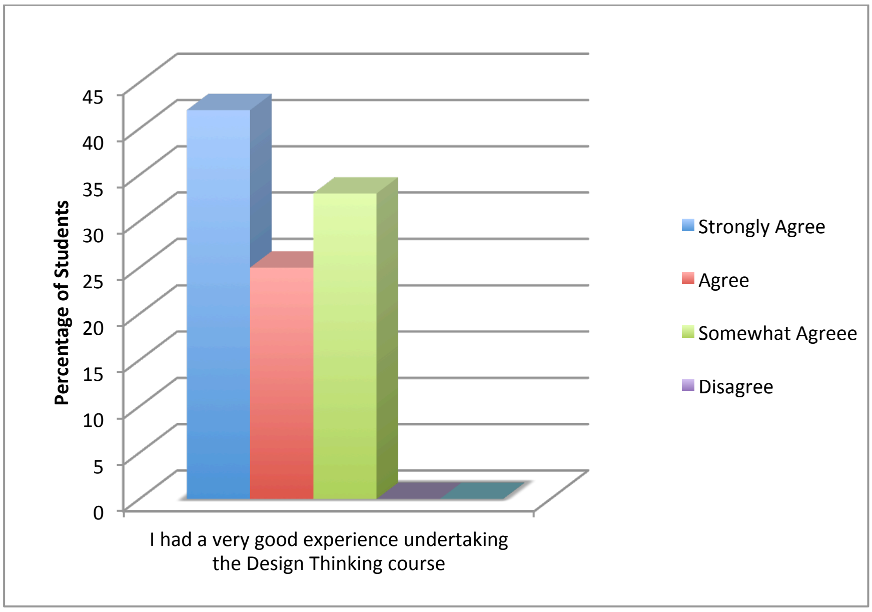

Figure 70. Students' ratings of their overall experience

7.5 Student perceptions

Positive feedback was expressed in the comments made by students. For example, five of the six students commented directly about how much they enjoyed the course.

> *Overall honestly I think you guys did a really good job. There are some little, little bits, but it's not a major thing. Overall it was a really positive experience doing the paper.*
>
> *It was actually really, a really good class.*
>
> *I think the class was a really good class and I did thoroughly enjoy it.*
>
> *I did really enjoy the paper as a whole. I don't think I would change it so much for the next class, coz I really enjoyed it.*
>
> *Yeah I think there is coz there's been a lot of positive feedback that I've heard from other people that did the course with me that oh wish I could do some design thinking again because it was really fun.*

However, a number of students also identified aspects of the course that they did not enjoy, or found very challenging. Much of this feedback is focused on the first few weeks of the course. Three students commented directly on this.

> *I didn't enjoy as much was I think the first week and the second week. There wasn't much to do except sit and listen.*

> *I struggled in the beginning because I didn't really know what was going on.*

> *I really didn't like the group work to start with. We didn't talk much. It did get a lot better towards the end.*

Many of the challenges appeared to stem from the substantial difference in the learning and teaching approaches of this course compared to the other courses that the students had experienced in the Faculty of Business.

> *It was very different than my other classes. Other classes are just theory, writing stuff down and learning it. This was a lot more hands-on. I did find this hard at the beginning.*

> *Totally different to what I've ever done before. Take something like business and information management for an example. Basically it was 2 or 3-hour classes, sitting in the classroom listening to someone talk, writing notes.*

> *But I know a lot of people that might have been kind of like put off at first because they weren't really sure what they were doing as it was so different. Coz I know a couple of friends in one of the other classes who didn't actually carry on doing it.*

Individual teacher interventions and encouragement however seemed to play a strong part in helping students through their uncertainty about key concepts and the direction of the class.

> *Ah, my lecturer was really good, he always came in and sat down for a good part of the class with each team and helped us point in the right direction. I think that he was really supportive.*

> *Teacher 2, he was fully aware of how I was feeling from the beginning and we had a chat about it towards the end. And he was like so how do you feel now coz I know that*

you were quite unsure about the whole thing? And it just gave me confidence, a lot more confidence in you guys, you know.

7.6 Impacts on students' expertise development

Similar to the findings described in relation to Action Research Cycle One, a majority of students reported in the survey that they perceived that the course positively impacted on their overall development of design thinking expertise, presented in Figure 71. Students also indicated that that the outcomes could be applied to their future studies and work. These findings again provide further validation and endorsement of the overall approach to the curriculum.

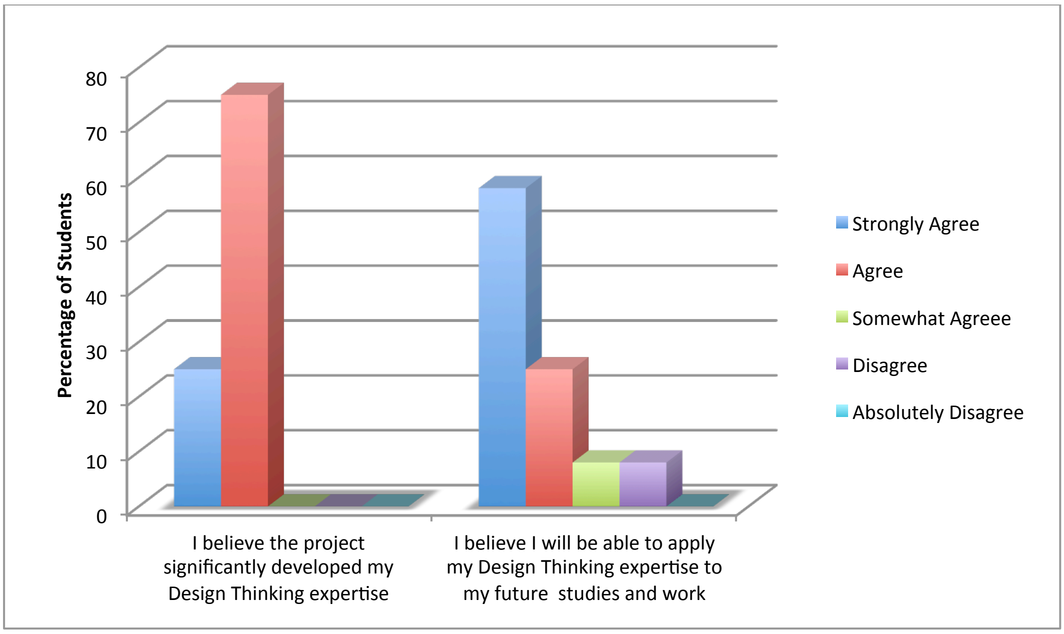

Figure 71. Student ratings of the overall impacts of the course

7.7 Student perceptions

Additional positive impacts were also reflected in interview feedback from students. Three students commented on the impacts of this design thinking course on other courses they were taking.

I'm in Human Resources … the best thing I took away from this course was finding out how people work in groups and how they deal with leadership. I think I can apply this in my other papers that have group assignments.

Most definitely especially with my Advertising major in the business school … you can't have advertising without being empathetic and understanding the customer.

I've had a couple of papers that are required for Events, but I've never considered actually prototyping the idea we have created. The actual thing (prototype) will be great for my presentations.

Again the idea of group dynamics coz in Events it's a major thing, you cannot take on this giant event by yourself and if you don't understand group dynamics and how it works and how to sort of respect other people and value their ideas and that sort of stuff. You're not going to be good at your job really, so that was a big one for me.

One other student commented that they were now inspired about the potential of design thinking as a future career.

And I'm like wow, this is something that I could probably want to continue and have some kind of career around.

7.8 Key tendencies and explanatory theory

- A majority of students commented in the interviews that overall, the course was enjoyable and a very positive learning experience. This aligned closely to the findings of the survey.
- Many students reported that the first few weeks of the course were especially challenging for them. Contributing factors appeared to include the substantial difference in approach to the course from previous learning experiences.
- Many students reported that the course had a positive impact on their development of design thinking expertise. A number of students specifically identified the potential transfer of their learning to other courses that they were taking, and to future work, as a positive outcome.

SECTION THREE: STUDENT MINDSET DEVELOPMENT

In this section, I present an analysis of data relating to students' development of various design thinking mindsets. Data are drawn from the survey and interviews with students. Overall pre- and post-course data are presented, in addition to selected examples of individual shift in mindsets. These are presented in Figures 72 and 73.

7.9 Pre-course mindsets

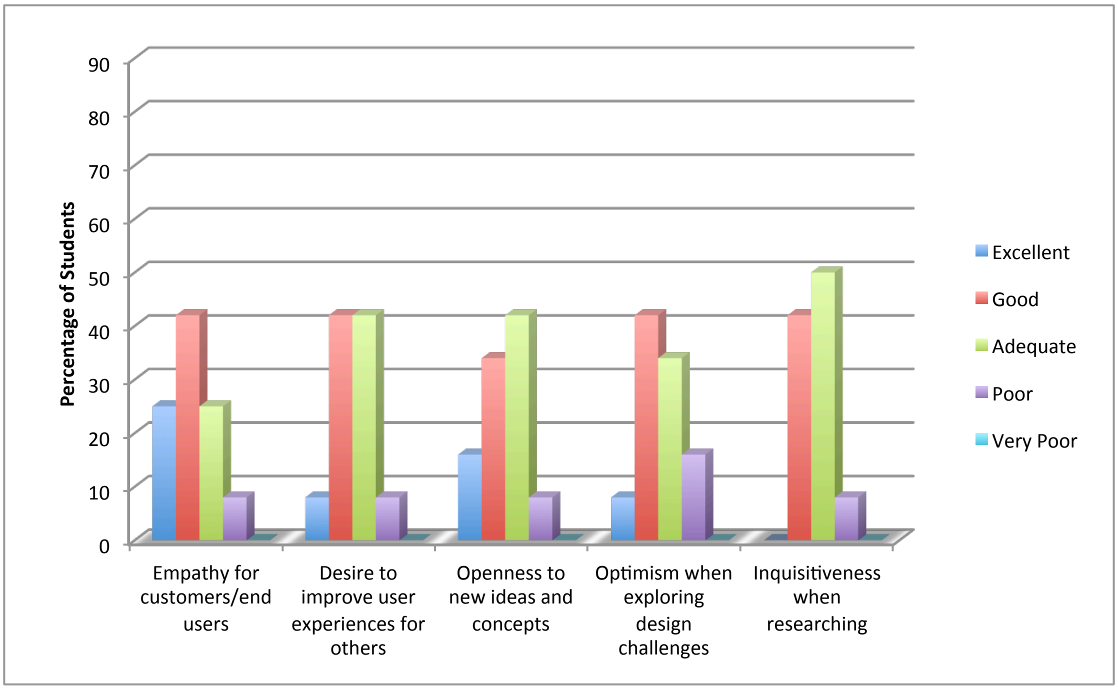

Figure 72. Students' ratings of their design thinking mindsets pre-participation in the course

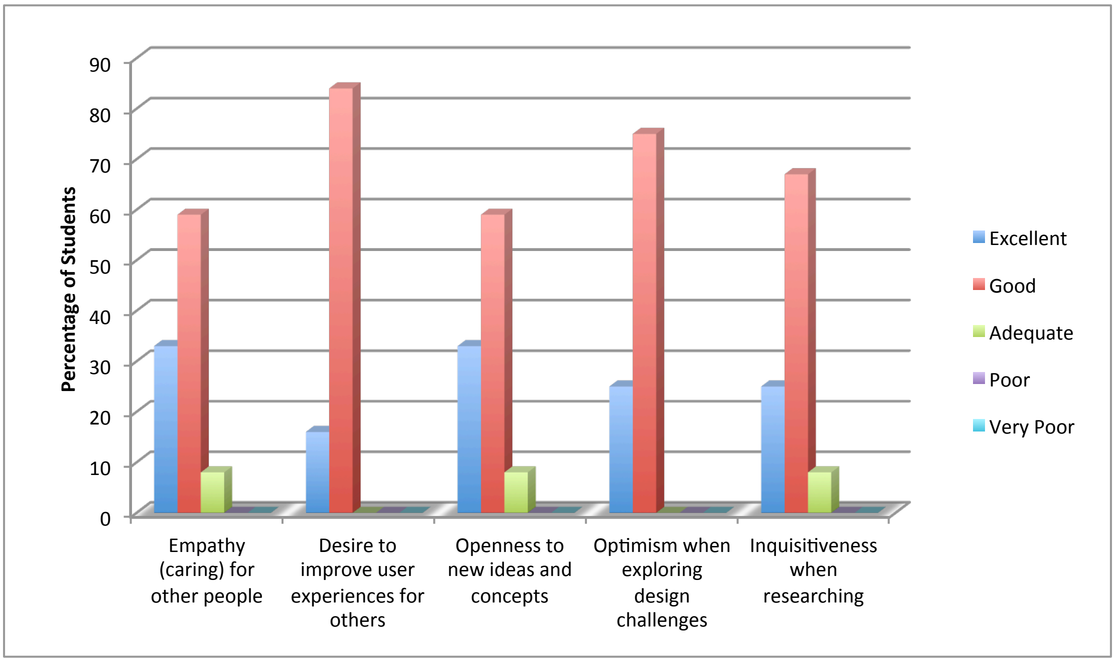

Figure 73. Students' ratings of their design thinking mindsets post-participation in the course

The following graphs present more detailed examples of shifts in students' mindsets.

7.10 Empathic mindset development

All students reported a positive rating of their personal empathy before they participated in the course. Post-participation, students reported increased positive ratings, as presented in

Figure 74. This positive bias and shift in ratings is very similar to the findings for Action Research Cycle One.

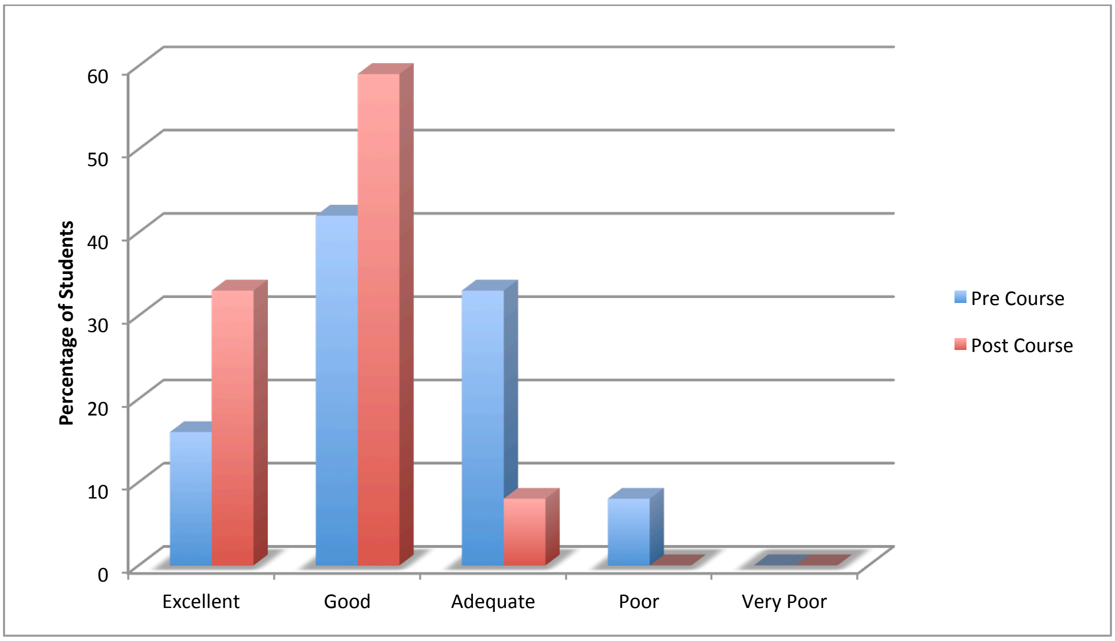

Figure 74. The change in students' ratings of their empathic mindsets pre- and post-participation in the course

Students commented in the interviews that the development of an empathic mindset in relation to design thinking was a particularly significant outcome for them. Three of the five students identified empathy when asked what was their most significant learning outcome from the course.

> *It was empathy.*
>
> *Yeah, I think it was definitely empathy. I've always found that I'm sort of a relatively empathetic person though anyway.*
>
> *Empathy, that's the most important thing we learnt.*

7.11 Desire to improve user experiences

As indicated in Figure 75, the students' ratings of their desire to improve user experiences increased towards the good/excellent range following the course.

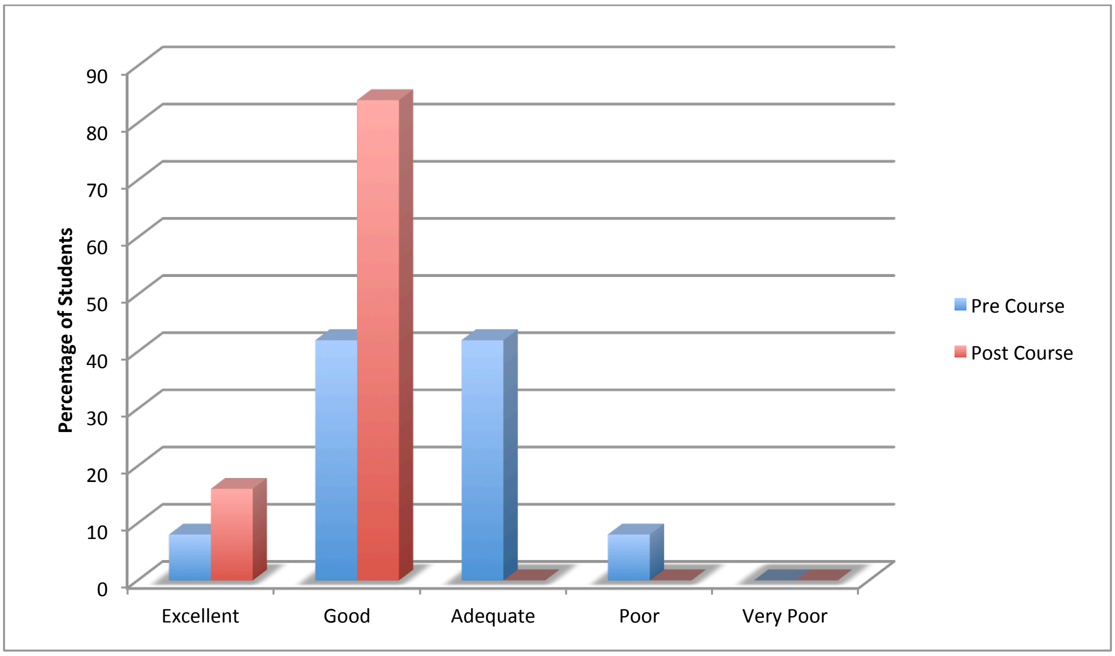

Figure 75. The change in students' ratings of their optimism mindsets pre- and post-participation in the course

SECTION FOUR: STUDENTS' DEVELOPMENT OF CONCEPTUAL KNOWLEDGE

In this section, I present an analysis of students' overall development of conceptual knowledge about design thinking, a summary of findings, and curriculum opportunities.

7.12 Review of portfolios

The review of the students' portfolios revealed a number of key points in relation to students' development of design thinking knowledge.

- All groups generally demonstrated a fundamental understanding of key design thinking concepts, especially when identifying and reiterating the basic principles and concepts that were presented in course work, and in the resources provided.
- The portfolios tended to have more focus on the earlier stages of the design thinking process, and a greater volume and depth of work in the early phases, rather than the latter stages.
- There was generally limited exploration of design thinking principles and concepts beyond those presented in class, with only three groups referencing other work and examples to help illustrate their own work.
- The final creative concepts produced by the groups were not as strong, i.e., not as creative and as well developed and refined, as concepts produced by the Product Design students in Action Research Cycle One.

7.13 Student perceptions

Students reported that they perceived the course enhanced their overall conceptual knowledge of design thinking, especially their understanding of key design thinking principles. This is evident in the rating data, as presented in Figure 76, which indicates a very positive shift in students' ratings of their knowledge of design thinking principles and concepts after participation in the course.

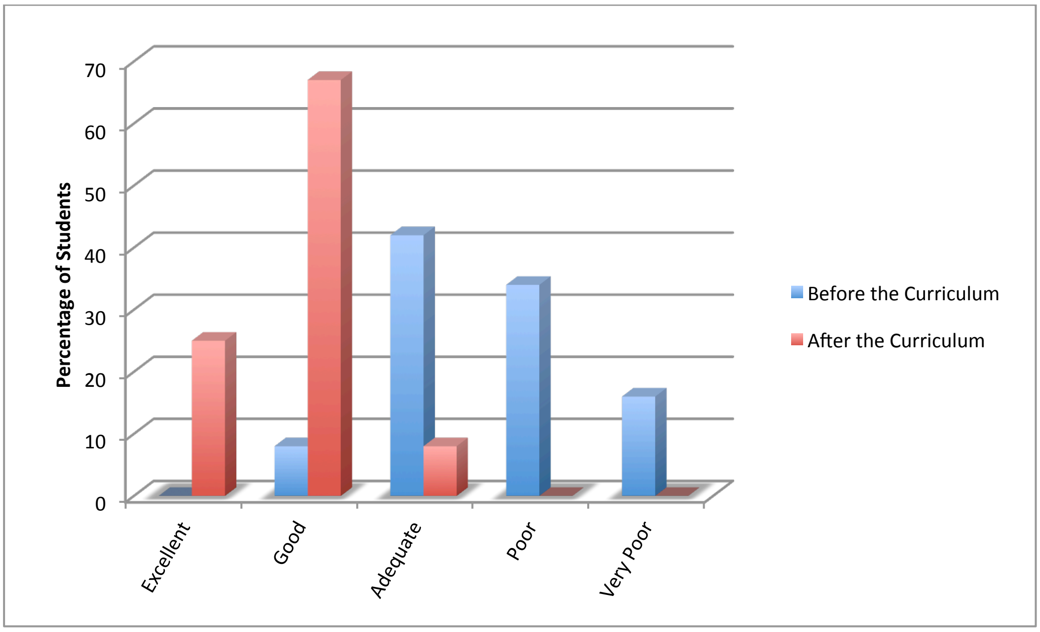

Figure 76. The change in students' ratings of design thinking concepts pre- and post-participation

While participation in the course clearly impacted on students' conceptual understanding of design thinking, students also indicated that they felt a bit lost, unsure and frustrated by their lack of understanding of key concepts early on in the course. These comments generally reflected uncertainty/confusion regarding learning goals, related activities and struggle with the experiential learning approach. This is reflected in a number of interview comments.

> *At the beginning of the first week I was like what the hell am I doing here going to this (laughter) you know? It was kind of frustrating, the mystery.*

> *And at first I was a little bit like the whole group was kind of like we don't know what we're really meant to be doing.*

> *At the beginning it felt kind of really unstructured and I had no idea where it was going at all.*

But going through it all it kind of slowly unravelled, but there wasn't like a clear sense of direction going right this is where we're trying to get at the beginning.

While students may have struggled early on, three students mentioned however, that key design thinking concepts became much more evident, clearer, and made more sense for them right at the very end of the course.

It was kind of all wishy washy all the way through. Towards the end of the paper you actually knew what you were doing. *Came together for me at the very end.*

Made sense in the end, yeah.

But yeah towards the end of the 12 weeks it definitely became a lot clearer. At the beginning it was kind of really unstructured and had no idea where it was going at all. But finally it all made, it kind of clicked. Made sense in the end, yeah.

Four students also felt that while the presentations were very good, there was not enough content and theory concerning design thinking delivered in the course.

Thought a lot of the theory was really good, but when I went home and looked at the slides and I couldn't quite remember what they were about. I wanted more books and papers to read.

The presentations were great. But I reckon the slides were pretty short in terms of the information per week. More theory would have been good for me.

Yeah a little vague on the theory I think. For example this is why we're doing it and this is what part it is. Yeah the main thing for me would be more structure around the theory, I guess, yeah.

Yeah, a bit more theory. And just a bit more like direction I guess.

Two of the six students also suggested there should have been more class discussions.

We didn't have enough class discussions.

> *People don't talk enough, but could have been encouraged to talk more in class discussions. I think as soon as someone starts talking other people will feel like they can say something, so that sort of bouncing.*

7.14 Researcher reflections and explanatory theory

Aligning with students' comments, I also noted that they struggled initially with key concepts, and the overall learning approach of the class.

> *I am realising how different the business students are to the design students, it's a paradigm shift for me, and probably for them too.*
>
> *I have to be careful because I am used to teaching design students and you make assumptions about what they know and how they will react. Certainly feel they are a bit puzzled by what is going on currently. Some look really confused about the concepts associated with Design Thinking.*

I also noted that some of the theoretical and pragmatic content could be improved, but importantly students needed to access the resources provided more, to develop their knowledge.

> *I need to cut/develop better content, and encourage more access to the background resources.*

7.15 Key tendencies and explanatory theory

The following key tendencies were identified and possible explanatory theory was developed. The latter was based on abductive reasoning, concerning relationships between student outcomes, student attributes, student mechanisms, and other features of the learning environment.

- Most students identified a very positive shift in their conceptual knowledge and understanding of design thinking, but this appeared to come off a low knowledge base. Many students had a very low, or no understanding at all of what design or design thinking was, what the class was about, and what would be involved before they enrolled in the course. This lack of fundamental understanding seemed to contribute to general confusion felt by many students during the earlier stages of the course. Some students felt quite uncertain and uncomfortable, and struggled to grasp key concepts.

- Overall, the conceptual understanding of design thinking appeared to 'click' towards the end of the course for many students, who noted that this happened when they began to see an outcome and a resolution from the design thinking process. That is, when they could see a tangible, somewhat resolved concept, they realised that this was a result of the hard work, and the application of practices, processes and thinking over the course of the design thinking process.
- Many students struggled with the experiential learning approach, which focused on 'doing' first, rather than theory-based lectures. This approach was very different to the approach that students had experienced in the business school, and the initial part of the course did not prepare students as well as it could have.
- In contrast to many students feeling unsettled during the early stages, the portfolios were stronger than in the first iteration of the curriculum, with a greater level of documentation during the early stages of the course. Contributing factors appeared to include:
  - general familiarity with research, rather than the later creative aspects;
  - there were many opportunities to document work through the research process; and
  - early enthusiasm, which tended to drop off during the middle stages of the course.

- A number of students noted that they wanted more theory and class discussions to help their conceptual learning.

7.16 Explanatory theory and curriculum enhancement

Drawing on this tentative explanatory theory, I identified a number of opportunities for enhancing the curriculum. These are presented in Table 22.

Table 22. Opportunities for enhancing the curriculum

Curriculum Consideration	Description of Potential Enhancements
Framework	
Experiential Learning Pedagogy	Clarify and capture (map) the experiential learning pedagogy that underpins the curriculum.
Content	
Foundational Concepts	Use the framework mapped above to develop enhanced foundational content (for example, key design thinking and experiential learning concepts), and use to better introduce, communicate, and help manage the orientation of the business students to the design thinking course.
Theoretical Content	Provide more theoretical papers and other academic texts to provide

	enhanced back-up for the experiential learning process.
Learning Activities	
Orientation	Develop an enhanced orientation to the course, including discussions and activities, to help the transition to what is conceptually a very different learning and teaching approach for business students, in particular the fast pace and volume of hands-on activities, and careful ongoing reflection.
Discussion	Develop structured discussion activities, to help students engage with, and reflect on, key concepts throughout the course.
Teaching	
Facilitate Dialogue	Facilitate a dialogue with students regarding their development of conceptual knowledge at key points in the course. Explain the difference in the experiential learning approach to other learning approaches that they may be used to, especially how much key conceptual knowledge is often only revealed after experience, and through reflection.
Resources	
Video Resource	Develop a video of students talking about their experiences of the course, and use to help communicate the journey to new students.

SECTION FIVE: STUDENTS' DEVELOPMENT OF PROCEDURAL KNOWLEDGE

In this section, I present an analysis of students' overall development of procedural knowledge in relation to design thinking, a summary of findings, and curriculum enhancement opportunities.

7.17 Review of portfolios

The review of the student group portfolios reflected the students' strong understanding of, and engagement with, the key procedural stages of the design thinking process. This was reflected in the good clarity with which student groups documented each stage of the design thinking process, guided by the model provided and discussed from course sessions and resources. All groups structured their portfolios around the six stages, and generally referenced material presented and/or provided. Three out of six groups provided further references, examples and comparisons to other design thinking process models in relation to their projects.

While all groups used the design process models provided, it was clear in the portfolios that there was a more substantial body of design thinking work documented for the first half of the process (research and problem reframing), than the second half (creative exploration and concept development). I noted a greater volume of writing, images and general processes documented and explored in the first half of all the portfolios in comparison to the second half.

7.18 Student perceptions

Most students reported that the key impact of the course was on their knowledge and understanding of design thinking processes (procedures) and associated practices. Aligning with Action Research Cycle One, this was evident in a strong, positive shift in students' ratings of their knowledge of the design thinking process as presented in Figure 77.

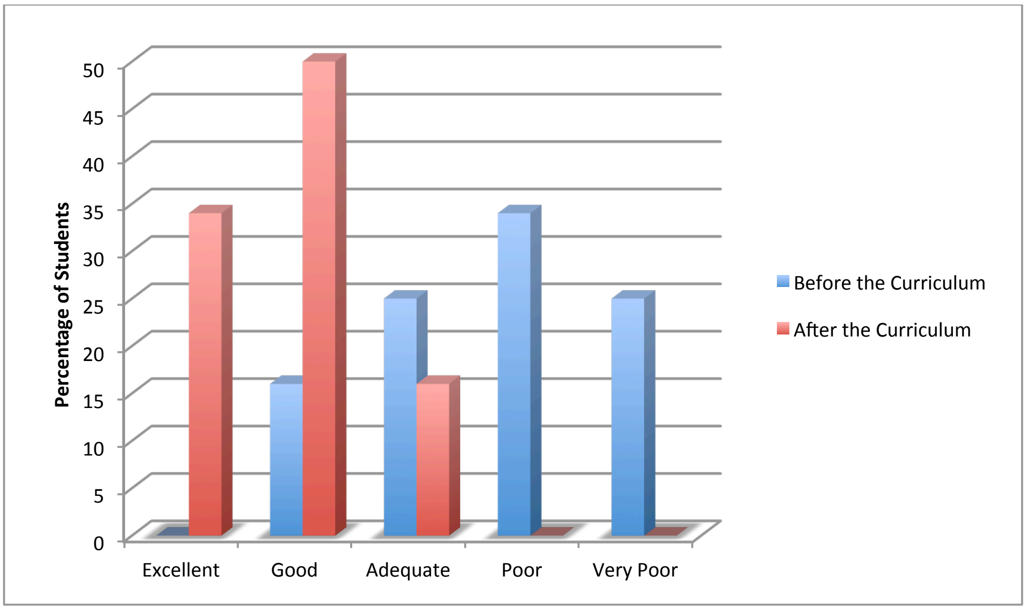

Figure 77. The change in students' ratings of their knowledge of the design thinking process before and after participation

Two students commented on how well structured the course was, especially in relation to the design process.

> *I think the paper was structured really, really well compared to other ones when it particularly because it show us some really good processes.*

> *The paper I think was very well structured. I liked how it linked to the design process.*

In addition to the positive feedback about their procedural knowledge development, three students specifically commented in the interviews that the greatest impact was the development of a more comprehensive understanding of the complexity and challenges of the activities associated with the design thinking process. This is reflected in some of their comments.

> *I really liked the design thinking map you gave as. Didn't realise how complex it would be. It really helped us.*

And I said well personally I've learnt how to get from 'a' to 'b' but you don't know how much has gone in beforehand until you have learnt about it, and that's what I found was really significant.

What I noticed is that the product in the end it's important, but everything in the process beforehand is actually more important. Didn't think that there would be so much work.

Three students noted that they perceived a greater weighting and focus on the research aspects of the course compared to idea development aspects. They also indicated that they did not have enough time to develop their ideas and concepts as thoroughly as they could have.

The research part of it felt slower and too long.

I just felt we spent a lot, a lot, a lot of time and focus on the research. I know how important that research is, but I felt like three quarters of the semester was taken up by research and not idea and concept generation.

And we had very little time to actually develop our ideas towards the end.

7.19 Researcher reflections and explanatory theory

I noted, in a couple of reflections, that students' development of procedural knowledge and engagement was closely associated to the process model I presented to them.

Went through the overall process model today, and students seem to get the key ideas, especially that the creative work comes after some in-depth research to lay a foundation for creative exploration. Anyway, I asked if they understood the model that I showed and their feedback was really positive. There were quite a few questions about the model, which is a good sign of engagement.

I noticed that all groups are referring to the overall process model I have given them. They seem to like it – in fact maybe too much – they are really holding on to it – like a map.

7.20 Key tendencies and explanatory theory

- There was a strong, positive shift in students' ratings of their knowledge and understanding of the design thinking processes, which like conceptual knowledge, came off a very low base of understanding before the course.
- Many students noted that their knowledge of design thinking processes and practices was their most significant learning. This appeared to reflect the tight learning structure of the course based around the process model, and the overall effort that went into communicating and explaining the process model and associated resources.
- A number of students noted that they perceived a greater general emphasis on the first half of the course, and wanted more time and focus towards the end for the creative aspects. Contributing factors may include:

    - the learning approach was new, and they were more focused while adjusting;
    - there were more practices in the first half; and
    - teachers may have emphasised, or focused more, on the first half of the process.

7.21 Explanatory theory and curriculum enhancement

Based on the tendencies identified, and associated explanatory theory, I identified the following changes that could be made to the curriculum to enhance students' development of design thinking procedural knowledge (Table 23).

Table 23. Opportunities for enhancing the curriculum

Curriculum Consideration	Description of Potential Enhancements
Structure, Sequencing and Timing	
Course Balance	Re-examine the overall structure and weighting of the course, and find ways to better balance the front and back ends.

In the following sections, I report on my application of the theorising methodology to data collected in relation to the design thinking practices of empathic research, problem reframing, creative practice, concept development, reflective practice, and collaborative practice. These practices generally correlate to concepts of functioning knowledge (Biggs, 1999).

SECTION SIX: INVESTIGATE (EMPATHIC RESEARCH) PRACTICES

The goal of empathic research, in the context of design thinking, can be described as the identification and understanding of the needs of the people who are being designed for, with the intention of improving their experiences (Eagen et al., 2011). Empathetic research practices are closely associated with empathic mindsets and include *Observational*, *Interview* and *Roleplaying* practices, and analysis of this research using *Empathy Mapping*, and *Personas*.

7.22 Student perceptions

Some students reported that they were particularly challenged at the beginning of the course by a number of the design thinking practices that were intended to improve their identification, understanding and classification of human needs.

> *I was definitely out of my comfort zone at first, watching people in the observation process.*

> *That was new, that was something I learnt … and was definitely new and enjoyable. It wasn't so clear at that point. We were really just observing what they were doing in the area. We didn't quite have the mindset that we were trying to find what they were missing until a bit later.*

> *We went there, but only saw a few people and didn't do much. I think we needed to spend much more time down on the waterfront. It was a bit unclear. I think we missed a lot of things, especially how to really look at people, to see what they are doing, and thinking. If I were going to do this now, it would be very different. But I guess that is why we do this course.*

In addition to being challenged, one student mentioned that their group did not even engage with *Roleplaying*, one of the key empathic research practices.

> *Our group didn't do the Roleplaying bit. Not sure why. We just didn't like the idea of doing it.*

7.23 Researcher reflections and explanatory theory

On three occasions I noted an observation that the students' engagement with the *Observation, Interviews* and *Roleplaying* practices was initially quite problematic and I engaged in abductive reasoning to develop explanatory theory for this tendency.

> *Just talked with the students about the observation and interview process, and they seem a little lost in regards what they should be looking for, even though we did the class exercise.*

Makes me think we need to build this practice better. More quick exercises in watching and understanding people in various locations would be good.

Can't get two of the groups to roleplay. I need to rethink this.

I challenged my own thinking and assumptions about the students' abilities to research using empathic approaches.

Not sure why they are uncomfortable, as all they have to do is pick a particular type of tourist and go down to the waterfront for a few hours, and then reflect. Maybe I have my own assumptions as an expert, about what they can and are able to do.

On the other hand, even though some students' engagement with these practices was initially poor (some students did not engage and appeared to struggle with some key concepts), they seemed to increasingly engage with them more confidently and competently when undertaking a structured classroom activity to create personas of key people that they had observed. The activity required them to actively participate in conjunction with the teacher. I noted the following:

A really good session with the personas and the students seem to have great time. Maybe it is much more tangible when they have to put faces to the people they saw and put a story together. The only problem is they get carried away, and stories are getting too elaborate.

Many students also appeared to be challenged by a deeper analysis of their empathic research using the *Empathy Mapping* practice to empathise with the perspectives of others, and help identify stakeholder needs. Empathy Mapping involves analysing data collected through key research practices, and asking a series of questions to develop a deeper and more empathetic understanding of what stakeholders (people observed) might be thinking and feeling. I noted that many students, and groups as a whole, struggled to get below basic descriptions of what people were doing, rather than a deeper, more empathic understanding.

It's not easy, as the students don't seem to be used to digging below the surface of something or someone.

At the same time, the 'digging' process appeared to be facilitated when students were prompted to ask particular questions when they observed and interviewed.

> *It does seem to come through the facilitation process, and asking students questions as part of the method. For example, what are they doing, what are they seeing, then how are they feeling?*

Informed by the findings of Action Research Cycle One, Maslow's (1943) hierarchy of needs was introduced to the design thinking course. The framework was useful in clarifying the concept of human needs (for example, what a need is), and how needs might be stratified from lower to higher levels. The impact of this framework appeared very positive, and helped students link the findings of Empathy Mapping to identifying potential opportunities for engaging with the needs of stakeholders.

> *Maslow's worked well. It was a good conversation point in class, and seemed to make sense to students when I showed them the pyramid. They seem to be getting more now. A number of students were able to quickly relate to some of their ideas. A few still a little puzzled ... but I think there is some real momentum now.*

I also noted in my reflections a number of opportunities for improving the learning activities that were intended to help students improve their empathy related dispositions and skills during the enactment of the course.

> *I wonder if we could get them to put personas together as part of the observation, roleplaying and interview process. Or even go once to research, come back and put some initial personas together, and then go down to observe and interview some more and then evaluate and refine them. Might make observation more tangible for them, or at least give them a focus, and help them understand a little better who they are watching. Might improve their confidence too.*

7.24 Key tendencies and explanatory theory

- Some students were particularly challenged when trying to use design thinking empathy research practices such as *Interviewing* and *Observation* practices in authentic (real) environments and situations. Contributing factors appeared to include:
    - students' lack of confidence to leave the classroom environment;
    - their lack of in-depth understanding around the purpose of the empathy practices and how they would build a foundational understanding of human needs; and
    - lack of confidence, and fear, of approaching people and asking questions.

- Some student groups did not use the roleplaying practice, even though they were asked to. Students appeared to:
    - be reluctant to 'act' in front of their peers, and in authentic environments;
    - lack the emotional and cognitive tools to try and get in the head of someone else;
    - be overwhelmed by the expectation of task; and
    - avoid the issue, by just not attempting to roleplay.
- In contrast, most students appeared much more motivated and engaged when utilising the *Persona* practice, although the results seemed naive. The students were clearly more comfortable back in a 'safer' classroom environment, and undertaking an activity driven by close facilitation, and where they could see quite immediate and tangible results.
- Many students also struggled to use cognitive strategies to 'unpack' the findings of their research, to dig beyond surface level observations and insights, and identify the possible needs of the people that they were studying. A lack of good research insights appeared partly to blame. Careful and intensive intervention and facilitation, and teacher modelling helped the process. Students appeared to:
    - struggle to understand the framework and methodology, which relied on abductive reasoning, which many were not used to utilising;
    - have limited ability to think deeply about the various needs of others, especially beyond immediate circle of friends and family; and
    - be overwhelmed by the complexity of what was expected, and the conceptual leap needed.
- The introduction of Maslow's (1943) hierarchy of needs framework did appear to clarify the concept of human needs for many students by providing a concept/framework that students could easily understand and grasp. It appeared, however, to have been introduced a little too late in the process.

7.25 Related research and explanatory theory

I drew on extant theory from literature to extend my abductive reasoning about the empathetic research data, in particular to develop propositions about mechanisms that may be involved in empathetic research and the attributes of students that may influence their exercise of these mechanisms.

According to T. Brown (2009), watching and observing people (rather than asking them questions) is important in developing a deeper understanding of their perspectives, and to get to know them. In addition, the degree to which we empathise with an observed person has a strong impact in determining how much we learn from them (Rak, Bellebaum, and Thoma (2013). Experiencing someone else's perspective is also a powerful mechanism to develop a deeper emotional connection to people. It is also the most difficult mechanism and requires a lot of effort. Experiencing can be described as walking in the shoes of someone else (van Kraayenoord, 2009), and acting out what people are doing, seeing, and feeling. A key to experiencing other people's perspectives is the use of roleplaying (Schoenly, 1994).

Other mechanisms include: *active listening*, which refers to a process of building empathy through good listening, including being attentive, nonjudgmental, and non-interrupting (Active listening 2002); *self-reflecting*, which Loreman (2011) describes as a form of *listening to oneself*, in order to uncover our own biases, misunderstandings and knowledge of others to help build empathy; and *comprehending*, which can be defined as when someone perceives, and then comprehends (understands), what the person is experiencing at a particular moment (Yogev, 2012), then uses this understanding to adopt that person's perspective (Rak et al., 2013).

Researchers have also identified and described a number of personal attributes that potentially influence empathic research. For example, gender appears to play some role in empathy and empathy development and therefore may be closely related to a person's ability to undertake empathic research. Females on average have a stronger tendency to empathise and to identify another person's emotions, thoughts and actions, while males on average tend to have a stronger tendency to systemise (Baron-Cohen, 2002). Systemising, in contrast to empathising, is an inductive process to analyse the variables in a system and to derive the underlying rules that govern the behaviour of that system (Baron-Cohen, 2002).

Age and maturity are also closely related to empathy development, and again therefore empathic research. A person's empathy develops through stages over time (Rak et al., 2013). In addition, cognitive development plays a role in someone's ability to empathise with others (Hogan, 1969; Yardley, 1999). Yardley's research confirmed a 'steplike' pattern in empathy development, consistent with structural stage theories of cognitive development.

7.26 Investigate (empathic research) mechanisms and student-related attributes

Based on my abductive reasoning, which was complemented by the use of retroductive reasoning, I theorised a set of mechanisms that students need to develop to engage in empathetic research practices, as well as attributes that may impact on their development and exercise of these mechanisms. This process involved asking counterfactual questions such as: *What key mechanisms need to be exercised to engage empathic research practices in design thinking*? *What student attributes influence (enable or constrain) the probability of students exercising empathic research mechanisms in the learning environment*? The mechanisms and attributes that I inferred are presented in Table 24 and in Figure 78.

Table 24. Empathic research mechanisms and student-related attributes

<table>
<tr><th colspan="3">Empathic Research Practices</th></tr>
<tr><th>Practices</th><th>Key Mechanisms</th><th>Student-Related Attributes Influencing Exercising of Mechanisms</th></tr>
<tr><td>Interviewing</td><td>• Connecting to
• Questioning
• Active listening, hearing
• Responding
• Reflecting
• Recording</td><td rowspan="5">• Conceptual and procedural knowledge
• Motivation
• Empathy, sensitivity
• Experience
• Maturity
• Focus
• Confidence
• Trepidation and fear
• Comfort
• Tenacity</td></tr>
<tr><td>Observation</td><td>• Watching, seeing
• Perspective Taking
• Recording
• Reflecting</td></tr>
<tr><td>Roleplaying</td><td>• Simulating
• Experiencing, feeling, acting
• Imagining, visualising
• Empathising
• Recording
• Reflecting</td></tr>
<tr><td>Empathy Mapping</td><td>• Reviewing, reflecting
• Digging deeper
• Pattern recognising/spotting
• Categorising/arranging
• Abducting</td></tr>
<tr><td>Personas</td><td>• Reflecting
• Further categorising
• Synthesising
• Making tangible
• Storytelling</td></tr>
</table>

Many of these mechanisms and attributes have been explored in the findings of other research.

Figure 78. Key student-related empathic research mechanisms and related attributes

7.27 Explanatory theory and curriculum enhancement

Based on the explanatory theory that I constructed concerning these mechanisms and attributes, as well as contingent relationships between the exercise of particular empathetic research mechanisms, other mechanisms in the learning environment (e.g. teacher mechanisms), and related conditions (e.g., timing and sequencing), I identified opportunities for curriculum/learning environment enhancements. The opportunities are summarised in Table 25.

Table 25. Opportunities for enhancing the curriculum

Curriculum Consideration	Description of Potential Enhancements
Framework	
Cyclic Model	Develop overarching cyclic model for the empathic research process. This may include quick ‘first go’ at research in the field, and after capturing initial findings with practices such as Personas and Empathy Mapping, encourage students to utilise the practices again at a deeper level of understanding and confidence.
Order of Practices	Reorder the research practices so that students engage with Roleplaying before other practices such as Observation, to experience and gain a deeper personal understanding, connection and insight into the perspectives of other people, before observing and talking with them.
Learning Activities	
Empathic Research	Create a brief series of introductory, in-class exercises to help students

Exercises	to better engage with observation, interviewing, roleplaying practices in a more controlled and 'safer' environment, before undertaking more extensive empathic research in the field.
Teaching	
Discussions	Deepen discussions with students around the relevance and need for empathic mindsets in design thinking, before engaging with the individual design thinking practices. This also may include discussions regarding the underlying mechanisms and personal attributes that influence a student's ability to exercise empathic research practices.
Facilitating Research Analysis	Refine the teaching and facilitation process to help students to unpack research findings, and identify people's needs. This may include a carefully ordered series of steps to help students through the process.
Teacher Support	
Teaching Guide	Use the findings of this research to enhance teaching guide. For example, to help teachers to be aware of the influence of various students' attributes on their abilities to exercise empathy research mechanisms.

SECTION SEVEN: PROBLEM REFRAMING PRACTICES

"Designers are not limited to 'given' problems, but find and formulate problems within the broad context of the design brief" (Cross, 2001b, p. 5). Problem framing can be conceptualised as the process of analysing large and complex design problems, sometimes referred to as 'wicked problems' (Rittel, 1972; Rittel & Webber, 1973), and (re) framing them into more clearly defined and manageable creative opportunities (Cross, 2008; Donald Schön, 1983). In design thinking, problem framing is a process of applying the findings of the research, and framing these as more defined and manageable opportunities for creativity and idea development.

In this section I present the outcomes of my application of the theorising methodology to data concerning students' development of design thinking problem reframing practices. These practices include developing a *Point Of View*, and *Opportunity Statement* writing.

7.28 Student perceptions

7.28.1 Survey

Students reported that they perceived the course enhanced their ability to reframe large, complex problems into more manageable design opportunities. This is evident in the data presented in Figure 79 which indicates a very positive shift in students' ratings of their ability to reframe problems.

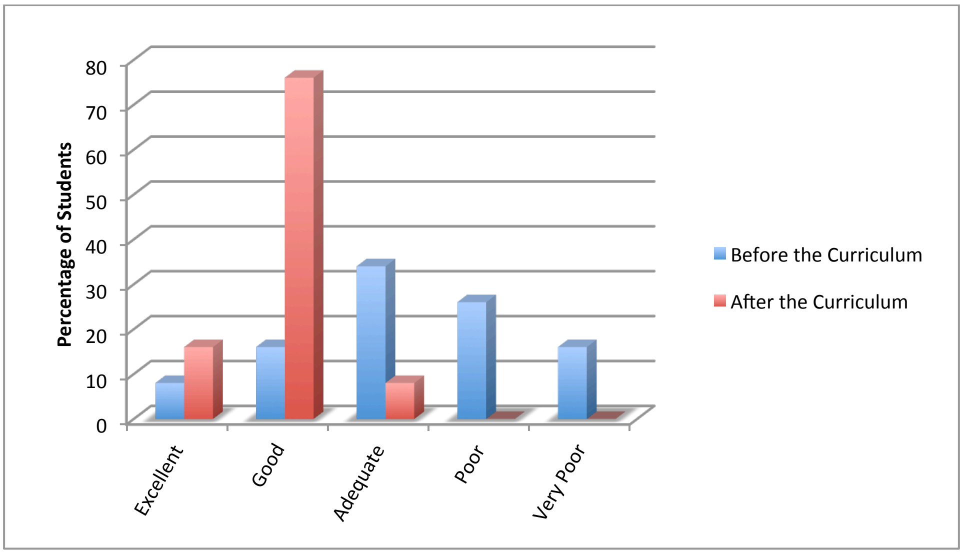

Figure 79. Students' ratings of their ability to frame problems before and after participation in the course

7.28.2 Interviews

While the survey indicated a strong and positive shift in students' ratings of their problem reframing abilities, some students found the problem reframing process particularly difficult and challenging. The level of struggle is reflected in the statements of four students in relation to the development of a defined opportunity from a larger problem.

> *The most difficult part of the course for me was defining the opportunity statement from the problem we were given, and from what we saw in the research.*

> *Yeah, we sat on the opportunity statement, for about five weeks. It was ridiculous and we were sitting there going, how do we not have this? And it is the most important part.*

> *And we just couldn't wrap our head around it (opportunity statement) and it just, I don't know, I don't know whether it was just because we just weren't thinking or whether we just couldn't agree.*

> *Writing the opportunity statement was really challenging.*

One student also described in detail the struggles that they had stopping themselves jumping to a solution too soon as part of the problem reframing process.

> *We thought that people might need somewhere to sit down because some of the older people we talked to said they were tired. That would improve their experience down at*

the waterfront. I found that really challenging because I kept thinking of a seat, because they need to sit down. It's really hard because it's just instinct to like here's a chair or something you know. It's like the difference between having a solution and a problem I think it was, so the people are tired but you don't say they need a seat. You reframe it to say the opportunity is to help them rest. I think I get it now, but it is still hard.

7.29 Researcher reflections and explanatory theory

I noted during the teaching how difficult the process of problem reframing was for students, especially to conceptualise, and to apply to their group work. This raised some questions as to whether the problem given to students may have been too complex for them to handle, or the design thinking practices used in this part of the course were not effective enough.

I wonder if the problem we have given them is conceptually too big for many students to get their head around.

Not sure we have given students the right tools and methods to reframe the larger problem into something both manageable, and that has the potential for creativity and innovation.

I also noted the intense teaching facilitation process that was needed to help manage students through the reframing process. This included the 'on the fly' development of an integrated way of linking human needs using the Maslow's (1943) model, insights and the students' *Points of View (POVs)*Figure 80Figure 80.

We started with taking the Point of Views and working into one opportunity statement. Was very intense teaching but with lots of facilitation. Was lucky to have Teacher 2 with me. Students really struggled, and the bits all seem fragmented. I used the whiteboard to quickly map a more integrated and understandable process out for students.

I then met with each group to work through the process. Maslow's model again helped us to revisit definitions of human needs. We eventually got all groups to some point of convergence.

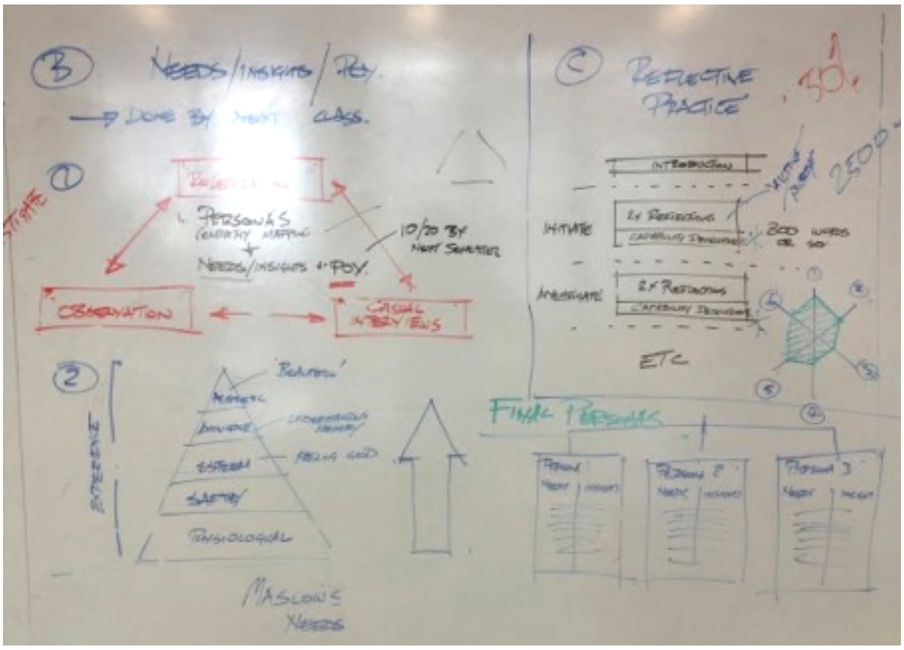

Figure 80. Whiteboard mapping

7.30 Key tendencies and explanatory theory

- While many students reported a strong positive shift in their problem reframing capabilities, and engaged well with data gathering (empathic research), they appeared to struggle, particularly to reframe the original complex problem into a new opportunity statement based on the outcomes of their research. This took a long time for many students, and was a very critical point in the course for them. Contributing factors appeared to include:
    - students' lack of conceptual understanding of the notion of reframing a problem into an opportunity;
    - the immediate impulse to jump to a solution rather than an opportunity statement;
    - difficulty in writing an opportunity statement clearly and succinctly; and
    - difficulty in making decisions as a group.
- The process needed careful intervention and teacher facilitation and modelling which seemed to work well.

7.31 Related research and explanatory theory

Researchers have offered the following concepts and propositions that assisted my development of explanatory theory about problem framing.

For example, Schön (1988) suggested that in order to formulate a design problem to be solved, the designer must frame a problematic design situation through *boundary setting*, and to select particular aspects for attention. *Defining, framing and reframing* the design problem is a key aspect of design thinking (Dorst & Cross, 2001). According to Cross (2001b), the formulation of appropriate and relevant problem structures (problem framing) from the ill-defined problem requires sophisticated cognitive skills in gathering and structuring information, and judging the moment to move on to solution generation.

Lindberg et al. (2010) described the problem framing process as a way of *illuminating* the problem space. They describe the need for paraphrasing a design challenge, a process where the design problem is formulated and re-formulated until a project has clarity. In contrast, Dew (2007) argued that the key to framing problems lies with the cognitive process of *abducting*, a process of making inferences or best guesses from information that is surprising or anomalous (Curedale, 2013). "The genesis of new designs … lies in the initial guesswork that designers do about the nature of the problem they are facing, and detecting what the problem 'really' is – this is the starting point for creative design. This guesswork is important because it informs which range of solutions is considered and sets the boundaries for the kind of option ultimately chosen" (Dew, 2007, p. 38).

In addition, Tschimmel (2012) also advocated for the use of abduction as a way of thinking in which feelings and emotions are just as important as rationality. In addition, Christiaans and Dorst (1992) described problem framing as a process of *self-reflecting*. "Problem setting is the process in which, interactively, we name the things to which we will attend and frame the context in which we will attend to them" (Schön, 1988, p.32).

7.32 Problem reframing mechanisms and student-related attributes

Again, based on abductive and retroductive reasoning, I proposed that the following key student-related mechanisms and attributes were associated with the development and exercise of reframing practices in design thinking. Mechanisms and student-related attributes are presented in Table 26 and Figure 81.

Table 26. Problem reframing mechanisms and student-related attributes

Problem Reframing Practices		
Practices	Key Mechanisms	Student Attributes Influencing the Exercise of Mechanisms
Point of View	• Comprehending • Decision-making • Reflecting • Illuminating • Framing, boundary setting • Formulating • Abducting • Synthesising	• Conceptual/procedural knowledge • Intellectual Intelligence • Confidence • Experience • Motivation
Opportunity Statement	• Storytelling	

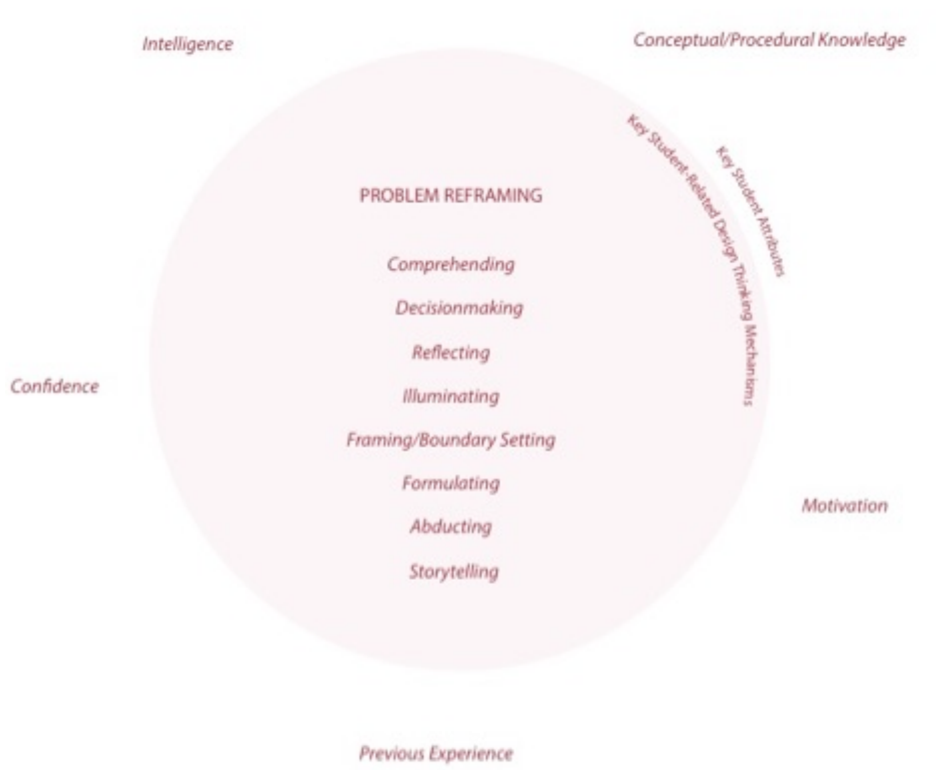

Figure 81. Summary of key problem reframing mechanisms, and student-related attributes

7.33 Explanatory theory and curriculum enhancement

Based on the explanatory theory that I had developed, I identified further curriculum enhancement opportunities that are summarised in Table 27.

Table 27: Opportunities for enhancing the curriculum

Curriculum Consideration	Description of Potential Enhancements
Content	
New Problem Reframing Practice	Integrate existing problem reframing activities into one (new) practice from analysis to the opportunity statement.
Learning Activities	
Problem Reframing Workshop	Develop a clearly structured workshop session that focuses on a more integrated problem reframing process.
Teaching	
Problem Reframing Discussion and Facilitation	Discuss with students both the importance of and complexity of the problem reframing process, and facilitate a more integrated approach in relation to the learning activities. A key goal would be to actively facilitate abductive thinking.

SECTION EIGHT: CREATIVE PRACTICES

“Thinking is creative if it leads to original and adaptive ideas, solutions, or insights” (Runco & Chand, 1995, p. 243). According to Abrahama and Windmann (2007), creative thinking is one of the most complex of all human cognitive abilities. In addition, “as the cornerstone of innovation, creativity is an elusive human characteristic that can make one individual a better design thinker than another” (Hawthorne et al., 2014, p. 66).

In this section, the outcomes are presented for my application of the theorising methodology to the data concerning students development of design thinking creative practices including *Brainstorming*, *Lotus Blossom* and *SCAMPER* practices.

7.34 Review of portfolios

The review of students’ portfolios indicated that groups generally engaged well in the creative process with a range of good examples of brainstorming processes and other creative practices documented in all of the portfolios. An example of student work is illustrated in Figure 82.

Figure 82. Example of student brainstorming work

A deeper review indicated that students' initial creative responses to their opportunity statements were quite limited and narrow, and there was generally a broad range of ideas. Groups had not responded with particularly lateral, or innovative, boundary-pushing concepts. Overall, I noted that concepts were predictable, and quite conservative. Concepts also tended to be large scale and somewhat grandiose responses, rather than simple, innovative proposals.

7.35 Student perceptions

7.35.1 Survey

Students indicated that they perceived the course enhanced their ability to think creatively. This is evident in the rating data, which indicates a positive shift in students' ratings of their creative abilities after participation in the course. This is presented in Figure 83.

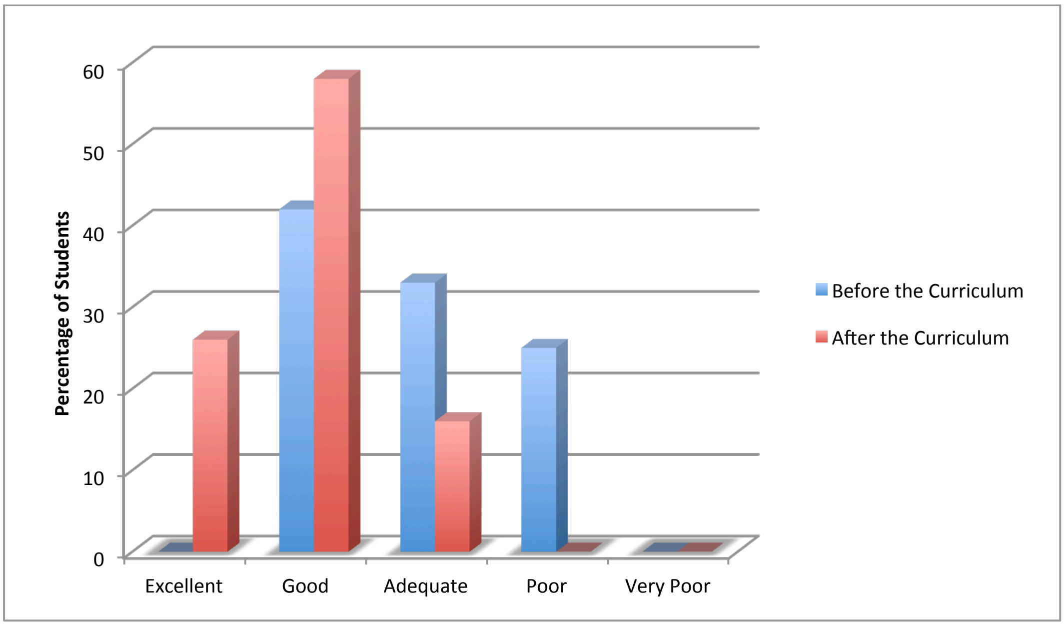

Figure 83. Students' ratings of their creative abilities before and after participation

7.35.2 Interviews

The development of creative thinking emerged as an important learning outcome for students. Two of the six students interviewed specifically commented on the positive impact that the course had on the development of their creative thinking abilities.

> *I think I'm probably more comfortable in my creative approaches now.*

> *I didn't think I am very creative, but that changed. I know a few of the other students felt the same way at the beginning, and towards the end they changed as well.*

There was not a lot of discussion in the interviews regarding the creative process itself, although one student commented on how much they enjoyed the creative aspects of the course, especially the concept that they could come up with 'crazy' ideas as part of the process.

> *I personally really enjoyed that because it sort of gave you free rein to just come up with a whole bunch of different ideas that you probably wouldn't have thought of before. Some of the ones I know that we came up with were crazy and completely irrational, but it was good.*

The divergent thinking aspects of creativity (creating lots of ideas in response to the opportunity), and convergent thinking (selecting and narrowing down to best solutions) emerged in discussions. Three students also indicated that they struggled with divergent and/or convergent thinking.

> *We had trouble at first trying to get as many ideas out as we could. We just kept trying to get it down to one idea. You have to let go.*

> *I found trying to expand everything and pull everything out really hard. I had never done design before. Yeah, I know I did learn how to get, find the differences between those approaches, although I still find it a bit confusing.*

> *There were so many different options and just narrowing it down to one idea, we found really hard and actually something that I found helpful was we were told to take all our ideas, and try put them as one big idea.*

One student noted that they found this process quite natural, and could see the value of it.

> *It was fun though doing that sort of stuff and sort of being able to narrow it down, expand it out again and narrow it down again. It just gives you a different perspective every time you do that, every time you go through that process.*

7.36 Researcher reflections and explanatory theory

I noted that the students were not very well prepared for engaging with creativity and creative practices after the research, and problem framing.

> *We kicked off the more creative part of the project. It was interesting to see that students were really looking forward to this. I was a bit surprised but I could see that they were very keen to get going. There was a bit of a buzz in class, which I hadn't seen for a few weeks.*

I also noted, through conversations with the other teacher, that the first ideas and concepts generated by the students were relatively unimaginative and both very 'safe' for some students and complex ideas for others. Solutions were very focused on product or spatial ideas.

> *A quick catch up with the other teacher revealed that students' ideas pretty unimaginative. Their ideas are quite naïve in many instances, as well as being overly complex in others. They are maybe missing the point around broader concepts of improving 'experience' and are bogged down with spatial and product solutions.*

I must push for a broader range of outcomes. Remember next time to push them harder here – and also remind them to keep ideas simple.

I noted that with the introduction of another creative practice called SCAMPER[12] 'on the fly' in class, and with some focused facilitation through another iteration of creative idea generation, students responded with some more creative ideas.

Got groups to use the SCAMPER practice to unpick their first ideas and come up with more. After working with each group it seems like you almost have to get some basic concepts out, critique them then push them to have more creative sessions to push their ideas further.

7.37 Key tendencies and explanatory theory

- Students appeared quite excited to start the creative aspects of the course after the research aspects. Contributing factors appeared to include:
    - students had waited quite a while for this after the lengthy empathic research and problem reframing processes;
    - they had expectations that it would be fun and enjoyable; and
    - they were beginning to 'relax' as groups were more comfortable with each other.
- Some students appeared to struggle with the divergent thinking process, especially generating a wide variety of ideas and concepts.
- The students' initial ideas and concepts appeared naive and unimaginative in relation to what was expected by the teachers. Contributing factors appeared to include:
    - students' lack of familiarity and preparedness with creativity and creative practices;.
    - students' defaulting to complex spatial and product solutions; and
    - a lack of confidence, or willingness to push ideas in the first instance.
- Careful teaching interventions and facilitation, including the use of a new creative practice, helped students push for more creative concepts.

7.37.1 Related research and explanatory theory

Given the importance of creativity to effective design thinking, and the relatively weak creative responses of students in this research, theoretical perspectives and frameworks potentially

[12]SCAMPER is a well-recognised creative method. It stands for: substitute, combine, adapt, modify, put to another use, eliminate and reverse.

provide some insight into developing better ways to help students to develop creative practices. Researchers have described a range of concepts that are closely related to creative practice in design thinking.

For example, Martin (2009) referred to *abductive inferring,* which he defined as 'what might be', as important for driving creativity. Bauer and Eagen (2008) argued that design thinkers use a generative process of *imagining* as the drive for the idea creation process, while *creative risk taking*, i.e., proposing and exploring unusual or unexpected ideas or concepts, is also essential (Gibson, 2010; Martindale, 1999; Ripple, 1989; Sternberg & Lubart, 1995). Researchers have also identified other mechanisms associated with creative thinking including: *associative thinking* (Bauer & Eagen, 2008); *abstract thinking*, (Cross, 2011a); *heuristic thinking* (D. Jones, 2008); and *reflecting* (Schon, 1988).

In addition, divergent and convergent thinking in creativity have been identified as fundamental in design thinking (T. Brown, 2009; Dym et al., 2006; Lindberg et al., 2008). Christiaans and Dorst (1992) argued that 'the problem' cannot be fully understood in isolation from consideration of 'the solution'. Lindberg et al., (2008), building on the work of Christiaans and Dorst (1992), go on to describe a divergent and convergent thinking process that enables the moving between problem and solution spaces. The Lindberg et al. model is presented in Figure 84.

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Figure 84. Model of divergent/convergent thinking (Lindberg et al., 2008)

This divergent/convergent process of the design thinker looks like a "rhythmic exchange between convergent and divergent phases" (T. Brown, 2009, p. 68). Researchers have identified and described some key personal attributes that influence the activation of creative practices.

Hawthorne et al. (2014), in referring to studies that have focused on where and how creativity originates in the brain (Abraham et al., 2012; Aziz-Zadeh, Liew, & Dandekar, 2013; Fink et al., 2012), argued that none has focused on assessing a person's capacity to become more creative over time. They defined creativity in design thinking "as a state of being and adaptation of personal skill sets that enables an individual to synthesize novel connections and express meaningful outcomes" (Hawthorne et al., 2014, p. 67).

Researchers also identified a number attributes that impact on creativity. This includes a person's personality traits such as *efficacy, independence, cognitive control, tolerance* and *integrity-honesty* as being associated with enhanced creativity, while *emotional stability, anxiety, dominance, aggressiveness,* and *leadership* are associated with being less creative (Hawthorne et al., 2014). Newton and Newton (2014) defined creativity as "a mental state where attention is defocused, thought is associative, and a large number of mental representations are simultaneously activated" (p. 149). Royalty, Oishi, and Roth (2014) also contended that an overall sense of confidence and agency are important aspects of creativity in design thinking.

Rauth et al. (2010) described a design thinking pedagogy focusing on moving students from engaging with practices to creative confidence as the key outcome. This model is presented in Figure 85.

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Figure 85. Design Thinking way to creative confidence (Rauth et al., 2010)

7.38 Creative practice mechanisms and student-related attributes

Based on abductive and retroductive reasoning, I proposed that the following key student-related mechanisms and attributes were associated with the development and exercise of creative practices in design thinking. Mechanisms and attributes are presented in Table 28 and Figure 86.

Table 28. Creative practice mechanisms, and student-related attributes

Creative Practices		
Practices	**Key Mechanisms**	**Student Attributes Influencing the Exercise of Mechanisms**
Brainstorming	• Divergent thinking • Abductive reasoning • Risk taking • Pushing, iterating • Imagining, visualising • Synthetic thinking • Convergent thinking • Decision-making • Selecting • Recording	• Conceptual and procedural knowledge • Previous experience • Motivation • Maturity • Confidence • Openness • Optimism, positiveness • Sense of fun • Cognitive control • Focus • Tenacity
Lotus Blossom	• Divergent thinking • Abductive reasoning • Risk taking • Pushing • Imagining, visualising • Synthetic thinking • Convergent thinking • Decision-making • Selecting, categorising • Recording	
SCAMPER	• Challenging, critiquing • Abductive reasoning • Imagining, visualising • Selecting • Recording	

.

Figure 86. Summary of key creative practice mechanisms and student-related attributes

7.39 Explanatory theory and curriculum enhancement

Table 31 presents a summary of possible curriculum enhancements, based on the explanatory theory that I had developed.

Table 29. Opportunities for enhancing the curriculum

Curriculum Consideration	**Description of Potential Enhancements**
Content	
Concept Critiquing practice	Develop a practice for mapping, analysing, critiquing and challenging initial creative ideas and concepts.
SCAMPER Practice	Further develop and refine the SCAMPER as a practice to help push ideas and process.
Learning Activities	
Iterative Creative Process	Develop iterative learning activities where students respond creatively using Brainstorming (or similar practice) to get some initial ideas out in response to their opportunity statements, and then revisit the problem statement (i.e., moving between the problem/solution space).
Teaching	
Unpacking Creative Processes	Unpack and discuss the creative process (including underlying process, mechanisms and contextual factors) with students before engaging them with the creative practices
Critiquing Ideas	Find teaching methods of unpacking/mapping initial creative ideas and then critique them with students to demonstrate how 'safe' they are, and challenge them to push harder. This may include developing ways to map existing ideas and to critique them

SECTION NINE: CONCEPT DEVELOPMENT PRACTICES

3D prototyping can be described as the process of creating visual representations of ideas and concepts in three-dimensional format, either full sized or scale model (Dow et al., 2012).

The theorising methodology was applied to data 3D prototyping, which is a concept development practice.

7.40 Review of portfolios

The review of student portfolios indicated that the quality of 3D prototyping work was generally reasonable, given that most students in the course had no previous experience of prototyping, other than work in high school. Students clearly utilised the basic materials and processes introduced in the course. In addition, I noted that the overall volume of prototyping was higher than the drawing aspects of the course, with most groups presenting a good number of pages documenting examples of both experimental prototyping and modelmaking work, and finished presentation work, in comparison to the amount of drawing work produced.

This is evidence that students put a lot of time and effort into the final 3D prototypes and models. The final models could be described as generally a little ‘overdone’, with students trying to create quite realistic scale models, rather than just focusing on conveying more of the essence of the idea. Figure 87 is an example of quick developmental models from two groups

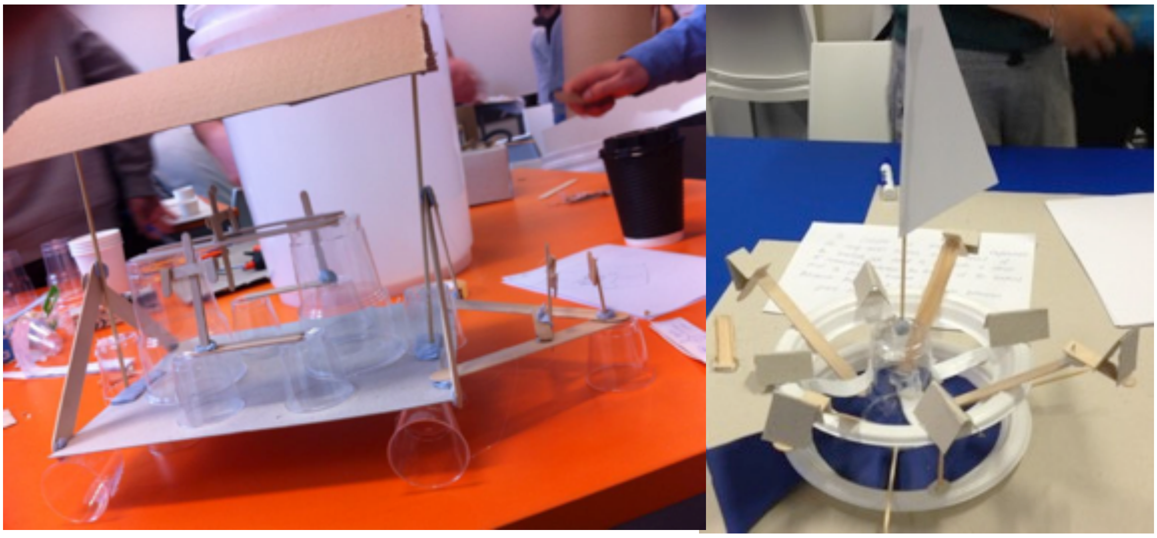


Figure 87. Example of 3D prototyping session

7.40.1 Student perceptions

7.40.1.1 Survey

Students reported that the course enhanced their 3D prototyping capabilities, making design opportunities more manageable. This is evident in the data presented in Figure 88, which indicates a very positive shift in students' ratings of their 3D prototyping capabilities before and after participation.

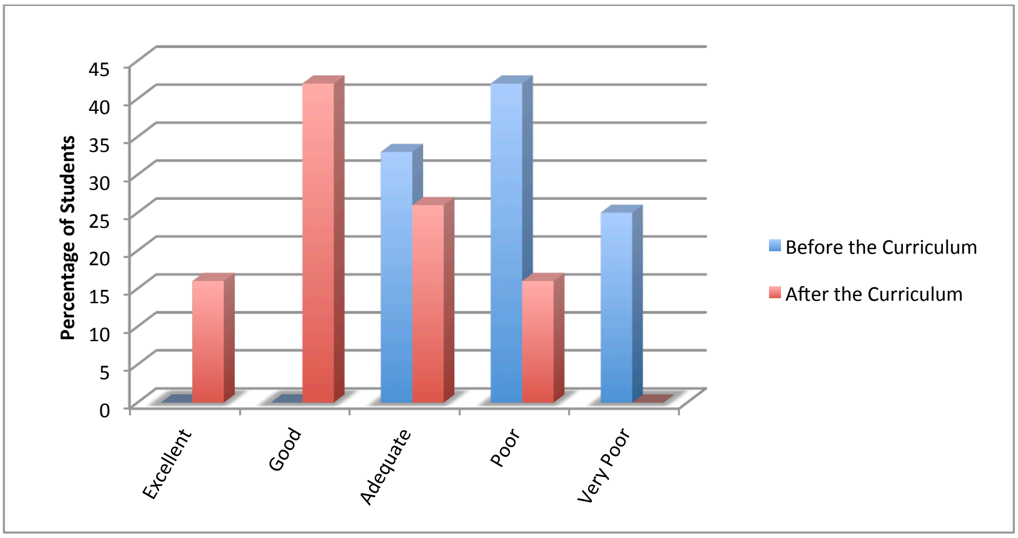


Figure 88. Students' ratings of their 3D prototyping capabilities pre- and post-participation

7.40.1.2 Interviews

In addition to the data reported in the survey, three of the six students commented in the interviews on how much they specifically enjoyed the 3D prototyping aspects of the course.

> *This was the best part of the class for me.*
>
> *Prototyping showed us that we actually all had different ideas in our heads, but we were explaining them the same. It was good.*
>
> *Our group had fun.*
>
> *So it was really helpful to actually build it, and see what it looked like. I never realised how important making a model is.*

In addition to the positive comments, one student reported that there was not enough support for the 3D prototyping.

> *Maybe there wasn't enough class time when it came down to this part, or maybe there was too much theory, and not enough actually constructing the prototype.*

7.41 Researcher reflections and explanatory theory

I noted that the approach used to get students quickly into 3D prototyping worked effectively for students in the class environment, and also noted that there was a good pick-up in the excitement and momentum when the 3D prototyping activities took place.

> *Got students straight into prototyping today, when we set them one hour to get the first idea out. It was great to see some models taking shape and they really liked this. I haven't seen the class so busy for a while.*
>
> *It was good to see how students can get an idea out so quickly when given a focused method, and tight time frame.*

I did note, however, that after the initial workshop session, while students were clearly proud of their work, they were too focused on using models to represent what they considered were resolved ideas, rather than using them as a design thinking process that enabled them to effectively and quickly to test, challenge and critique ideas. They also seemed reluctant to keep prototyping once they had completed a model.

We met with a few groups today. A lot of groups seem very pleased with the concepts - in fact a little too pleased! I think it has got something to do with the models, they have put quite a bit of work in, and seem a little unwilling to push on when they were challenged by us.

Trying to convince them that it is all right to deconstruct models, experiment and use them to quickly push ideas around. They are too precious, and not seeing the models as just part of the design process.

7.42 Key tendencies and explanatory theory

The following key insights were developed in relation to themes and tendencies identified from the data.

- Many students identified the 3D prototyping as one of the most fun, exciting and satisfying parts of the course. All students reported a very positive shift in their 3D prototyping capabilities. Contributing factors appeared to include:
  - ideas and concepts were starting to resolve into more tangible concrete outcomes, and students could now start to see where all their previous work was leading; and
  - many students appeared to have little experience of making things, and were very surprised at what they were able to do when encouraged and supported in a structured workshop environment. This appeared to lift many students' confidence, both in prototyping but also in the design thinking process.
- While many of the students really enjoyed the prototyping aspects of the course, many of the prototypes that created by students were too detailed and resolved, and students were unwilling to further develop or change their ideas when challenged. Contributing factors appeared to include:
  - students put too many hours into the modelmaking;
  - students were then too 'precious', i.e., not wanting to change or evolve their ideas once they had made a prototype;
  - there was a lack of understanding around the concept of low-fidelity prototyping, i.e., using the process to quickly make an idea concrete, evaluate it and then improve it.
- In addition, while most students seemed satisfied with support given, a couple of students suggested that there wasn't enough time and support for the 3D prototyping. This reflected the diverse range of students' attributes and needs.

7.43 Related research and explanatory theory

Researchers have described a range of concepts that are closely related to 3D prototyping and design thinking.

The use of quick and effective prototyping is recognised as an essential method/tool in the design thinking process (T. Brown, 2009; Curedale, 2013; Liedtka & Ogilvie, 2011; Stickdorn & Schneider, 2011), and design thinkers should build ideas early and often, with the goal to learn, rather than to test, in a process that affords the opportunity to 'make mistakes faster' (Liedtka & Ogilvie, 2011). In this sense, 3D prototyping is essential for capturing initial ideas and concepts in the design thinking idea generation process, grounding group communication and facilitating decision making (Dow et al., 2012), and assisting with feedback from the user, client or teammate (Jobst & Meinel, 2014). Gerber and Caroll (2012) explained that the use of low-fidelity prototyping can have a positive impact on the innovation process, helping people manage the uncertainty in the development of new ideas. The creation of prototypes provides a tangible return and a sense of satisfaction. This aligns with Jobst and Meinel (2014) who state that "the successful prototype provides confidence and a feeling of control in a highly ambiguous process"(p. 111).

T. Brown (2009) also argued that while we often refer to prototypes as physical things we can pick up, anything tangible that lets someone explore an idea, evaluate it and push it forward is a prototype. Curedale (2013) identified a range of different types of prototypes in design thinking, including: appearance prototypes (looks like, but doesn't look like the final product); dark horse prototypes (the most creative idea built as a fast prototype); low-fidelity prototypes (cardboard prototyping as a quick way of gaining insight and informing decision making); and generative prototypes (sometimes called 'thinkering' where participants build simple prototypes from supplied material to explore ideas). Other prototypes may include flowcharts, storyboards, videos, and business concept illustrations (Liedtka & Ogilvie, 2011).

Researchers have identified and described a number of factors that potentially influence whether people can engage effectively with 3D prototyping. They include fear of failure, which Gerber and Caroll (2012), citing March (1991), argued happens as people construct new knowledge in the design process. They contended that people initially experience uncertainty, or a state of being in doubt, because the final outcomes are not yet known. They go on to argue that low-fidelity 3D prototyping helps the reframing of uncertainty and failure as an opportunity for learning, "fostering a sense of forward progress, and strengthening beliefs about creative ability" (Gerber & Caroll, 2012, p. 81). Previous experience of 3D prototyping processes, which may come from school, family backgrounds, and from other interests outside of tertiary study, also has an impact on whether people can engage effectively with 3D prototyping.

7.44 3D Prototyping mechanisms and student-related attributes

Based on abductive and retroductive reasoning, I proposed that the following key student-related mechanisms and attributes were associated with the development and exercise of 3D prototyping practices in design thinking. Mechanisms and attributes are summarised in Table 30 and Figure 89.

Table 30. 3D prototyping mechanisms, and student-related attributes

Concept Development Practices		
Practices	Key Mechanisms	Student Attributes Influencing the Exercise of Mechanisms
3D Prototyping Practices	Reviewing Selecting Imagining/visualising Organising Constructing/joining Judging/critiquing Changing/reconfiguring/subtracting/adding Reflecting Documenting	Conceptual and procedural knowledge Experience Creative confidence Fear of failure Hand/eye coordination Spatial perception Tactile sensitivity Tenacity

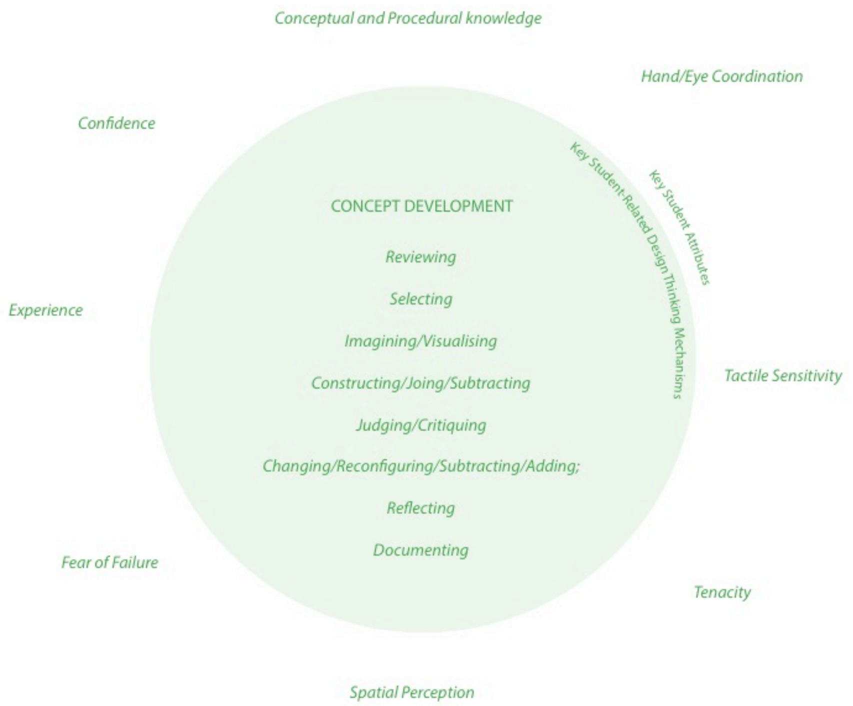


Figure 89. Summary of concept development mechanisms and student-related student attributes

7.45 Explanatory theory and curriculum opportunities

Curriculum enhancement opportunities that take account of explanatory theory concerning students development of 3D prototyping practice capabilities are summarised in Table 29.

Table 31. Opportunities for improving the curriculum

Curriculum Consideration	Description of Potential Enhancements
Content	
Prototyping Examples and Case Studies	Develop better examples and case studies of the range of appropriate prototypes, especially low-fidelity examples.
Learning Activities	
Prototyping Activities	Strengthen the 3D prototyping session/s, especially better communicating the role of prototyping as an idea development tool, in contrast to a presentation tool, develop students' fundamental prototyping skills, and encourage students to be more experimental with their prototypes.
Teaching	
Discussions	Create better discussion with students regarding the role of 3D prototyping, especially the use of low-fidelity prototyping to drive quick and effective idea exploration and evaluation.
Resources	
Update Resources	Update resources as per above.

SECTION TEN: COLLABORATIVE PRACTICES

Multi-disciplinary teamwork (Lindberg et al., 2010), disciplinary empathy (Curedale, 2013) and engagement with stakeholders as collaboration in design thinking (Goldman, Kabayadondo, Royalty, Carroll, & Roth, 2014), are all key aspects of design thinking. In this section I present an analysis of collaborative practices within the design thinking course.

7.46 Review of portfolios

The entire course was structured around a collaborative design thinking project. While the evidence of the successful development of collaborative capabilities was not explicit in the data, it is important to note that all groups successfully completed their group portfolios, and presented a final overview of their project. Students also had an opportunity to reflect on the collaborative process in their reflective journals. In five out of six portfolios reviewed, students also provided narrative descriptions of their attempts to collaborate, including during the early stages of group formation and the setting of group parameters and guiding principles. There is generally very little content however in the portfolios that provides further data about how collaboration evolved, and some of the emergent issues and problems.

7.47 Student perceptions

7.47.1 Survey

Most students reported that their ability to collaborate increased positively after participation in the course, as presented in Figure 90.

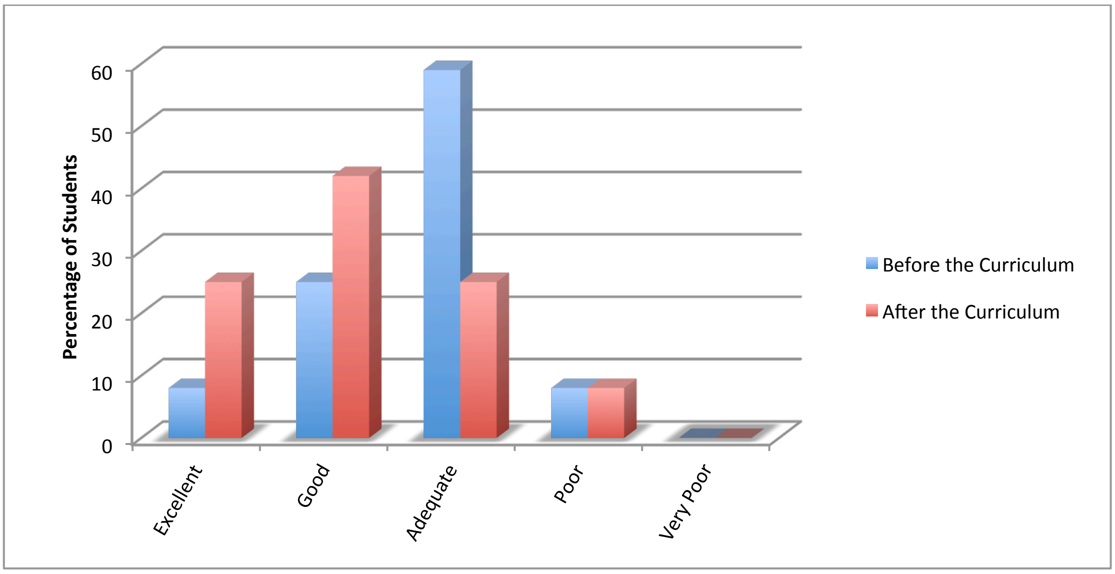


Figure 90. Students' ratings of their ability to collaborate pre- and post-participation

There were, however, mixed feelings around teamwork and collaboration, which was reflected in survey results regarding the students' perceptions of the helpfulness of collaboration during their learning. Just under half the students rated group collaboration as helpful or very helpful. A large group (43%) of students rated the group collaboration as only slightly helpful to them, as presented in Figure 91.

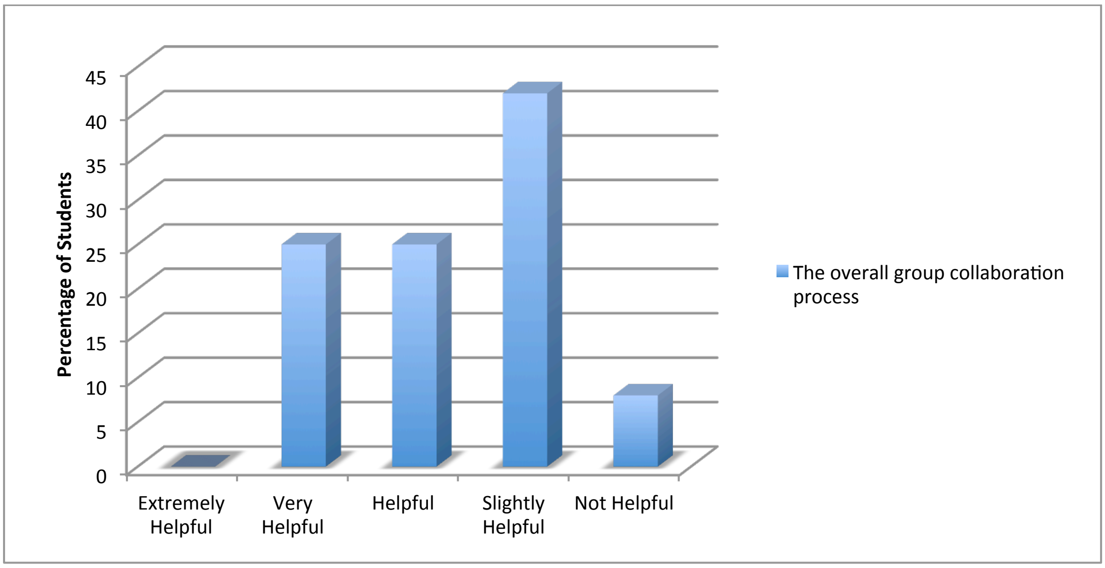


Figure 91. Students' ratings of the helpfulness of the collaboration process

7.47.2 Interviews

Various perspectives on group work and collaboration featured very prominently in the interview discussions with students. Some students particularly noted how the course was strongly underpinned by collaboration, and that this was something they had not experienced before. This is reflected in the following statements of two students.

> *Literally every single class was a group class. That was interesting – different to what I have had before.*

> *Well the design paper in my opinion was basically based on the whole group process. I haven't had this in the other papers.*

Collaboration and teamwork emerged as both a very positive aspect of the learning experience for three students, but was also an aspect of the course that presented challenges for two of them.

> *I had a great time with my group.*

> *Honestly it had its challenges – It was enjoyable, but it definitely had its challenges*.

> *Yeah that was very good and hard.*

The students offered a range of views on collaboration. Many students had quite negative opinions on their personal teamwork abilities including in relation to their own inclinations and capabilities for collaboration. Two students commented they did not consider themselves good at group or teamwork.

I'm not the most greatest group person.

Yeah, I struggle with working in a team.

In addition, three students mentioned that they had a preconception before the class that they thought the group work would not go well for them, with two specifically mentioning that the issue was with other group members.

Because, I was kind of like a little bit worried that it wouldn't go too smoothly.

I had a low opinion because I don't really enjoy them (teams) as much as I probably should, just because people tend to slack a lot and I've got a bit of a high standard with my work.

I always think there are always people you don't get along with.

Further to this, three students commented that to have a good group was somehow unusual, or if it went well then it would be a surprising outcome for them.

I was quite lucky I had a really good group.

I was actually surprised how well we worked together.

This is my best group experience so far. It went so well which is a bit unusual for me.

Two students specifically mentioned positive responses to the meetings that teachers had with individual groups, and the positive impact that it had on their group collaboration process. It is important to note that the formal meetings with each group did not happen until later in the course.

Well I think you guys did a pretty good job in supporting everyone and making sure that we have ample time to meet towards the end. Be good if it was sooner.

It wasn't until we had like set, allocated times towards the end of the paper that we all actually got together with the lecturers and discussed and we suddenly understood what we were doing, we had to do it and we had to take a lot of time to get it right.

The students identified a number of issues that they thought were negatively impacting on the group collaboration process. For example, three students identified group size, especially groups bigger than four/five, as negative.

> *Our group had six people. Some groups had four; some had five. I didn't think six worked as well.*

> *I think four would have been good. Three might have been too small for getting ideas and stuff because just with this particular sort of paper and what it requires you need that ability to bounce off each other and stuff and I think having four people would make that work.*

> *We ended up with six people. So I was just very put out at the time, but then I thought okay, yeah, I'll try and make this work. But we had some very strong personalities and people that were really quite opposite and it didn't. But with six people it was the matter of getting the group together and getting everyone to contribute and it was just that one or two people too many that there was one person that never showed up and one person who didn't say anything.*

Two students identified language and cultural differences between students as problematic.

> *I think language was a big challenge for us, and just the different cultures that were around in the group (my personal group).*

> *There was one person in the group, he was very (culturally) different from the rest of us. It made it hard.*

Three students identified issues with practical organisation as negative, especially getting students together outside of class.

> *Just getting everyone organised together and trying to organise it with all of the other group projects that they're doing outside of the class, that kind of had its challenges.*

> *We found it very difficult to get together as all of us had work at different times.*

> *Yeah, basically I was trying to organise group meetings and it was just quite difficult to get everyone at the same time.*

One student mentioned that lack of good leadership was problematic.

I guess one of the big achievements was learning how to actually develop something in a group. But our group didn't have a leader, which made it hard.

One student specifically mentioned lack of motivation of other team members as having a negative impact of the outcome.

With my group it did. I think if I'd have had different people, at least a couple of people who were more willing to be a group and worked harder.

7.48 Researcher reflections and explanatory theory

Aligning with some of the comments made by a number of the students, I also noted the positive impacts from the teacher/group meetings on facilitating and improving group collaboration, particularly towards the end of the class.

Met with one group who are having real problems communicating. We talked and seem to have worked it out. Funnily enough more of misunderstanding based on cultural and age differences between two of the team members. After that the group seemed to fly.

Makes me realise the need to have some catch-ups with each group more often. Good to clarify and reiterate issues to each group – you forget what they don't pick up in class.

7.49 Key tendencies and explanatory theory

- Various perspectives on collaboration featured heavily in the interviews with students. It was also clear that students' experiences of the whole course were closely linked to how they experienced their collaboration with their team.
- Experiences of collaboration were associated with a journey that had both highs and lows.
- The high level of collaboration that was expected and requested in the course was something that students appeared to not have experienced before and was harder at the beginning of the course.
- Most students agreed that the collaboration aspects were very difficult, especially in the early parts of the course, but were also very rewarding. Contributing factors appeared to include:
    - many students had quite negative perceptions of teamwork and collaboration coming into the course; and

    - they were quite surprised how well it went for them, especially towards the end of the course when they had got to know each other and there was quite a bit of pressure on the whole team to perform.
- Some students articulated negative perceptions of teamwork. Contributing factors appeared to include:
    - groups bigger than four or five members did not work as well;
    - cultural misunderstandings negatively impacted on some groups;
    - some groups struggled to organise themselves, especially outside university hours; and
    - other issues involved lack of leadership and lack of motivation of at least one team member.
- Interventions and team facilitation by the teacher was essential in preventing one team imploding.

7.50 Related research and explanatory theory

Researchers have described a range of concepts that are closely related to collaborative practice in relation to design thinking.

As designers tackle ever more complex problems, having multi-disciplinary, diverse and complementary team members is conceived to be an ever more important part of design thinking (T. Brown, 2009; Lindberg et al., 2010). "All of us is smarter than any of us, and this is the key to unlocking the creative power of any organization"(T. Brown, 2009, p. 26). Ballinger (2006) argued that design thinking is also an excellent platform for facilitating all multi-disciplinary collaborative activity. "Design thinking allows multi-professional teams to develop a mutual understanding due to its strong emphasis on team-based learning regarding both the problem and its potential solutions"(Lindberg et al., 2010, p. 35). Maximised competence as a result of having complementary team members has been promoted by the design agency IDEO, rooted in the activities of Stanford University's d-School (Lindberg et al., 2010).

Researchers have described a number of key factors, which underpin and support effective collaboration in design. For example, successful (or not) group outcomes are often influenced by the dynamics of the group. Dynamics can be defined as the behaviour of the group as a whole, which is a sum of all the parts (Lawson, 2006). According to Lawson (2006), group behaviour is often influenced by the perception of goals, the development of group norms, and the characteristics of interpersonal relationships. Beckman and Barry (2007) argued that given design thinking is a learning process, there should also be representation from a range of learning styles on a team if it is to successfully execute innovation through design thinking. They outline a number of experiential learning styles, based on Kolb (1984), including assimilating, converging, diverging, and accommodating.

- Relationship building: “A sense of belonging and togetherness, and sharing joint goals are important to design group’s abilities to apply itself to its class projects successfully” (Goldman et al., 2014, p. 13). Some researchers propose strategies for developing teams. For example, the positive affect that is often experienced at the end of group brainstorming sessions could be an important part of team building (Callaghan, 2009).
- Planning/organising: This includes finding times where and when to meet, how to work on tasks together, and agreeing on decision-making processes. Teams worked best in the design thinking process when individual members could not accomplish the tasks alone (Goldman et al., 2014).
- Sharing: Dow et al. (2012) found in research that when people produce and share multiple alternatives (prototypes) with group members, they explore more diverse ideas, integrate more of their team members’ features, engage in more productive design conversations, and ultimately, create higher-quality work.
- Arguing: Goldschmidt and Badke-Schaub (2008) argue that contrary assumptions and conflicts in design groups should not to be shied away from as they are actually beneficial to the design outcome.

Goldman et al. (2014) referred to other collaborative factors including conflict, team alignment, abilities and an ambiguity in the design process as important. They also contended that an important factor is the collaborative mindset of group members. This is characterised by a belief that collaboration is a key component of problem solving, and that radical collaborations undergird transformative innovation. According to (Leise, Beyerlein, & Apple, 2005), other factors that are relevant to teamwork include:

- Defining team roles – deciding on roles that support a goal
- Setting rules – defining ethical and professional expectations
- Confronting poor performance – requiring specific change
- Recruiting – selecting qualified personnel for specific functions
- Mediating – resolving interpersonal conflicts
- Building consensus – developing goals and plans that are well-accepted
- Motivating – arranging rewards that fit individual aspirations

In addition to the mechanisms described above, T. Brown and Katz (2011) noted that we need to invent a new and radical form of collaboration that blurs the boundaries between creators and consumers. "It's not about *us-versus-them* or even *us-on-behalf-of-them*. For the design thinker, it has to be *us-with-them*" (p. 382). Stickdorn and Schneider (2011) referred to this approach to collaboration with stakeholders as co-creation or participatory design.

Researchers have also identified and described a number of personal attributes that potentially influence successful collaboration. They include disciplinary empathy, which Curedale (2013) defined as a willingness to understand the disciplinary perspectives of other team members; flexibility, which "combines the wisdom of many disciplines working in close and flexible collaboration" (Curedale, 2013, p. 22); individual motivation, where team members share passion, common goals, and commitment to excellence (Goldman et al., 2014); and cognitive differences, which Kress and Schar (2012) contended significantly impacts on a team's potential success in the reframing of problems.

7.51 Collaborative practice mechanisms and student-related attributes

Based on abductive and retroductive reasoning, I proposed that the following key student-related mechanisms and attributes were associated with the development and exercise of collaborative practices in design thinking in design thinking. These are presented in Table 32 and Figure 92.

Table 32. Collaborative mechanisms and student-related attributes

Collaborative Research Practices		
Practices	**Key Mechanisms**	**Student Attributes Influencing the Exercise of Mechanisms**
Collaborative Practice	• Getting to know • Meeting • Befriending • Relationship building • Talking/listening/perspective taking • Aligning roles • Planning • Goal setting • Organising • Cooperating/helping/sharing • Negotiating • Compromising • Leading	• Conceptual and procedural knowledge • Maturity/emotional intelligence • Motivation • Empathy • Disciplinary empathy • Flexibility • Openness/friendliness • Confidence • Communication style • Ego • Cultural perspectives

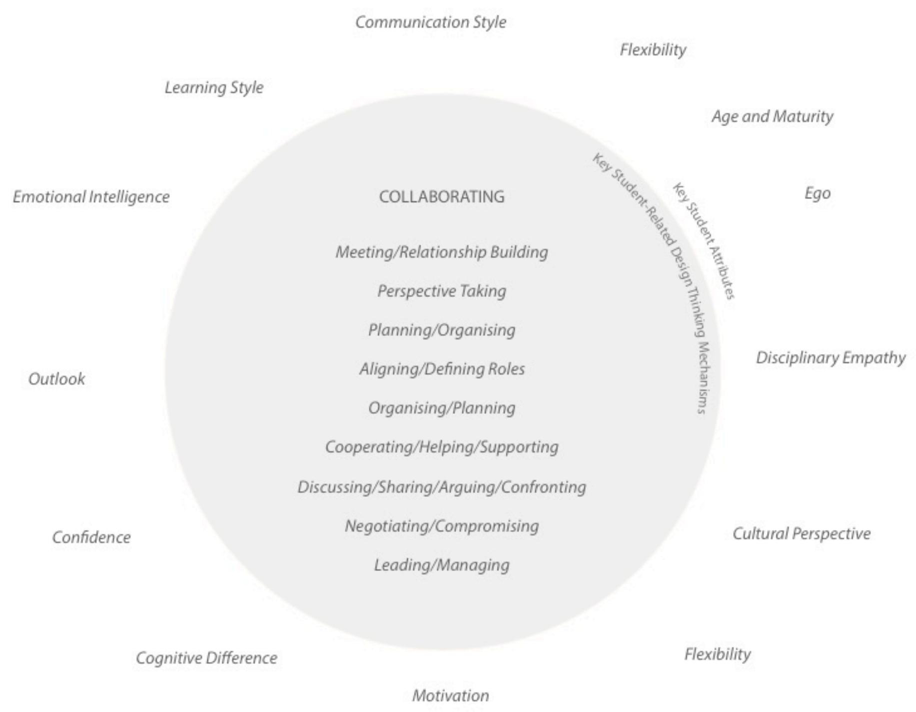


Figure 92. Summary of key collaboration mechanisms and student-related attributes

7.52 Explanatory theory and curriculum enhancement

Explanatory theory concerning students' development of collaboration practices suggested the curriculum enhancement opportunities that are summarised in Table 33.

Table 33. Opportunities for enhancing the curriculum

Curriculum Consideration	**Description of Potential Enhancements**
Learning Activities	
Group Orientation	Revise the group orientation process to develop a better foundation for the project. This may include discussion with students about their preconceptions, previous experiences of group work, and students' and teachers' expectations. In addition, provide better explanations; for example, of how to build strong team dynamics through developing shared goals, leadership, planning, and managing conflict.
Group Goal Setting	Set goals with students around conceptualising and facilitating collaborative mindsets through the design thinking process.
Teacher/Group Facilitation	Develop a programme of more teacher/ group facilitation sessions throughout the semester. Use these to not just talk about progress on work, but also to unpack how the group is going and identify other mechanisms and practices to support this process.
Group Journey Mapping	Develop a process for groups to discuss and map their journey through the design thinking process.
Teaching	
Group Size	Limit groups to no more than three or four members.
Group Participant Allocation	Develop a process for identifying disciplinary, cultural perspectives, and the learning strengths of students, and use to help facilitate the

	formation of diverse teams.
Resources	
Update Resources	Update resource in relation to above points.

SECTION ELEVEN: REFLECTIVE PRACTICES

The concept of reflection and reflective thinking relates to a complex and deliberate process of thinking about and interpreting experience in order to learn from it (Atkins & Murphy, 1995). Designing operates as a reflective conversation with the situation, as an interactive process (Cross, 2011a), and reflection is one of the key skills employed by designers and design thinkers in the design process (Cassim, 2013).

In this section, I present an analysis of students' reflective practices within design thinking.

7.52.1 Review of portfolios

Reflective thinking is generally represented in the reflective journals produced by the students as an assessed outcome of the course, and not in the portfolios. Unfortunately, specific use of the journals as data in this research was not approved in the ethics approval process for this research; however, general feedback on the reflection journals can be reported as part of my observations as researcher.

7.53 Student perceptions

7.53.1 Survey

While students were not asked directly about their development of reflective thinking capabilities in the survey, students rated the reflective component of the learning environment as generally helpful to very helpful post-participation. This is evident in the rating data in Figure 93.

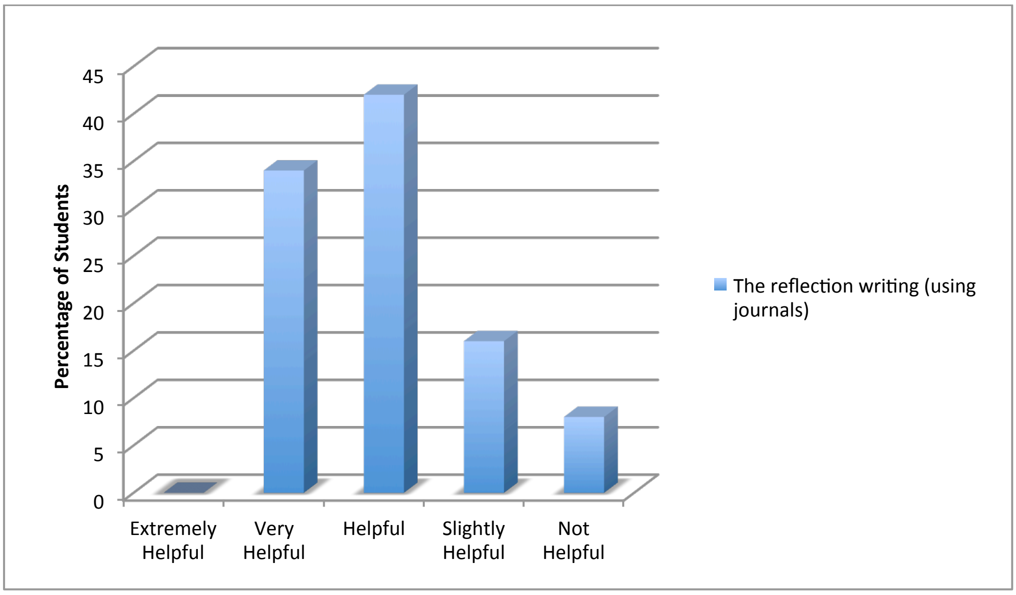


Figure 93. Students' ratings of the reflective component of the course

7.53.2 Interviews

Three of the six students interviewed indicated that they really enjoyed the reflective thinking aspects of the course, and found it valuable.

> *Yeah, I enjoyed the reflections.*

> *Reflections are important - What you think you're going to learn when you go into it and what you actually learn coming out of it are two completely different things.*

> *I think that the reflective journal was a really good way of documenting the learning as opposed to just experiencing it if you know what you mean.*

Two students, however, indicated that they found the process of self-reflection difficult at the time, and it was only later they fully realised the positive impact that it had on their learning.

> *I didn't find it useful until the end when we had to actually go there and analyse it.*

> *Yeah it just didn't seem great at the time. It wasn't until the end and I'm sort of looking over and going, ah, I can see how this helped me over here and I was sort of like wow, I did learn something.*

As part of the course, students were offered a mini-workshop to help them understand and use the reflective thinking model provided in class. I noted that the workshops were poorly attended, although three of the six students who did attend mentioned that they found them personally very useful in developing their reflective thinking capabilities. This is reflected in their comments.

> *Those workshops that you guys did after the class to help with the reflections, those were really helpful and I found that those reflections that we went through step-by-step.*

> *Yeah. But to sit there and just work through and just go what happened here, what, you know what could we have done better? It's opened my mind a lot more.*

> *It was a little difficult at first until we had that sit down with our lecturer and he told us a little bit more about kind of the words we kind of had to write in it and what we would look at.*

Even though the importance of ongoing self-reflection and the need to keep reflective journals up to date was emphasised in class, two students noted that many other students did not keep an up-to-date journal.

> *Well definitely the thing that I noticed was a lot of people didn't keep it.*

> *Yeah, two people in my group didn't seem to be using their journals at all.*

7.54 Researcher reflections and explanatory theory

Echoing findings of the previous action research cycle, and even though a lot of work had been put into developing a new reflective framework, based on the model from Atkins and Murphy (1995), including the mini-workshops, I noted that reflective thinking appeared to be a problematic aspect of the course. I noted that the outcomes of the reflective journals were generally very poor.

> *I talked about reflection, and presented the new reflective model based on Atkins and Murphy in class today. Not sure the students really understood the key concepts, as there were many questions at the end. Suggested mini workshops to go through the process, and most of the class thought this was a good idea.*

> *Ran the first workshop but didn't have many students come to the workshop today. Either can't see the value, or too busy.*

Just read the reflective journals. Hmm, I really need to rethink this, as many students seemed to have really missed the point. Some reflections are very poor, and are barely descriptions of some of the things that they have done in relation to the course.

7.55 Key tendencies and explanatory theory

- There were conflicting accounts of engagement with and usefulness of the reflective thinking aspects of the course from students.
- The Atkins and Murphy (1995) reflection model was useful in the teaching process, but students still appeared confused. Contributing factors appeared to include:
  - many students hadn't grasped the fundamental concept, rationale, and importance of reflective thinking during the learning;
  - many had no previous experiences of formal reflection; and
  - the Atkins and Murphy model was too complex for many students to grasp, especially concepts after the first two levels of the model.

- An extra workshop on the use of the reflective thinking model was provided, but was poorly attended by students. Contributing factors appeared to include:
  - it was outside of timetabled class hours, and students did not seem to realise the need for and benefit of extra help in this area. I noted that those who attended seemed very pleased with the impact on their learning; and
  - it was only after the course had finished that some students realised the value of reflective thinking.
- The reflective thinking component (journal) handed in by students was generally poor. As noted, many students appeared to be able to reflect through two levels of the Atkins and Murphy (1995) reflection model.

7.56 Related research and explanatory theory

Researchers have described a range of concepts that are closely related to reflective practice, reflective practice in education and design thinking.

Boud, Keogh, and Walker (1985) described reflection as a process in which individuals engage to explore their experiences, in order to lead to new understandings and appreciations. King and Kitchener (1993) contended that the ability to reflect develops over our lifetime, from childhood to adulthood through five stages, leading to a sixth and seventh stage that represent 'reflective judgment' stages where humans become more inclusive, differentiating, and critically reflective, with an integrative frame of reference, which is a characteristic of adult reasoning.

Other researchers have explored the dimensions of reflection. For example, Serafini (2002) believed that reflection is a process that begins with a reflective stance, the willingness to question and to take a critical look at beliefs, theories and practices. This aligns with Dewey (1933), who stated that reflection requires attitudes that value both the personal and intellectual growth of oneself and others. Dewey identified five stages associated with the reflective thinking process:

1. Perplexity, confusion, doubt.
2. Attentive interpretation of the given elements.
3. Examination, exploration, and analysis to define and clarify the problem.
4. Elaboration of the tentative hypothesis.
5. Testing the hypothesis by doing something overtly to bring about anticipated results.

While reflective thinking has been identified as a key mechanism in the learning process (Boud, Keogh, & Walker, 1985), Dunn and Musoline (2011) contended that there are no good constructs to drive and measure the development of reflective thinking. They did however identify a useful framework developed by Kember et al. (2000) titled the 'Questionnaire for Reflective Thinking' (QRT). The framework describes four levels of reflective thinking, including:

1. Habitual action, which corresponds with actions that are performed unconsciously.
2. Understanding, which corresponds with student thinking that shows comprehension of concepts "without reflection upon its significance in personal or practical situations" (Kember et al., 2000, p. 384).
3. Reflection, which represents actions where information is connected with experience.
4. Critical reflection, which is when transformation of beliefs and meaning occurs. It involves constructing personal meaning and using higher-level cognitive skills such as analysis, synthesis, and evaluation.

According to Tschimmel (2012), the problem-solving paradigm of design changed in the late 1980s to a paradigm focusing on interpretation of the design process as a reflective practice. Reflective thinking in design can be described as how the designer "shapes the situation, in accordance with their initial appreciation of it, the situation 'talks back', and they respond to the situation's back-talk" Schön (1983, p. 78). Cassim (2013) contended that reflection is an activity in design which takes in two contexts; firstly, while designers are 'in action' in a process that is a continuous moving back and forth between formulating, representing, moving and evaluating design decisions; and secondly, 'reflection on action' which takes place once the design outcome has been produced.

Reflective thinking "allows designers to focus on the entire design process instead of merely focusing on the result of the process … allows the designers to explore important avenues during the design process and also encourages them to take responsibility for their actions … and enables the designer to measure the success of the design process as well as the final result of that process" (Cassim, 2013, p. 196). Reflective thinking in design includes monitoring and evaluating design decisions in the design process (Cassim, 2013), and judgment making (Dunn & Musoline, 2011).

7.57 Reflective practice mechanisms and student-related attributes

Based on abductive and retroductive reasoning, I proposed that the following key student-related mechanisms and attributes were associated with the development and exercise of reflective practices in design thinking in design thinking. These are summarised in Table 34 and in Figure 94 .

Table 34. Reflective mechanisms and student-related attributes

Reflective Thinking Practices		
Practices	**Key Associated Mechanisms**	**Student Attributes Influencing the Exercise of Mechanisms**
Reflective Thinking	• Attention • Monitoring • Examining • Exploration • Describing • Interpreting • Comprehending • Elaborating • Decision-making • Communicating	• Conceptual and procedural knowledge • Previous experience • Motivation • Willingness • Age and maturity • Openness • Focus • Tenacity.

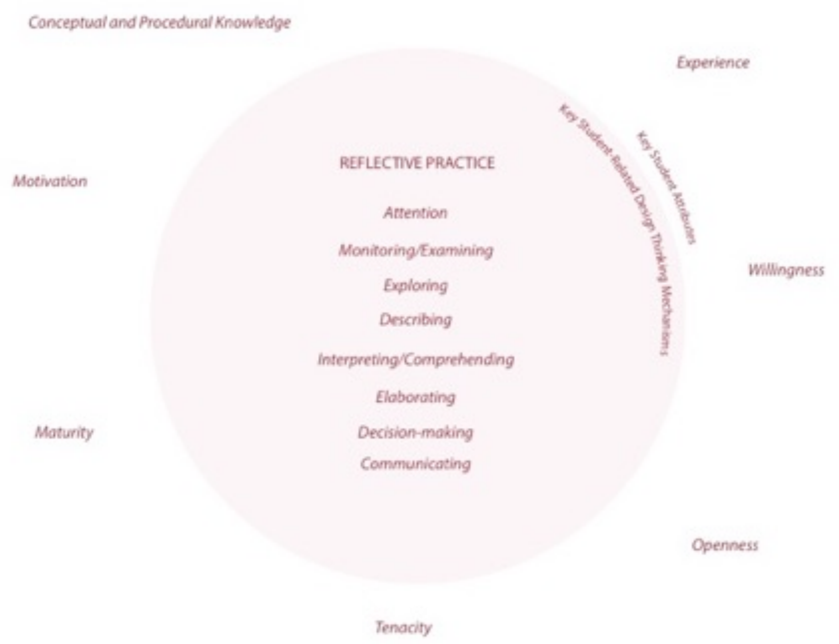


Figure 94. Summary of key reflective practice mechanisms and student-related attributes

7.58 Explanatory theory and curriculum enhancement

Explanatory theory concerning students' development of reflective practices suggested the curriculum enhancement opportunities that are summarised in Table 35.

Table 35. Opportunities for improving the curriculum

Curriculum Consideration	**Description of Potential Enhancements**
Framework	
Prioritise *Reflective Practice*	Given the importance of reflection to experiential learning and design thinking, prioritise the building of students' engagement and understanding of *Reflective Practice*. This includes prioritising students' use of reflection in the learning and teaching approach.
Content	
Reflection Model	Revisit and consider simplifying the Atkins and Murphy model or look for other models, or develop a new reflective thinking model used in the teaching such as Kember et al. (2000) to provide a better reflective practice model.
Reflection Questions	Provide students with better reflective questions to explore and ask themselves at different stages of the design thinking process. Differentiate questions from reflections on design thinking, and those directly about learning.
Structure, Sequencing and Timing	
Reschedule Workshops	Reschedule the reflective thinking workshops into timetabled class time so all students can participate.
Learning Activities	
Learning Activities	Align activities associated with *Reflective Practice* as per above.
Assessment	

Align Assessment	Review reflective assessment requirements. Align with reflective questions provided and an updated reflective model.
Resources	
Update Resources	Update resource as per above changes.

SECTION TWELVE: OVERALL SUMMARY DESIGN THINKING MECHANISMS AND STUDENT-RELATED ATTRIBUTES

In this section, I present an overall summary of key student-related design thinking mechanisms and attributes that that I inferred, which influence (enable or constrain) the students' abilities to activate these mechanisms. These are presented in Figure 95. I also present further reflections on my research approach.

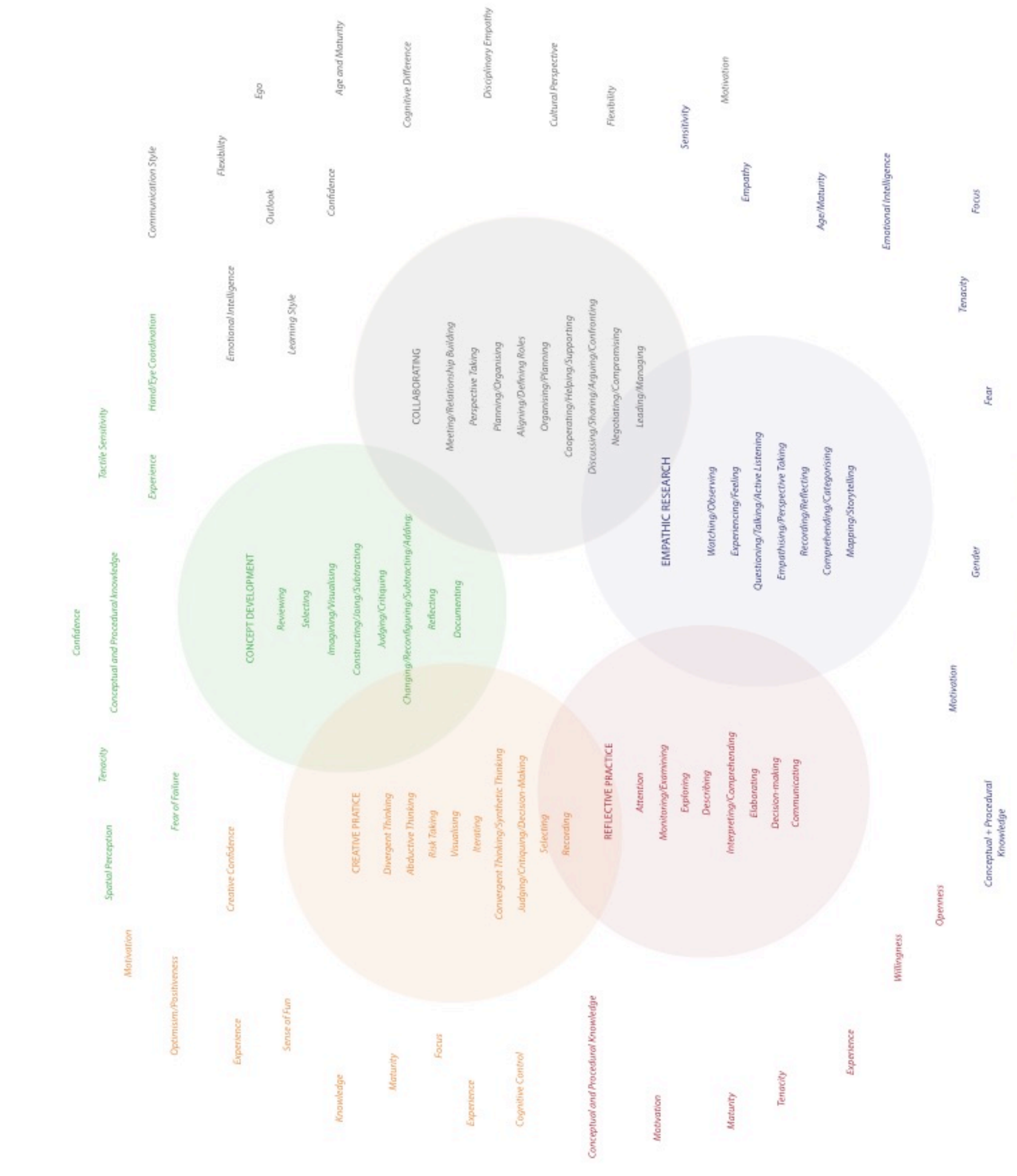


Figure 95. Overall summary of key student-related design thinking mechanisms and attributes

7.59 Further reflections on my research approach

In this chapter, I presented what I believed was another effective enactment of the design thinking curriculum. As with the previous cycle, the analysis of data delivered another comprehensive set of findings that informed the continuing enhancement of the curriculum. While I believed the critical realist approach was useful in developing explanatory theory, especially inferring key student-related design thinking mechanisms and attributes that influence (enable or constrain) the students' abilities to activate these mechanisms, and identifying curriculum enhancement opportunities, I noted a number of issues:

- the survey data were becoming saturated, as I was seeing similar findings across the first and second action research cycles;
- quite a few curriculum enhancement opportunities appeared to be similar to those identified in the previous cycle;
- I had an emerging realisation of the complexity of the phenomena, such as the vast plethora of mechanisms and other factors that are involved, or impacting on students' learning within the learning environment, and I had difficulty identifying which of these were the more important or significant; and
- I identified the opportunity to focus on learning and teaching mechanisms, and understanding their potential impact on students' development of design thinking expertise.

7.59.1 Recommendations

Based on the above, and my continued emergent knowledge and understanding of critical realism, a number of changes were suggested to the third action research cycle (cases three and four). These included:

- Futher constraining the data analysis using analytic resolution to focus on a reduced number of design thinking practices that I had identified as particularly significant, to avoid repetition and saturation of the data, and to deepen the analysis and theorising;
- attempting to confirm/disconfirm the preliminary explanatory theory (inferring of key student-related mechanisms and associated attributes) identified in this cycle; and
- focusing on developing further explanatory theory in relation to teacher-related mechanisms, and reviewing the findings of relevant literature.

7.60 The next chapter

In the next chapter I present Action Research Cycle Three.

CHAPTER EIGHT: ACTION RESEARCH CYCLE THREE (CASE STUDY THREE AND FOUR)

8.1 INTRODUCTION

In this chapter, I present the third action research cycle, which includes a summary of curriculum development undertaken in response to opportunities identified in the previous cycles, an account of my application of the theorising methodology to the data gathered, and a presentation of further implications for the enhancement of the curriculum that took account of theory. As with previous action research cycles, data were gathered from my reflections as the researcher, students' self-reported learning experiences from interviews and a survey, and student achievement from portfolios of work. With respect to analytic resolution, I decided to focus on and deepen the analysis for three design thinking practices: namely empathic research practices, creative practices and collaborative practices. While continuing to develop explanatory theory concerning student mechanisms and attributes that may be associated with these practices, I also developed theory about teaching-related mechanisms that potentially influenced the likelihood of design thinking mechanisms being exercised by students. This cycle represents Case Studies Three and Four.

To minimise repetition, the findings are presented in a more abbreviated and summarised format than the previous chapter, without the inclusion of survey graphs and with only limited examples of quotes from students.

8.2 Student participants

The third iteration of the curriculum, incorporating improvements identified in Action Research Cycle Two, was enacted with two student groups in semester two, 2013.

One group comprised 36 first-year, Bachelor of Business students who made up two classes within a first-year course titled Design Thinking. The course was an elective option within the Bachelor of Business. The course, which was was enacted over 12 weeks, one session per week. A teacher from the Product Design and Innovation Department enacted both classes. Of the 36 students present in the two classes during the briefing, 22 students agreed to participate and completed the pre-participation survey. Of those, 16 students completed the post-participation survey. A further five students participated in key informant interviews.

The second course was enacted as a project with 26 first-year Product Design students in a course titled Product Design Studio II. The project was enacted over six weeks, two sessions per week for a total of 12 sessions. Another teacher from the Industrial Design and Innovation Department enacted this project. Of the 26 students present in the class during briefing, 19 students completed the pre-participation survey and of those, nine students completed the post-participation survey. A further five students participated in key informant interviews.

It is important to note that in this chapter, the curriculum enactment is generally referred to as the Bachelor of Business course, and the Product Design project.

SECTION ONE: IMPROVEMENTS TO THIRD ITERATION OF THE CURRICULUM

In this section, I present a summary of changes to the curriculum that were made in the light of explanatory theory that emerged from the previous cycle.

8.3 Summary of curriculum development

It is important to note that given the short time between research cycles, many suggested changes were noted and deferred for consideration in the final, 'end-of-project' curriculum. Curriculum developments are described below.

8.3.1 Content

- The project briefs for both groups were updated.
- A number of foundational concepts were added to the curriculum introduction, including an enhanced articulation of design thinking mindsets, and why they are important, how they are relate to various design thinking practices, and how/why the experiential learning is utilised to underpin the curriculum.
- A new *Concept Mapping* practice was to help students to better analyse and categorise concepts produced in the creative process.
- The *SCAMPER* creative model was further developed into a practice, and added to the curriculum resources.
- The Kember et al. (2000) reflective model was adapted and incorporated into *Reflective Practice*, to extend the Atkins and Murphy (1995) model. An updated set of reflection questions was added. The questions were categorised for students as either reflection on design thinking, or reflection learning.

8.3.2 Framework

- The design thinking methodology model used to underpin the curriculum was further evolved to communicate each stage as a cycle, to encourage students to potentially revisit various design thinking practices as needed (see Appendix V, Figure 116) for a picture of this model).

- The *Generate* stage of the process model was renamed the *Create* stage.

8.3.3 Learning activities

- The orientation to the curriculum (with a focus on the first day) was updated with a section on experiential learning (i.e., what/why/how), with associated class discussion on the implications of participating in experiential learning environments for students who are not familiar with or have not previously experienced this learning approach.
- A framework was developed to help facilitate discussion with students about their preconceptions and previous experiences of group work, and student and teacher expectations of collaborative practice.
- A set of introductory, empathic research learning activities was developed to help students better orientate to these practices.
- A series of teacher/group facilitation activities was developed and scheduled in the teaching planners. The goal was to better support groups through the design thinking journey.

8.3.4 Learning resources

- All learning resources were updated to reflect the changes and improvements made to the content and framework described above.
- The teaching guide was also updated to reflect changes made.

SECTION TWO: STUDENTS' OVERALL EXPERIENCES AND IMPACT OF CURRICULUM

In this section, I present summarised findings of the data analysis relating to students' overall experiences, and their perceptions of the impact of the course on their development of design thinking expertise.

8.4 Overall student experience

8.4.1 The Bachelor of Business Course

8.4.1.1 Survey findings

The vast majority (94%) of students reported that they strongly or very strongly agreed that they had had a very good experience of the design thinking course, while 6% of students reported that they only somewhat agreed that they had had a very good experience and none disagreed or absolutely disagreed. This result generally aligns with the findings of Action Research Cycles One and Two, and endorses the overall learning approach.

8.4.1.2 Interview findings

Table 36 presents a summary of relevant themes and tendencies from the data gathered from interviews in relation to student experiences.

Table 36. Summarised themes and tendencies in relation to student experiences

Interpretation - Students indicated that they:	**No. of Students**	**Indicative Student Quote**
Enjoyed the interactive learning approach, which identified it as different to previous experiences.	5/5	*I liked the teacher's approach. It was very interactive … whereas in other classes you're forced to learn it in one-way. This class was not structured so much whereas we had to do it this certain way.*
Particularly enjoyed prototyping practices.	1/5	*I liked the prototyping part that was definitely my favourite part. That was the fun part.*
Particularly enjoyed the group work and collaborative practices.	3/5	*I really liked the group I got put with. I think everyone just felt comfortable around each other.*
Apprehensive before the course started.	3/5	*It was a bit of a mystery, I had no idea what to expect. I was kind of nervous because I didn't ever do anything creative before, so I was sort of worried that maybe I wouldn't do so well.*
Felt challenged on the first few weeks of the course.	3/5	*A little bit confusing to start with, but that's when, I think that's just because I hadn't grasped what the paper was actually about then.*
Not sure about the direction of the course early on.	2/5	*A lot of the time it was hard to see the direction that we were going in the class.*
Specifically felt challenged by the creative aspects.	2/5	*There were some challenges…. obviously creating new ideas.*
Specifically felt challenged by the reflective aspects.	2/5	*I've never done reflective thinking really, like I don't recall doing reflective so that was definitely a challenge for me.*

8.4.2 The Product Design Project

8.4.2.1 Survey findings

The majority (89%) of students reported that they strongly or very strongly agreed that they had had a very good experience of the design thinking project. Only 11% of students reported that they only somewhat agreed that they had had a very good experience, and no students reported that they disagreed or absolutely disagreed.

8.4.2.2 Interview findings

Table 37 presents a summary of relevant themes or tendencies from the data gathered from interviews in relation to student experiences.

Table 37. Summarised themes and tendencies in relation to student experiences

Interpretation - Students indicated that they:	**No. of Students**	**Indicative Student Quote**
Enjoyed overall learning approach, especially the structure.	3/5	*I found the structure really good. The project was really set out so I knew what was expected of me a lot more.*
Particularly enjoyed learning techniques.	3/5	*I really loved how it helped you go through all the possible techniques of design thinking in quite a small space of time.*
Specifically enjoyed the group work and collaborative practices.	2/5	*It was quite good working with the team, with the group.*
Felt challenged by various aspects of the project.	1/5	*I clashed quite a bit with my group I think in terms of their thinking styles and my thinking styles and the age difference as well I guess was a big part.*
	1/5	*He (the teacher) annoyed me at times … he would be critical of our ideas and I'm like why do you like being so mean about this like, but it actually helped me to think and to actually see from a different perspective.*
	1/5	*And it was quite frustrating … team leader would, would pick apart my idea, show me all the faults that I hadn't realised and then sort of I'd be there standing there going right, okay. It was hard.*

8.4.3 The Bachelor of Business Course

8.4.3.1 Survey findings

All students (100%) reported that they strongly or very strongly agreed the course very positively impacted on their overall development of design thinking expertise, and 100% reported that they strongly or very strongly agreed that they believed that the outcomes could be applied to their future studies and work.

8.4.3.2 Interview findings

Table 38 presents a summary of relevant themes or tendencies from the data gathered from student interviews in relation to the impact of the course.

Table 38. Summarised themes and tendencies in relation to the impact of the course on design thinking expertise

Interpretation - Students	**No. of**	**Indicative Student Quote**

indicated that the course:	Students	
Positively impacted their creative practices.	2/5	*I have become more creative and learning the design thinking projects has helped.*
Positively impacted their teamwork practices.	3/5	*I was comfortable in that situation with my group at the end, and for me that was quite a big achievement.*

8.4.4 The Product Design Project

8.4.4.1 Survey findings

All students (100%) reported that they strongly or very strongly agreed that the project very positively impacted on their overall development of design thinking expertise, and 88% reported that they strongly or very strongly agreed that the project could be applied to their future studies and work, while 12% somewhat agreed.

8.4.4.2 Interview findings

Table 39 presents a summary of relevant themes or tendencies from the data gathered from student interviews in relation to the impact of the project.

Table 39. Summarised themes and tendencies in relation to the impact of the project on design thinking expertise

Interpretation - Students indicated that the project	No. of Students	Indicative Student Quote
Positively impacted their understanding of practices.	2/5	*I finding myself using the methods already, you know straight away without needing any prompting now. You just kind of think to use them, which is good.*
Positively impacted their ability to manage the design thinking process.	1/5	*Definitely process management if that's the right word. Knowing how to manage the process is a great outcome.*

8.5 Key tendencies and explanatory theory

Reflecting similar findings to Action Research Cycles One and Two, students reported high or very high ratings of their experiences, and of the impacts of both the course and project on their design thinking expertise development. Many students also commented in the interviews that overall the course and project were generally positive and enjoyable experiences. In the interviews, the business students generally commented positively about the overall learning and environment, the interactive nature of the learning and how rewarding they found the group work. In contrast, some of the product design students commented they enjoyed the tight structure, and that the project went through a whole cycle from research to end product.

Both groups commented positively on the usefulness of practices and techniques they developed. The concept of 'fun' was mentioned many times in the interviews with students.

As with the Action Research Cycle Two, the business students also generally reported that the first few weeks were particularly challenging for them and the course was very different to previous and concurrent learning experiences. Students also reported examples of the potential transfer of learning (expertise) to other courses that they were taking, and to future work.

SECTION THREE: INVESTIGATE (EMPATHIC RESEARCH) PRACTICES

In this section, I present an analysis of the design thinking practices in the *Investigate* stage, of both the design thinking course and project. The practices include observational, interview and roleplaying research, and analysis of this research using Empathy Mapping, and Personas.

8.6 Student perceptions

8.6.1 The Bachelor of Business Course

8.6.1.1 Survey findings

Pre- to post-participation in the course, there was an improvement in students' ratings of their ability to undertake design thinking research as excellent (up from 5% to 32%). There was also an improvement in students' ratings of their overall research capabilities as good (up from 55% to 62%), and a marked decline in students' ratings as adequate (down from 40% to 6%). Students rating themselves as poor was unchanged (at 0%).

8.6.1.2 Interview findings

Table 40 presents a summary of relevant themes or tendencies from the data gathered from student interviews in relation to empathic research.

Table 40. Summarised themes and tendencies in relation to impact of the course on empathic research practices

Interpretation - Students indicated that:	No. of Students	Indicative Student Quote
More could have been made of the group observations.	2/6	*It wasn't that we weren't reminded to do observations; it was just that we felt like we'd completed it when really we probably hadn't. We should have done more to get a better understanding of the people who we are designing for.*
The interview practice as	2/6	*I really loved it. Interviewing, because obviously if*

particularly useful.		*you start the conversation in the right way, and it's the right environment you can get a lot about someone's perspective.*
Interviewing people who had very different needs and perspectives from their own was particularly powerful.	2/6	*We interviewed a physically disabled girl and she really opened our mind to how they get around the campus and everything. So that was quite good. It made us actually aware because you don't think of kind of the view from the physically disabled.*
Roleplaying was particularly challenging.	1/6	*Roleplaying was hard. Because we are students already, we thought the best roleplay we could do was wait at school for the longest break anyone had which would be maybe five hours, and what would we do in that time.*

8.6.2 The Product Design Project

8.6.2.1 Survey findings

Pre- to post-participation in the project, there was an improvement in students' ratings of their ability to undertake design thinking research as excellent (up from 4% to 11%). There was also very substantial improvement in students rating their overall research capabilities as good (up from 48% to 78%), and a decline in students rating themselves as adequate (down from 48% to 11%). Students rating themselves as poor was unchanged (at 0%).

8.6.2.2 Interview findings

Table 41 presents a summary of relevant themes or tendencies from the data gathered from student interviews in relation to empathic research practices.

Table 41. Summarised themes and tendencies in relation to impact of the course on empathic research practices

Interpretation - Students indicated that:	**No of Students**	**Indicative Student Quote**
Interviewing was personally challenging but rewarding.	2/5	*Yeah, one on one research, talking to people and that sort of stuff, I found a lot more difficult. But it was a good experience.*
They, and their groups, did not engage with the roleplaying practice, even though it was highly recommended.	3/5	*We did it a little bit. Some of the boys did it. I didn't want to – I should have really done it. I'm too shy.*
Focusing on people with physical disabilities was identified as specifically meaningful and a key turning point.	2/5	*We witnessed this one disabled guy who took like the full time and extra to cross because he was just so slow and then, and like there was also like everyone was trying to walk past him and he kind of had to get out of the way of people.*
Going through the empathy research practices twice would have helped students gain a much	2/5	*But definitely like more time would've definitely ended up with better results with things like that. Because the first time we went to go talk to people*

deeper understanding of people's perspectives.		*it was kind of a complete shambles, you know. I think looking back now if we had gone back we should've got a lot more out of it.*
Having a better explanation of the rationale and the reasons for engaging with the various empathy research practices and process may have helped students focus more.	2/5	*Yeah, maybe sort of explain at the beginning how long the research process is going to take and the reasons for this, and once we've achieved this it will lead to our final solution.*
They enjoyed the Persona practice, but they also noted that it 'got a little out of hand'.	1/5	*Personas were fun and we really got in to it. Yeah it was over the top and so we kind of struggled with that a little bit because one of our personas that we created all of a sudden was going through a mid life crisis.*

8.7 Researcher reflections and explanatory theory

The following observations and reflections are based on my own experiences, and my conversations with the teachers of both groups of students. Note that the teacher of the Bachelor of Business course is referred to as Teacher 1, and the teacher of the Product Design project is referred to as Teacher 2.

8.7.1 The Bachelor of Business Course

I noted in conversations with Teacher 1 that the *Assumption Mapping* practice emerged as problematic, especially students' misunderstanding of the role of this practice in helping remove their preconceptions about a problem before the *Investigate* stage. Teacher 1 commented that the students considered it a creative mind-mapping exercise, rather than the identification and mapping of personal assumptions about the problem. He also commented that most students tended to think of it as a way to eliminate initial or preconceived ideas and solutions, rather than explore preconceptions that might underpin their thinking, and that could be tested later. In addition, Teacher 1 also commented that there was an opportunity to better define, qualify and communicate what 'assumptions' could be for each context.

I noted that the groups generally appeared to have worked well through the practices. Teacher 1 commented, however, that from his own observations and reflections many of the students found it quite hard to think outside their own personal experiences in the research process. I noted possible ways of getting students to roleplay in this context, including getting students to undertake some initial observations and use these to identify and create personas of the various categories of students, followed by the selection of one or two personas that were different from them, and roleplaying them. I also noted that this could promote deeper empathy and understanding of other people's perspectives. This process could then be followed up with interviews and more observation.

The students also appeared to struggle to use the photos that they took as part of the observation process. Teacher 1 discussed a strategy that he developed during the teaching process to help students analyse the photographs.

8.7.2 The Product Design Course

When recruiting students, I noted that the profile of the students did not seem as diverse as the Bachelor of Business group, and appeared to be dominated by younger males, with a small number of females in the class. Teacher 2 commented that it was quite hard engaging the younger students with the empathic research process.

Teacher 2 made a point of facilitating a roleplaying exercise with students during the class session to kick off the *Investigate* stage, and before students went to the location to do the research. The session seemed to go reasonably well. After the research, the teacher was asked to reflect on the engagement and the performance of students. He noted that:

- some of the younger students were quite shy, and reluctant to get into the research in town;
- not many of the groups engaged with roleplaying;
- the first lot of insights from the research were quite obvious, and a little naïve; and
- a number of the groups were encouraged to go back to repeat some of the empathic research process.

8.8 Key tendencies and explanatory theory

The overall findings of the analysis generally aligned with the previous research cycle. Findings that align with the previous analysis include:

- Some students (and their teacher) believed that they were not effective in their initial *Observation* and *Interview* practices, and identified that they should have gone back and repeated the practices using the enhanced knowledge and experience from the first time.
- A number of students did not engage with the *Roleplaying* practice, and could not or did not see the value of it at the time.
- Age, maturity and gender attributes appeared to have an influence on engagement with empathic research.

New findings, and findings that do not necessarily align with previous findings include:

- Focusing on more 'extreme' users, such as those with physical disabilities, was a significant turning point for two of the students when developing deeper empathetic insights from the research.
- The analysis of observation research could be enhanced through the use of photography in the teaching process.

8.9 Research on teaching and facilitating empathic research

I reviewed literature that offered theoretical concepts and propositions that might support and extend my initial theoretical redescription of the data concerning empathic research (abduction). The literature covered learning outcomes and processes associated with empathy, mechanisms, and attributes students require to engage in empathic research, and teaching-related mechanisms and attributes that can facilitate students' development of empathic research practices.

8.9.1 Empathy and learning

Loreman (2011) argued that a good level of empathy between teachers and their students is an essential aspect of an effective learning and teaching environment. "Empathic teachers understand their students to a greater degree, and are perhaps more sensitive and able to respond to strengths and needs" and "empathetic students might be more adept at responding to a teacher, and in drawing out learning through more perceptive responses to learning situations" (Loreman, 2011, p. 17).

Aligning with the orientation aspects of the course and the project, Dhaliwal (2013) explained that increasing students' self-awareness, a fundamental teaching strategy, will help students to become more aware of their own judgments, biases, values, beliefs, emotional state, body sensations, and worldview, and therefore better prepare them for the empathic research. Dhaliwal (2013) also described the importance of discussing and acknowledging the challenges that students experience in learning and conveying empathy. Teaching empathy principles involves teaching the underlying principles and theories of empathy to students. Loreman (2011) identified a framework of 'Empathic Intelligence', developed by Arnold (2005), as a possible structure. The framework is described as a sustained system of psychic, cognitive, affective, social and ethical functioning derived from the ability to:

- Differentiate self-states from others' states ('who owns what').
- Engage in reflective and analogic processing to understand and mobilise a dynamic

between thinking and feeling in self and others (self narrative).

- Be enthusiastic, engaging, actively empathic, intelligently caring and professionally expert.

In addition, Loreman (2011) identified a commitment to the wellbeing and development of self and others.

Aligning with Dhaliwal (2013) and Loreman (2011), Pierre and Oughton (2007) argued that when teaching for empathy, teachers should demonstrate behaviours in their teaching that model affective attitudes and mindsets, including empathy. Eva Lu, Dane, and Gellman (2008) described a number of experiential learning exercises that have been used to help social work students foster a deeper sense of empathy, and facilitate empathy development. Their aim was to help students become more aware, empathic, and accepting of others. Exercises included:

- The 'emptying' of attachments and assumptions.
- Promoting contemplation, which acknowledges and facilitates the role of intuition, and seeks to expand the innate human capacity of intuitive perception as a cornerstone of empathy.
- 'Being present', arguing that presence constitutes true intuition and radical spontaneity, and has the potential to modify students' values, attitudes, assumptions, and behaviours in a positive manner.

8.9.2 Teaching for empathy and empathic research in design thinking

There appeared to be relatively little research into teaching and facilitating empathy, or empathic research in design thinking educational contexts. Lugmayr et al. (2013), however, advocated the need for identifying and setting human-centred goals at the beginning of a design thinking process, and using the collaborative team process as a way of getting students to understand and reflect on their own personality traits, including empathy. They also go on to suggest that teachers can pose a series of questions to students to help them empathise more deeply with users during design thinking research. Questions include: 'Which emotions trigger/guide the consumer, which kinds of stories do they tell, and what helps us to know their experience?' (Lugmayr et al., 2013, p. 14). Other researchers have identified a number of related strategies that provide experiential learning opportunities, which generally align with the approach currently used in the design thinking curriculum. These include:

- Facilitating ‘play’, which Loreman (2011) promoted, where the idea of ‘play’ includes engagement in roleplay scenarios where empathy can be developed; problem-solving simulations; cooperative activities, games, and tasks; and so forth. “Through play we can imagine how others feel in low-stakes scenarios where we can feel comfortable to take on what normally might be seen as radically different perspectives” (Loreman, 2011, p. 26).
- Facilitating authentic roleplaying, where Wilkes, Milgrom, and Hoffman (2002) had healthy preclinical medical students admitted to a teaching hospital with fake diagnoses, and the physicians caring for them believed that they were real patients. “Students reported confidence that this experience would help them be more empathetic toward patients” (Stepien & Baernstein, 2006, p. 528).
- Facilitating and supporting student reflection to help students develop empathy. For example, DasGupta and Charon (2004) described reflective writing exercises conducted with second-year medical students in which they reflected on their own previous experiences to help them empathise with patients. “Qualitative analysis of students' evaluation comments indicated that the exercise, although emotionally challenging, was well received and highly recommended for other students and residents” (DasGupta & Charon, 2004, p. 351).
- Facilitating ongoing practice that may include encouraging students to study people, and people’s behaviours, in various contexts and settings in an ongoing manner outside of the classroom and project environment, and to be always looking to identify people’s unmet needs and opportunities for innovation (Dhaliwal, 2013).

8.9.3 Teacher attributes

Loreman (2011), identified that teachers who model empathy also help students develop their own empathy.

8.10 Investigate (empathic research) mechanisms, student-related attributes and related teaching mechanisms

Based on abductive and retroductive theorising, I inferred key empathic research mechanisms, student-related attributes, both specific to empathic research and those associated with learning in general, which would enable/constrain the probability of empathic research mechanisms being exercised by students. I also inferred potential teaching mechanisms that could help students exercise empathic research mechanisms in the learning environment. This involved asking counterfactual questions such as: *What teaching-related mechanisms would* *need to be exercised by teachers in the learning environment, to counteract student attributes, and the influence of the mechanisms of other entities (such as mechanisms of other students) that may be constraining students exercising of empathic research mechanisms*?

Figure 96 illustrates the framework, further adapted from Sayer (2000, p. 15), which I utilised for this theorising.

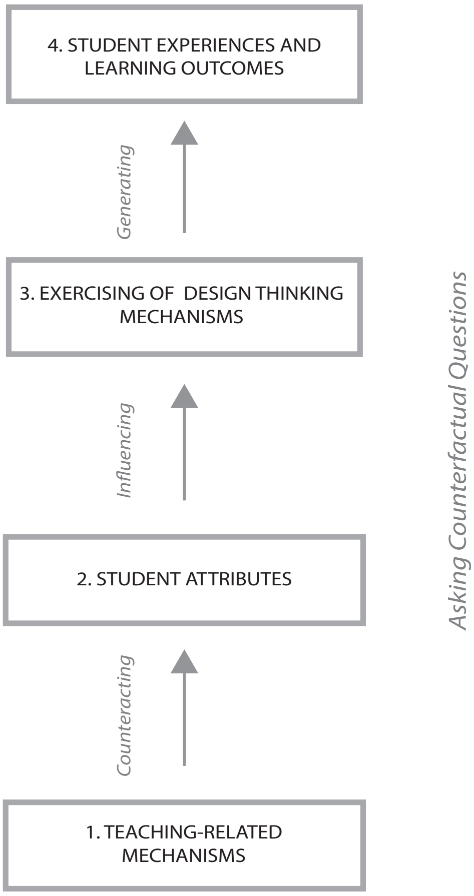


Figure 96. Critical realist theorising framework. Further adapted from Sayer (2000, p. 15)

Empathic research mechanisms, student-related attributes, and teaching mechanisms that I inferred are presented in Table 42 and **Figure 97**. In Table 42, new mechanisms that were identified are shown in bold.

Table 42. Empathic research mechanisms, student attributes, and teaching mechanisms

Investigate (Empathic Research) Practices			
Practices	**Design Thinking Mechanisms**	**Student Attributes Influencing (Enabling/Constraining) the Probability of Design Thinking Mechanisms Being Exercised**	**Teaching Mechanisms and Related Teacher Attributes**

<table>
<tr>
<td>Interviews
Practice</td>
<td>• Approaching
• Connecting to
• Questioning
• Active listening, hearing
• Empathising Responding
• Reflecting
• Recording</td>
<td rowspan="3">• Empathic research conceptual and procedural knowledge

• Empathy, sensitivity
• Experience
• Maturity
• Focus
• Confidence
• Trepidation and fear
• Comfort
• Tenacity

*Acknowledged more general learner attributes
• Attentive
• Motivated
• Wanting to make sense
• Wanting to remember

* For each of these generic attributes there are associated mechanisms e.g,, attending mechanisms.</td>
<td rowspan="3">A. Teaching mechanisms

• Modelling/demonstrating empathy
• Orienting/facilitating students' awareness of own empathy perspectives
• Presenting empathy, and empathic research theory
• Facilitating/guiding introductory research exercises
• Encouraging/directing research
• Observing students
• Intervening/discussing
• Unpacking/discussing findings
• Encouraging reflection
• Encouraging repetition of research
• Facilitating ongoing practice

B. Related Teacher Attributes

• Empathy</td>
</tr>
<tr>
<td>Observation
Practice</td>
<td>• Positioning
• Scanning
• Watching, seeing
• Perspective taking
• Recording
• Reflecting</td>
</tr>
<tr>
<td>Roleplaying
Practice</td>
<td>• Simulating
• Experiencing, feeling, acting
• Imagining, visualising
• Empathising
• Recording
• Reflecting</td>
</tr>
<tr>
<td colspan="4">Note: There were other conditions in play in the learning environment influencing (enabling/constraining) the probability of design thinking mechanisms being exercised. This included the influence of the mechanisms of other entities such as other students.</td>
</tr>
</table>

Figure 97. Summary of teaching mechanisms for empathic research practices and teacher-related attributes

8.11 Curriculum enhancement

I integrated the outcomes of the abductive and retroductive theorising, as described in the previous section, on students' potential for exercising of mechanisms associated with various empathic research practices. I also considered the influence of other related conditions in the learning environment, such as content, timing and sequencing. I used this theorising to help identify potential changes to the curriculum/learning environment.

Table 43. Example of process for theorising to identify opportunities for curriculum enhancement

Issue (Tendency) Identified	Key Student-Related Mechanisms Needing To Be Exercised (Most Important in Bold)	Student Attributes Potentially Constraining the Exercising of Mechanisms	Examples of Potential Changes to Curriculum/Learning Environment (Teaching Mechanisms)
Some students and were not effective in their initial *Observation* and *Interview* practices. A number of students did not engage with the *Roleplaying* practice, and could not or did not see the value of it at the time.	• Approaching • Connecting to • Questioning • Active listening • **Deeply Empathising** • Responding • Scanning • Watching, seeing • **Perspective taking** • Simulating • **Experiencing, feeling** • Acting • **Imagining** • Recording • **Reflecting**	Lack of motivation, a young age, and a general lack of maturity appeared to have an influence on lack of initial engagement with empathic research.	*Introducing* students to empathy principles, theories and frameworks before the experiential learning aspects of the empathy research. *Facilitating* empathy mindset development exercises and activities (personal reflection on beliefs, attitudes and approaches) during class orientation, and before the empathic research. *Encouraging* students to interview, observe and roleplay with people who are outside the traditional and 'expected' user groups. For example, this may include elderly and/or people with disabilities.

A summary of potential changes to enhance the learning environment are presented in Table 44.

Table 44. Summary of curriculum enhancements

Curriculum Entity and Aspect	Description of Potential Enhancements
Content	
Empathic Research Questions	Develop a framework of questions that students can ask during the *Investigate* stage, to help them more deeply empathise with users and analyse findings.
Learning Activities	
Empathic Mindset Development	Develop empathy mindset development exercises and activities (personal reflection on beliefs, attitudes and approaches) during class orientation, and before the empathic research.
Assumption Mapping Practice	Redefine, qualify and better communicate *Assumption Mapping* practices to help students develop more clarity of thinking (removing any assumptions) before the empathic research.
Photographic Analysis	Develop a practice to help students more effectively analyse photographs taken during the observation process. This includes focusing on unexpected activities and/or situations.
Teaching	
Empathy Theory	Introduce students to empathy principles, theories and frameworks before the experiential learning aspects of the empathy research.
Initial Observation	Encourage students to undertake initial observation of people to first help identify and create personas (who represent key groups of users), which can then be used to better select key users for roleplaying exercises, interviews and observation.
Diverse Users	Encourage students to interview, observe and roleplay with people who are outside the traditional and 'expected' user groups, as a way of getting deeper engagement with empathy and to help trigger an empathic mindset. For example, this may include empathy research with elderly and people with disabilities.
Ongoing Practice	Encourage students to look (i.e., have 'ways of looking') on an ongoing basis at situations and contexts with an empathic mindset to further develop and enhance empathy skills and capabilities.
Teacher Guidelines	Update teaching guidelines to describe the various teacher behaviours, strategies and mechanisms that may help teach empathic research practices.
Manager Guidelines	Develop guidelines for managers to help identify appropriate teacher attributes, which align to effective teaching of empathic research practices.

SECTION FOUR: CREATIVE PRACTICES

In this section, I present an analysis of practices in the *Create* stage of the process model, in both the Design Thinking course and the Product Design project. Creative practices include *Brainstorming* and *Lotus Blossom*.

8.12 Student perceptions

8.12.1 The Bachelor of Business Course

8.12.1.1 Survey

Pre- to post-participation in the course, there was an improvement in students' ratings of their ability to generate and explore a wide range of creative ideas as excellent (up from 0% to 38%). Reflecting this improvement, there was a small decline in those rating their overall creative capabilities as good (down from 55% to 44%), and a more marked decline in students' ratings as adequate (down from 36 to 18%) and poor (down from 9% to 0%).

8.12.1.2 Interviews

Table 45 presents a summary of relevant themes or tendencies from the data gathered from student interviews in relation to the development of creative capabilities.

Table 45. Summarised themes and tendencies in relation to impact of the course on creative practices

Interpretation - Students indicated that:	No. of Students	Indicative Student Quote
The development of creative confidence in the group context was a key creative learning outcome.	2/5	*I was able to express my ideas without being worried about, you know, what everyone else thought.*
They were apprehensive and nervousness about the creative aspects of the course before it commenced.	2/5	*I was kind of nervous because I didn't ever do anything creative before, so I was sort of worried that maybe I wouldn't do so well.*
The development of knowledge of creative process was specifically beneficial to their creative thinking capabilities.	3/5	*Now I know what the process is, I know exactly what it needs, I know all the different things to get that good idea and get that great idea.*
The Brainstorming practice was significant for the development of their creative thinking development.	3/5	*Like I've never been really a kid that has gone out of my way to try many different ways or techniques. And then I agreed at the end that brainstorming actually did work for us.*
They struggled at first with the Brainstorming practice.	2/5	*Yeah, it was quite challenging at the beginning just to forget certain ideas or, coz yeah, people in the group would be focused on this one idea and then eventually, once we focused on that idea, we realised it wasn't the best. But we couldn't see past it for a while.*
Aspects of the Brainstorming process were very challenging.	2/5	*When we were doing the other brainstorms we weren't really bouncing off each other's ideas.*
The use of Lotus Blossom was a significant and positive turning point in the creative process.	3/5	*None of us really actually got an idea until we finally got up to our last brainstorm which was the lotus blossom. And once we actually got our idea*

		and saw how much work we'd actually done, like how much everything went, we were just like wow. Like we actually just had a breakthrough, it was a big learning moment.
Prototyping was important in helping students 'see' and finalise their concept.	3/5	*Yeah, but that was good because that was useful. Because it made us see how boring our ideas were and how much further we could take them.*
Interventions and feedback from teachers were identified as having a significant impact.	2/5	*The teacher came over and he was like wow, that's really cool. That was definitely one of my biggest achievements.*

8.12.1.3 Review of portfolios

In the review of student group portfolios, I noted the following tendencies:

- There appeared to be excellent engagement with brainstorming and other creative practices, as was evident with general high level of documentation of the creative process, including *Brainstorming* and *Lotus Blossom* using post-it notes.
- Ideas can be generally categorised as service-oriented ideas (such as providing a historical service for tourists), rather than graphic, spatial or product.
- There was very little evidence of drawing and sketching. Not unexpectedly, I noted the drawing was relatively poor quality.
- Three of the five groups presented ideas that could be described as at a more radical end of the scale (i.e., very innovative and pushing the boundaries beyond existing ideas).

8.12.2 The Product Design Project

8.12.2.1 Survey

Pre- to post-participation in the project, there was a very substantial shift in students' ratings of their ability to generate and explore a wide range of creative ideas as excellent (up from 16% to 66%). Reflecting this improvement, there was a small decline in those rating their overall creative capabilities as good (down from 48% to 43%), and more marked decline in students' rating themselves as adequate (down from 36 to 18%), or poor (down from 26% to 0%).

8.12.2.2 Interviews

Table 46 presents a summary of relevant themes or tendencies from the data gathered from student interviews in relation to the development of creative capabilities.

Table 46. Summarised themes and tendencies in relation to impact of the project on creative practices

Interpretation - Students indicated that:	**No of Students**	**Indicative Student Quote**
Knowledge about the creative process was specifically beneficial.	3/5	*Because before I was like I'll just do that, do this, and there was no sort of structure to what I was doing. But now I kind of feel like if I do the background first and not jumping ahead of having a preconceived idea of what I want to make. So I think now have a better structure to the way I work.*
They were quite lost during mid part of the process, although now it all made more sense.	3/5	*I think my motivation suffered in the middle a little bit. I just went like, it started getting like we went through a phase like, we started off well and then we started getting kind of caught in this and that and then getting lost with, yeah, getting lost with where we were in the process.*
Brainstorming practice as both beneficial in the creative process, but also quite challenging.	2/5	*I don't like just doing a brainstorming chart and throwing things down on it just so it's done, it looks pretty and put it out the way and it's in the portfolio. I could sense that a lot of people did it, quite happily did it, but a lot of people didn't actually know why they were doing it.*
The *SCAMPER* practice was particularly challenging.	2/5	*And I think it's also one that needs a bit more practice, Scamper. I think it's a bit harder to get your head into the mindset of using it, coz it's almost like a whole set of tools do you know what I mean. I couldn't wrap myself around it and understand what, yeah, like Eliminate how we should approach it and the different ways we can approach it using Eliminate in 15 minutes.*
They could use some of the creative practices in their future work.	2/5	*And then definitely the techniques themselves I've started using a lot more. Like I said, this project straight away I've kind of started playing with them a lot more straight away, just in my head.*
The negotiation of creative differences, persuasion and compromise was as important in the creative aspects of teamwork.	2/5	*And creative, severe creative differences were an issue but we worked it out. By the time we had kind of caught up we were so far behind it was kind of just like, let's finish.*
Teaching interventions were helpful with their group work throughout.	2/5	*That's all right, I just thought the teacher was really good at pushing you within the group and giving you that directive to get a concept.*

8.12.2.3 Review of portfolios

The findings of a review of the product design student group portfolios generally correlated with the teacher's comments regarding the generally mediocre quality of creative responses to the problem in the brief. I noted the following points:

- There appeared to be good engagement and documentation of brainstorming and other creative practice.
- Generally, the selected ideas and concepts generated overall seemed quite 'safe', which may have been impacted by the perceived constraints of the brief.
- Given that there were four students in each group, there could have been wider exploration of initial ideas and concepts through drawing.

8.13 Researcher reflections and explanatory theory

The following observations and reflections are based on my personal experience and conversations with the teachers of both groups of students.

8.13.1 Bachelor of Business Course

I noted in conversations with Teacher 1 that students struggled through the early stages of the creative process, but most groups appreciated the Week 8 emphasis on mapping out the relative strengths and effectiveness of their initial ideas. As noted, I was involved in teaching the *Lotus Blossom* session (while Teacher 1 was on leave). I noted that this creative practice seemed to be very significant in the creative process. Teacher 1 also mentioned that the *3D Prototyping* practice was problematic, and noted that many students were still confused about the role of prototyping in the creative process.

8.13.2 Product Design Project

I noted in conversations with Teacher 2 that the level of creativity and creative thinking was generally a bit disappointing in comparison to other courses he has worked with, especially the third-year product design students. He noted that this probably reflected the overall lower level of motivation and abilities of the class. He noted the following key points:

- Once the groups had reframed the problem, they were generally slow to generate ideas, even though he facilitated a good *Brainstorming* session.
- There was quite a bit of confusion over the Lotus Blossom practice and SCAMPER. Some groups were quite reluctant to utilise these practices.
- Three groups had quite a lot of creative differences, and/or took quite a bit of time to resolve a design direction. In essence, they lost quite a bit of momentum through middle, creative stages of the project. The subsequent lack of time impacted on their ability to refine and resolve the final idea.

- While overall, the creative level of the class was mediocre, as reflected in overall grades in the C to B range, one group responded to the problem in the brief with a very creative concept.

8.14 Key tendencies and explanatory theory

The findings of the analysis of the survey, the interviews and review of portfolios generally align with previous research cycles. Findings that align with previous sets of analysis include:

- The development of creative confidence was identified as a significant learning outcome for three of the five Bachelor of Business students interviewed.
- A number of business students were apprehensive before the course, especially because they did not think they were very creative.
- The development of knowledge of the creative process was a significant learning outcome for students in both groups.
- Some students struggled with the divergent thinking aspects of the processes, especially generating such a large volume of ideas during brainstorming.
- A range of student-related creative thinking mechanisms were self-identified by students of both groups.

8.14.1 New and emergent findings, not aligning, or not identified in previous findings:

- The *Brainstorming* and *Lotus Blossom* practices were identified as having significant impact on the creative process for both groups, with the use of Lotus Blossom a significant turning point in the identification and interrogation of final concepts.

8.15 Research on teaching and facilitating creative thinking development

I reviewed literature that offered theoretical concepts and propositions that might support and extend my initial theoretical redescription of the data concerning creative practice (abduction). The literature covered learning outcomes and processes associated with collaboration mechanisms and attributes students require to engage in creative practice, and teacher mechanisms and attributes that can facilitate students' development of creative practices.

8.15.1 Facilitating creative mindsets

A creative mindset can be defined as bias towards creative behaviour in uncertain situations that require problem solving (Rauth et al., 2010) or 'as a state of being' (Hawthorne et al., 2014). Creativity is more likely to occur when there is a positive attitude, a tolerance for ambiguity (Lau, 2009), a cognitive state where the mind is defocused and thinking is associative (DeHaan, 2011; L. Newton & Newton, 2014), when students feel they can take risks (Gibson, 2010; Martindale, 1999; Ripple, 1989) and have a good level of creative confidence (Rauth et al., 2010). Suggested strategies for facilitating a creative mindset include facilitating concepts that everyone has a creative capacity and potential that can be unlocked, and that creativity is not the exclusive preserve of gifted people (Bouchard, 2013; DeHaan, 2011); undertaking specific instruction in creative processes and the undertaking of creative exercises (see research on creative process instruction below); and by repetitively experiencing and applying creative processes (Rauth et al., 2010) to build creative confidence.

8.15.2 Facilitating creative motivation

Personal motivation plays a strong role in creativity (Amabile, 1983; Meador, 1997). Amabile (1983) argued that people are more creative when they are motivated by personal commitment. Suggested teaching mechanisms for facilitating students' creative motivation include unpacking personal ambitions and motivations and aligning to creative outcomes, aligning creative project briefs with students' personal interests (Amabile, 1983) and developing students' intrinsic motivation by creating fun (Lau, 2009). Lau (2009) also suggests that making the creative task interesting is important to motivating students. As Eisenberger (2003) explains, people are able to perform to their maximum creative ability particularly when engaging with challenging or interesting tasks. Lau (2009) also proposed that an effective way to enhance students' creative motivation and self-determination is by giving them more autonomy instead of any anticipated rewards in doing creative tasks.

8.15.3 Creative process instruction and facilitating creative exercises

Education is one of the most useful practices for improving individuals' creative performance (Nickerson, 1999; Ripple, 1989; Schlee & Harich, 2014), and a deliberate design and arrangement of creative learning activities is crucial to assist students to unlock their creative potential (Lau, 2009). Students reported that "they particularly benefited from deeply understanding creativity as a process, and from the specific divergent and associative thinking exercises" (Martindale, 1999, p. 288). The teaching of specific creative processes and exercises includes identifying and mapping problem attributes (Schlee & Harich, 2014), divergent and convergent thinking (Martindale, 1999; Schlee & Harich, 2014), and probing emotion and the subconscious in creating possible ideas (Schlee & Harich, 2014).

8.15.4 Other teaching mechanisms

Other teaching mechanisms include:

- Encouraging and facilitating risk taking in the search for ideas is an essential component of facilitating students' creativity (Gibson, 2010; Martindale, 1999; Ripple, 1989; Sternberg & Lubart, 1995). Teaching mechanisms to encourage creative risk taking include discussing self-perceptions of creative ability (Schlee & Harich, 2014) and the influence of previous conditioning (Lau (2009), and discussing with students the role of risk taking in creative thinking. Martindale (1999) also noted that less emphasis on assessment (see de-emphasising assessment below) and grading can encourage students to take more risks necessary for creative thinking.
- Facilitating engagement with personal experiences. Wong and Radcliffe (2000) argued that "[design] students make use of their personal experiences and prior successful cases to form a knowledge base for exploring creative ideas while evaluating them"(p. 155). It is useful to research previous solutions to problems and get students to reflect on their own previous experiences.
- Promoting 'no right answer' (Martindale, 1999) and encouraging flexibility in the creative process. Ripple (1989) argued that this also helps students express their creativity and encourages them to take creative risks.
- Providing creative feedback. Specific feedback mechanisms that support creative thinking include assuming the role of the audience, "which implies a non-judgmental attitude and emphasizes active listening, followed by constructive feedback" (Martindale, 1999, p. 286). Driver (2001) and Gibson (2010) also argued that specifically rewarding creative ideas is an important part of a positive feedback process in facilitating creativity.

Assessing creativity: Hawthorne et al. (2014) propose that using creative assessment tools are useful in the teaching process. They suggest a three-axis framework for assessing creative outputs from (a) existing to new/novel, (b) linear to synthesising, and (c) no value/meaning to meaningful. This model is presented in Figure 98. They also propose that a enactable or process with high novelty, meaning, and synthesis is considered highly creative and so is the person responsible for this enactable or process.

Image removed due to copyright restrictions.

Figure 98. Creativity framework (Hawthorne et al., 2014)

Other creativity assessment tools include the Torrance Tests of Creative Thinking (TTCT) or Torrance (1966) test which measures creativity in terms of fluency, originality elaboration, abstractness of titles and resistance to premature closing. , There is also the Amabile (1982) consensus-based evaluation of creativity called the Consensual Assessment Technique, and the Design Thinking Creativity Test (DTCT), developed by academic staff at the Stanford University d.school, which reflects problem solving needs in the twenty-first century by testing an individual's ability to exercise their creativity effectively in real-world scenarios (Hawthorne et al., 2014).

- De-emphasising assessment. In contrast to Hawthorne et al. (2014), Martindale (1999) advocated for de-emphasising assessment in the creative classroom. In interviews with students about facilitating creativity in higher education, they noticed and responded positively to the lack of focus on assessment, indicating that "this aspect of the class made them feel more comfortable in expressing creative ideas" (p. 286). In addition, Gibson (2010) argued that it is important to involve the students as much as possible in the formulation and manner of any assessment of creative work.

Researchers have also noted other teaching mechanisms that are important in facilitating creative thinking such as creating creative time, keeping theory lectures short and emphasising creative activity and practice (Martindale, 1999); encouraging the questioning of assumptions, encouraging dissent and diversity, and encouraging the refraining from evaluating/judging (De Souza, 2000; Driver, 2001); managing student emotions (i.e., promoting positive moods of students) and removing students' obstacles to creativity such as exploring cultural viewpoints, encouraging opinions to be expressed and norms to be challenged (Lau, 2009).

8.15.5 Facilitating creative practices in a design thinking context

Rauth et al. (2010) described a design thinking pedagogy which focused on moving students from engaging with design thinking practices to creative confidence as the key outcome. This goal is represented in Figure 99 as a pyramid model that places creative confidence at the top.

Image removed due to copyright restrictions.

Figure 99. Design thinking way to creative confidence (Rauth et al., 2010)

Specific teaching mechanisms in the design thinking pedagogy include providing and introducing a basic set of creative tools, teaching an empathising process (i.e., cognitive knowledge transfer), and then repeating the (creative) design thinking process to build students' confidence (Rauth et al., 2010). In each of the repetitions, more creative tools are introduced.

8.15.6 Teacher attributes

Researchers have identified a range of conditions, which potentially activate or inhibit the activation of teaching-related mechanisms identified and described above. These include a number of key personal attributes of teachers, including:

- Teacher enthusiasm and attitude. Lau (2009) contends that instructors should model enthusiasm, optimism and a positive approach when creating environments that facilitate students' creativity. They should model creative behaviours in their own approach to teaching, and not be scared to join creative exercises with students.
- Understanding of students' cognitive styles. Lau (2009) argues that it is important for educators to understand design students' thinking habits before developing approaches to develop their creative-friendly learning behaviours. They refer to the Harrison and Bramson (1984) typology as one example of classifying thinking styles.

"This classification system is not to be used to analyse design students' psychological performances, but rather provides guidelines for design educators to build awareness and consider the different design students' thinking habits prior to developing and implementing creativity training" (Lau, 2009, p. 155).

8.16 Creative mechanisms, student-related attributes and related teaching mechanisms

Based on further abductive and retroductive theorising, I inferred the following key creative mechanisms, student-related attributes, and teaching-related mechanisms that could influence students' exercise of mechanisms associated with creative practices in the learning environment. These are presented in Table 47 and Figure 100. In Table 47, new mechanisms that were identified are shown in bold.

Table 47. Creative practice mechanisms, student-related attributes, and teaching mechanisms

Empathic Research Practices			
Practices	**Design Thinking Mechanisms**	**Student Attributes Influencing (Enabling/Constraining) the Probability of Design Thinking Mechanisms Being Exercised**	**Teaching Mechanisms and Related Teacher Attributes**
Brainstorming	• Idea generating • Divergent thinking • Abductive reasoning • Risk taking • Pushing, iterating • Imagining, visualising • Synthetic thinking • Convergent thinking • **Idea interrogating** • **Idea critiquing** • Categorising • Selecting • Decision-making • Recording • Reflecting	• Creative conceptual and procedural knowledge • Previous experience • Motivation • Maturity • **Creative confidence** • Openness • Optimism, positiveness • Sense of fun • Cognitive control • Focus • Tenacity *Acknowledged more general learner attributes • Attentive • Motivated	A. Teaching Mechanisms: • **Creating positive creative environment** • **Discussing perceptions of creative ability and cognitive styles** • **Encouraging creative risk taking and divergent thinking** • **Encouraging fun and enjoyment** • **Emphasising creative process** • **Encouraging questioning** • **Presenting creative theory** • **Inspiring** • **Modelling/demonstrating creative thinking** • **Engaging in the creative practices with students** • **Managing student emotions**
Lotus Blossom	• Divergent thinking • Abductive reasoning • Risk taking • Idea interrogating • Idea extending • Imagining, visualising		

	• Synthetic thinking • Convergent thinking • Decision-making • Selecting, categorising • Recording • Reflecting	• Wanting to make sense • Wanting to remember * For each of these generic attributes there are associated mechanisms e.g., attending mechanisms.	• **Actively engaging with ongoing critiquing** • **Providing positive feedback** • **De-emphasising assessment** B. Related Teacher Attributes: • **Enthusiasm** • **Optimism** • **Knowledge of cognitive styles** • **Knowledge of creative theory**
SCAMPER	• Challenging, Critiquing • Abductive reasoning • Imagining, visualising • **Idea rethinking** • Selecting • Recording • Reflecting		
Note: There were other conditions in play in the learning environment influencing (enabling/constraining) the probability of design thinking mechanisms being exercised. This included the influence of the mechanisms of other entities such as other students.			

Figure 100. Summary of teaching mechanisms for creative practice and related teacher attributes

8.17 Curriculum enhancement

I integrated the outcomes of abductive and retroductive theorising to help me identify potential changes to the curriculum/learning environment that would enhance the probability of creative research mechanisms being exercised. I identified the following key opportunities to further enhance the curriculum. These are presented in Table 48.

Table 48. Summary of curriculum enhancement opportunities

Curriculum Entity	Description of Potential Enhancements
Content	
Creative Theory	Provide students with a greater range of readings and theoretical papers on creativity and creative thinking.
Teaching	
Perceptions of Creative Motivation, Confidence and Ability	Discuss with students their preconceptions of their creative thinking capabilities, and how this may impact their creative confidence. This may also include testing/evaluating students' thinking styles to help drive strategies for teaching creative thinking.
Individual Creative Perspectives	Facilitate discussions of students' perspectives on the problem, and help find ways for students to find and link in personal connections to help drive creative motivation.
Creative Environment	Facilitate a creative environment, including inspiring, modelling creative practice, collaborating, and encouraging fun.
Teacher Guidelines	Update teaching guidelines to describe the various teacher behaviours, strategies and mechanisms that may help teach creative practices (such as managing student emotions and encouraging collaborative approaches with students).
Manager Guidelines	Develop guidelines for managers to help identify appropriate teacher attributes, which align to effective teaching of creative practices.
Assessment	
Formal Teacher Assessment	De-emphasise formal assessment during creative stages of the design thinking process.
Student Self-Assessment	Introduce simple ways that students can assess their own creativity (such as the Torrance test).

SECTION FIVE: COLLABORATIVE PRACTICES

In this section, I present an analysis of collaborative practices.

8.18 Student perceptions

8.18.1 The Bachelor of Business Course

8.18.1.1 Survey findings

Pre- to post-participation in the course, there was an improvement in students' ratings of their ability to collaborate as excellent (up from 18% to 50%). Reflecting this improvement, there was a decline in students rating their overall creative capabilities as good (down from 55% to 38%), adequate (down from 22% to 12%), or poor (down from 5% to 0%).

8.18.1.2 Interview findings

Table 49 presents a summary of relevant themes or tendencies from the data gathered from student interviews in relation to the development of collaborative capabilities.

Table 49. Summarised themes and tendencies in relation to impact of the course on collaborative practices

Interpretation - Students indicated that:	No. of Students	Indicative Student Quote
Social relationships and friendship mechanisms were important in successful teams.	4/5	*It was like you weren't forced to do study by yourself, you were doing it with your friends, and it made it more enjoyable.*
Enjoyment of collaboration was emergent, and increased as the course evolved.	3/5	*Our group got better, and it was more fun at the end when we had to pull everything together.*
Collaboration as a key learning outcome.	3/5	*I think the teamwork was definitely one of the best ways to learn in the class. I am much better at collaborating now I think.*
Had low expectations of group work and the potential for success.	3/5	*My group was good which I'm lucky about I guess. I ended up enjoying it.*
Competition between groups was also mentioned as significant and important.	3/5	*Because it was sort of like we can share our ideas without worrying people would sort of steal them or something.*
Competition between groups seemed to ease or changed towards the end.	3/5	*But we, there were times more towards the end when we started talking to other groups and getting ideas off them and getting their insights and stuff like that.*
There was a need for structure and guidance, one mentioned that success was really up to the group's members themselves.	3/5	*I feel like you guys gave us the shoes, like you know, we just had to wear them and that was down to us, not really you guys.*
Other students not pulling their weight negatively impacted group work.	3/5	*We were annoyed because we'd done all this work and, you know, he was going to get the same mark as us.*
Overcoming shyness, especially regarding the sharing of ideas and being open was identified as important.	3/5	*I'm normally quite a shy person, but by the end of the semester I was able to spread my ideas and contribute a lot.*
They enjoyed the group collaboration.	2/5	*Yeah, I enjoyed the group work.*
That collaboration was different (better) from other classes.	2/5	*Our group work was much better in this class.*
Meetings that their groups had outside of class time was a significant contributor to their success.	2.5	*We actually had at least one meeting every week, and I felt like we all got a lot from it, even though we were all very different.*

8.18.2 The Product Design Project

8.18.2.1 Survey

Pre- to post-participation in the project, there was an improvement in students' ratings of their ability to collaborate as excellent (up from 0% to 33%), and an improvement in students rating their ability as good (up from 16% to 22%). There was little change in students' ratings of themselves as adequate (slightly down from 47% to 45%), and a decline in students rating themselves as both poor (down from 32% to 0%) and very poor (down from 5% to 0%).

8.18.2.2 Interviews

Table 50 presents a summary of relevant themes or tendencies from the data gathered from student interviews in relation to the development of collaborative capabilities.

Table 50. Summarised themes and tendencies in relation to impact of the project on collaborative practices

Interpretation - Students indicated that:	**No. of Students**	**Indicative Student Quote**
They specifically enjoyed the collaborative group work.	3/5	*I enjoyed working with a group of fellow students or designers. I found it (collaboration) an insight into the industry.*
Teacher and teaching interventions positively impacted their collaboration.	3/5	*Clarke that sort of like, you know, you've got to work through it and you've got to get through your group bits and you'll go through that whole like butting heads phase.*
The development of group cohesion was emergent throughout the process.	3/5	*So it was kind of like it happened about 3 weeks in. The first 2 weeks after the chaotic project work that didn't really make, well it wasn't as coherent as it should have been.*
Friendship was identified as a significant component in the enjoyment and success of the collaboration.	2/5	*So we sort of we were able to build a friendship and a relationship throughout that project where we got kind of close.*
The group generated rules as a factor in their group success.	2/5	*We did work ourselves through all the things that we talked about in our how to work as a group things.*
Watching other teams was useful in reflecting on their own group and collaboration development.	2/5	*I began to watch other teams. I noticed one of the groups was just, everyone in that group seemed to hate each other and I don't know if it was like deliberate.*
Shyness, and a lack of confidence about drawing was a major barrier.	2/5	*I'm a really shy person. It was hard at the beginning.*
Some believed 'luck' was involved in successful group work.	2/5	*I thought I was lucky to get put with people that had all got all good marks before, so they were all quite on to it people.*

8.19 Researcher reflections and explanatory theory

8.19.1 The Bachelor of Business Course

It appeared that class attendance was low for some group members earlier on in the course, and quite a few groups were slow to meet outside of the class and to get underway. By mid-semester, group insights were few and the range of resulting ideas was also limited.

Teacher 1 suggested a number of possible solutions to these issues, including bringing an emphasis on team meeting, bonding and identity, and assessment with shorter time frames. He also suggested that we introduce a 'State of Grace' document and give some group members guidelines on how to respond to group members who do not keep their part of an agreed action.

8.20 Key tendencies and explanatory theory

The analysis of the survey and interviews generally aligned with previous research. Findings that aligned with previous sets of analysis included the following.

- There were positive shifts in students' development of collaborative capabilities.
- The development of collaborative practices was identified as a significant learning outcome for a majority of the students interviewed.
- A number of students had negative views around collaboration, and articulate that they were 'lucky' that it went well.
- Collaboration was described as an emergent journey, and that groups tended to collaborate better towards the end.
- Specific issues and factors negatively impacted on the collaboration process for some students including:
    - team members not pulling their weight, not contributing or not attending; and
    - individual shyness, and the inclination to not share ideas.

New emergent findings, not aligning, or not identified in previous findings:

- The experience of collaboration for the business students was often very different to previous experiences. In the design thinking course collaboration was deeper and more significant for them.
- The lack of maturity of some team members affected motivation and caused conflict with older or more mature students.

8.21 Research on teaching collaboration and facilitating collaborative capability development

I reviewed literature that offered theoretical concepts and propositions that might support and extend my initial theoretical redescription of the data concerning collaborative practice The literature covered learning outcomes and processes associated with collaboration mechanisms and attributes students require to engage in collaborative practices, and teacher mechanisms and attributes that can facilitate students' development of collaborative practices.

Researchers have identified a range of teaching mechanisms that can positively influence the development of students' collaborative practices in higher education.

8.21.1 Collaboration in learning and teaching

While collaborative learning and teaching environments enhance student learning and performance (Ocker & Yaverbaum, 2004), other researchers have identified a range of issues that can negatively impact on group collaboration. These include poor communication, lack of effective leadership, varying grade expectations, and differences between students' work ethic (Snyder, 2008).

8.21.2 Teacher-related mechanisms

In addressing some of the issues identified above, researchers have described a number of teaching mechanisms which underpin and support the effective teaching of group collaboration and the facilitation of students' development of collaborative capabilities, as well as being relevant to design thinking and informing the enhancement of the curriculum.

Orientating: According to McGraw and Tidwell (2001), Prichard, Bizo, and Stratford (2006) and Snyder (2008), before facilitating student collaboration, teachers should orient students, not just to the goals of the group project, but also towards the group development and evolution process. Prichard et al. (2006) stated that empirical evidence indicates that training before collaborative projects "produced superior collaborative group work compared with that of students merely placed in unaffiliated groups"(p. 176). Orientation mechanisms include:

- Identifying student learning styles: Kim and Sonnewald (2002) argued that learning styles should be considered as a potential variable that influences collaborative learning outcomes, and should be identified and discussed before the collaboration process. They outline cooperative, competitive and individualised types (Owens & Barnes, 1992) as potential learning styles to be explored with students.
- Facilitating positive preconceptions of teamwork: Students also often report negative perceptions of group work especially when time outside of class is required. Preconceptions should be identified, discussed and addressed before a collaborative project commences (Snyder, 2008).

- Creating a collaborative mindset: This is characterised by a belief that collaboration is a key component of problem solving, and that radical collaborations undergird transformative innovation (Goldman et al., 2014).
- Communicating the phases of team evolution: This helps students understand their roles within the group. At a minimum, Snyder (2008) recommends that teachers introduce the 'Forming–Storming–Norming–Performing' model of team development (Tuckman, 1965). "Understanding the phases of team development helps students navigate the collaborative experience as well as identify their own roles within the group dynamic" (Snyder, 2008, p. 66).
- Creating and facilitating student interdependence: Ettington and Camp (2002) argued that to achieve the full potential of a collaborative group, individual members should perceive themselves to be interdependent (i.e., individuals are mutually dependent on each other's work).

Teaching collaborative skills and capabilities: Educational programmes that provide group members with specific collaborative skills before they embark on a project are considered by some to be an essential aspect of an effective collaborative outcome (Kim & Sonnewald, 2002; Snyder, 2008).

Creating challenging assignments: When developing collaborative projects and activities, teachers should ensure that they are designed to facilitate and promote both team interaction and the key learning objectives of the course (J. Anderson, 2005; Kreie & Steiner, 2007; Snyder, 2008). Developing collaborative projects that specifically enable interdependence can facilitate a more cohesive group experience and more desirable outcomes (Ettington & Camp, 2002).

Facilitating peer to peer interaction and communication: Strong peer to peer communication and social interaction is important in group work (Bouchard, 2013; Leenders, van Engelen, & Kratzer, 2003). Class discussions play an important role in encouraging classroom and peer to peer communication (Gibson, 2010; Martindale, 1999). Teaching mechanisms for facilitating peer to peer discussion and communication include setting discussion frameworks, rules and times, observing groups in action and intervening with encouragement and behaviour modelling during creative collaboration when necessary (Lau, 2009). Paulus (2000, cited by Hyunjee , Mishra, Hinds, and Liu 2012), also argued that successful group creativity is often triggered by social stimuli mechanisms, such as competition, accountability, upward comparisons and goals.

Team facilitation: Goldman et al. (2014) contended that instructor facilitation plays a major role influencing team success. “As instructors attempt to create environments where teams can accomplish their independent work and achieve success, they are the supporting cast to the design thinking team ensemble” (Goldman et al., 2014, p. 13). They also concluded that the results of their research raise questions and suggest implications for teaching design thinking, and the need to better support independent teamwork. According to Snyder (2008), research by Payne, Monk-Turner, Smith, and Sumter (2006) indicated that weekly meetings, actions lists, and team roles (leader, record keeper, etc.) by instructors significantly increased student group communication, cohesion, and success.

Facilitating individual reflection: Effective collaboration involves reflection (Higgens, Flower, & Petraglia, 1992; McGraw & Tidwell, 2001) both throughout the collaboration process as well as after the project is completed (Snyder, 2008). McGraw and Tidwell (2001) suggested a group exercise to promote students’ collaborative skills by getting students to reflect on the factors that contribute to a group’s success and failure, including group identity, team conflict, rights and responsibilities, interpersonal and behavioural skills, leadership issues, and time management.

Facilitating the observation of other teams: Snyder (2008) argued that “students’ behavioural intentions to use their team skills are influenced by students observing or listening to other teams solve conflicts and by having a supportive, encouraging intra-team environment” (p. 62). She proposed that observation of other teams could be facilitated in classroom settings using roleplaying activities or case studies that focus on observation.

Assessing: “Students often cite collaborative grading as a negative factor of participating in group work” (Snyder, 2008, p. 67). They argue that assessment techniques should be developed to provide evaluations that represent both students’ individual efforts, as well as the overall group performance.

8.21.3 Related teacher attributes

Teacher motivation and enthusiasm was identified as an important attribute for the teaching of collaboration. Students’ negative perceptions of collaborative group work often also affect an instructor’s own perceptions of collaborative assignments (Stephens & Myers, 2000). Snyder (2008) argued that to counter students’ negative perceptions, teachers need to be enthusiastic and positive about the collaborative aspects of student learning.

In addition to those identified by researchers, other teacher attributes were inferred including knowledge of collaborative principles/theories and processes, and capabilities in facilitating and managing groups. This includes the ability to empathise with group members, watching and intervening when necessary.

8.22 Collaboration mechanisms, student-related attributes and related teaching mechanisms and attributes

Based on further abductive and retroductive theorising, I inferred the following key collaborative mechanisms, student-related attributes, and teaching-related mechanisms that could influence students' exercise of mechanisms associated with collaborative practices in the learning environment. These are presented in Table 51 and Figure 101. In Table 51, new mechanisms that were identified are shown in bold.

Table 51. Collaborative mechanisms, student-related attributes, and teaching mechanisms

Collaborative Practices		
Design Thinking Mechanisms	**Student Attributes Influencing (Enabling/Constraining) the Probability of Design Thinking Mechanisms Being Exercised**	**Teaching Mechanisms and Related Teacher Attributes**
• Meeting • Getting to know • **Overcoming shyness** • **Becoming comfortable** • Talking/listening/perspective taking • Befriending • Aligning roles • Relationship building • Planning • Goal setting • Organising • Cooperating/helping/sharing • Negotiating • Compromising • Leading • Watching and reflecting on other teams • **Individual and group self-reflecting**	• Conceptual and procedural knowledge • Preconceptions of collaboration (often based on previous experiences) • Maturity/emotional intelligence • Shyness with other group members, especially when not knowing them • Motivation • **Work ethic** • Empathy • Disciplinary empathy • **Gender attitudes, including female role stereotypes** • Flexibility • Openness/friendliness • Confidence • Communication style • Ego • Cultural perspectives	A. Teaching Mechanisms • **Orienting to collaboration** • **Selecting and allocating team members** • **Presenting collaboration theory** • **Facilitating positive attitudes towards collaboration** • **Facilitating collaboration exercises/training** • **Parameter setting (structure giving)** • **Actively monitoring** • **Meeting with teams** • **Intervening** • **Facilitating peer to peer communication** • **Negotiating** • **Encouraging the observation of other teams** • **Facilitating individual**

	*Acknowledged more general learner attributes • Attentive • Motivated • Wanting to make sense • Wanting to remember * For each of these generic attributes there are associated mechanisms e.g., attending mechanisms	**and** • **ongoing group reflection** • **Assessing both individual and group learning** B. Related Teacher Attributes • **Motivation/enthusiasm** • **Flexibility** • **Knowledge of collaboration theory and principles**
Note: There were other conditions in play in the learning environment influencing (enabling/constraining) the probability of design thinking mechanisms being exercised. This included the influence of the mechanisms of other entities such as other students.		

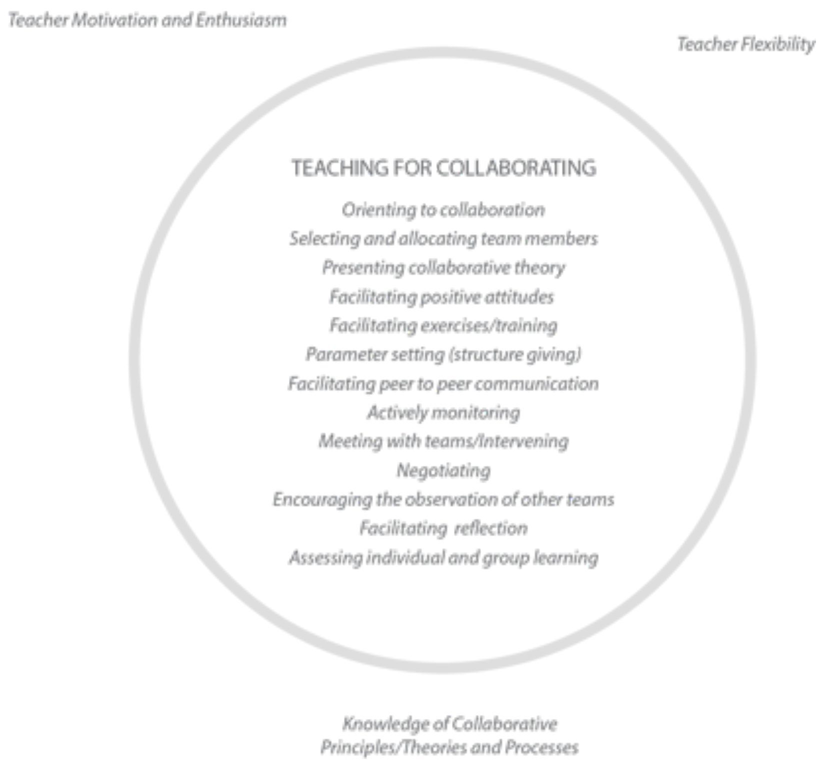


Figure 101. Summary of teaching mechanisms for collaborative practice and related teacher attributes

8.23 Curriculum enhancement

Based on further abductive and retroductive theorising, I inferred the following key collaborative mechanisms, student-related attributes, and related teaching mechanisms that could help students exercise collaborative mechanisms. Based on the explanatory theory, I identified key opportunities to further develop the curriculum. These are presented in Table 52.

Table 52. Summary of curriculum enhancement opportunities

Curriculum Entity and Aspect	Description of Potential Enhancements
Content	
State of Grace document	Introduce a *State of Grace* document that can be co-created by group members to help build and maintain a high quality relationship between group members during the project/course.
Teaching	
Orientation (Preconceptions of Teamwork Cognitive Styles)	Facilitate the identification and discussion of students' negative preconceptions of teamwork, reframing as opportunities for success.
	Facilitate discussion re learning and other cognitive styles that may impact group work.
Group Monitoring	Proactively monitor groups including watching for issues and problems, for example negative gender issues, lack of motivation or a group member impacting on others, miscommunication, and cultural misunderstandings.
Observation of other Teams	Facilitate students' observation of, and reflection on, the development and performance of other teams.
Teacher Guidelines	Update teaching guidelines to describe the various teacher behaviours, strategies and mechanisms that may help teach collaborative practices.
Manager Guidelines	Develop guidelines for managers to help identify appropriate teacher attributes, which align to effective teaching of collaborative practices.
Assessment	
Individual Assessment	Review assessment to incorporate more individual performance measures.

SECTION SIX: OVERALL SUMMARY TEACHING MECHANISMS AND TEACHER-RELATED ATTRIBUTES

Figure 102 presents an overall summary of the key teaching-related mechanisms (and teacher attributes) that I identified, which influence students' exercising of mechanisms associated with three key practice areas of design thinking.

Figure 102. Overall summary of teaching mechanisms and related teacher attributes informing the enhancement of the design thinking curriculum

8.24 The next chapter

In the next chapter I present and discuss a set of comparative case studies based on the findings of the three action research cycles.

CHAPTER NINE: COMPARATIVE CASE STUDIES

9.1 INTRODUCTION

In this chapter I present and discuss data analysis, and explanatory theory associated with four comparative case studies. As noted previously, the case studies were intended to provide opportunities to (a) identify possible context-related differences between cases that would have implications for explanatory theory and subsequent curriculum decisions, (b) verify/test explanatory theory, and (c) assess the practical adequacy of such theory when it is the basis for curriculum decisions.

Four case comparisons were undertaken:

A. Case Study One and Two (the first enactment of the curriculum with product design students and the second enactment of the curriculum with business students).
B. Case Study One and Three (the first enactment of the curriculum with product design students and the third enactment of the curriculum with product design students).
C. Case Study Two and Four (the second enactment of the curriculum with business students and the fourth enactment of the curriculum with business students).
D. Case Study Three and Four (the third enactment of the curriculum with product design students and the fourth enactment of the curriculum with business students).

In the first sections, I present the results of correlational analyses of the questionnaire quantitative data for the four comparative case studies. In the following two sections, I categorise and compare key tendencies in students' description of their response to the curriculum. identified from the qualitative data described in the individual case studies to identify alignments and areas of contrast. Analytic categories used included: overall student experiences; impacts of the curriculum on learning; design thinking work outcomes; and students' design thinking practices. The findings of the comparative case studies were drawn on when I engaged in a final theorising process, drawing on the outcomes of the three action cycles.

Quantitative data analysis

A correlational analysis of quantitative survey data was undertaken using a Mann Whitney U Test (Mann & Whitney, 1947). The goal was to identify any significant differences in the distribution of students' responses to survey questions associated with the development of their design thinking expertise. Based on the sample sizes, a 'U' value of fewer than 30 was used to identify examples of significant difference. Examples of significant difference were further analysed using median scores.

It is important to note that given time and resource constraints, not all of the possible case comparisons were made. The four that were selected fulfilled the following criteria: they compared curriculum enactment with both contrasting cohorts of students (i.e. product students with business students), and with similar cohorts of students (i.e. product students with product students), along with the first sequential enactment of the curriculum (i.e. comparing the first enactment with the second enactment). While other comparisons were possible, (e.g. first cohort of product design students and the second cohort of business students), I did however compare tendencies evident in the qualitative interview data for these cases (see Table 50.), and used abductive analysis to develop related explanatory theory where differences were evident.

9.2 Comparative Case Study A

Comparative Case Study A compares Case Study One (enactment of curriculum to first cohort of product design students), with Case Study Two (enactment of curriculum to first cohort of business students).

9.2.1 Mann Whitney U Test (Correlational analysis of survey data)

The correlational analysis of students' responses to survey questions associated with their ratings of expertise development identified two instances of significant differences in the distribution of responses of the two student cohorts. There was a significant difference between the product design and business students' rating of their capability to collaborate with others in a team environment ($U = 27$, $Z = 1.88$). The median rating for the product design group was 4/5 (mean rating = 4.08), while the median rating for the business group was 3/5 (mean rating = 3.2).

There was a significant difference in the product design and business students' rating of their capability to draw ($U = 11$, $Z = 2.8$). The median rating for the product design group was 4/5 (mean rating = 3.6), while the median rating for the business group was 3/5 (mean rating = 3.0).

9.3 Comparative Case Study B

This comparative case study compares Case Study One (enactment of curriculum with the first cohort of product design students), with Case Study Three (enactment of curriculum to the second cohort of product design students). It is also important to note the scope of the analysis in the third enactment of the curriculum was limited to three design thinking practice areas: empathic research practices (Investigate stage); creative practices (Create stage); and collaborative practices. The tendencies that I identified and discussed were therefore predominately limited to these three areas.

9.3.1 Mann Whitney U Test (Correlational analysis of survey data)

The correlational analysis of students' responses to survey questions associated with expertise development indicated a very high level of correlation between both cohorts of product design students. No instances were identified of significantly different responses from the two cases studies.

9.4 Comparative Case Study C

This case study compares Case Study Two (enactment of curriculum with the first cohort of business students), with Case Study Four (enactment of curriculum to the second cohort business students).

9.4.1 Mann Whitney U Test (Correlational analysis of survey data)

The correlational analysis of students' responses to survey questions associated with expertise development indicated a very high level of correlation between both cohorts of product design students. No instances were identified of significantly different responses from the two cases studies.

9.5 Comparative Case Study D

This comparative case study compares Case Study Three (enactment of curriculum with the second cohort of product design students) with Case Study Four (enactment of curriculum to the second cohort of business students).

9.5.1 Mann Whitney U Test (Correlational analysis of survey data)

The correlational analysis of students' responses to survey questions associated with expertise development indicated a very high level of correlation between the cohorts of product design and business students. There were no instances identified of significantly different responses from the two cases studies.

9.6 Qualitative data analyses

Table 53 was developed to categorise and compare the tendencies that I identified in the findings of my qualitative analysis of student interviews, my reflections as the curriculum designer and a teacher, and my review of student portfolios. The table was structured around key aspects of the curriculum development framework that I had utilised in the initial curriculum design. I then looked for tendencies across each of the case studies that were in a similar topic area and aligned them under the appropriate heading in the table. When I could not find another tendency to compare, I left the table blank. In many cases, the tendencies that I identified in each area or topic were the same or similar (i.e., the same tendency was identified) or they were significantly different (i.e., there was a notable difference). Through this process I was able to build up a rich picture of patterns in the tendencies that I identified.

Table 53. Tendencies across case studies

Case Study One Product Design Students (Action Research Cycle One)	**Case Study Two Business Students (Action Research Cycle Two)**	**Case Study Three Product Design Students (Action Research Cycle Three)**	**Case Study Four Business Students (Action Research Cycle Three)**
Tendencies relating to student experiences (Students reported)			
A very positive overall learning experience.	A very positive overall learning experience.	A very positive overall learning experience	A very positive overall learning experience.
			Some apprehension regarding the course, before it commenced
	The first few weeks of the course were challenging. This included a general feeling of confusion by many students.		A level of uncertainty about the direction of the course early on. It appeared that class attendance was low for some group members earlier on in the course, and quite a few groups were slow to meet outside of the class and to get underway.
Class morale lifted during project in comparison to previous projects.	Early enthusiasm tended to reduce during the middle stages of the course	A loss of momentum through the middle parts of the project	
The tight structure of the project was enjoyed.		The tight structure of the project and design thinking techniques were enjoyed.	
The experiential learning approach including workshops with structured presentations and associated activities was generally enjoyed.	There was some difficulty engaging with the experiential learning approach, which focused on 'doing' first, rather than theory-based lectures.		The interactive learning approach was enjoyable, and was different to previous learning experiences. Group collaboration was identified as a specifically enjoyable and meaningful aspect of the course.
Tendencies relating to impacts on learning			
	Initially (?)there was very		

	low, or no understanding at all of what design or design thinking was, what the class was about, and what would be involved pre enrolling in the course.		
The project significantly impacted design thinking expertise development, although most students had a generally high rating pre-project.	The course significantly impacted development of design thinking expertise. Overall, conceptual understanding of design thinking appeared to 'click' towards the end of the course for many student.	The project positively impacted students' abilities to manage the design thinking process.	The course positively impacted development of design thinking expertise.
The biggest impacts of the project were on personal knowledge and understanding of design thinking methods, practices and processes.	A significant impact was on conceptual knowledge and understanding of design thinking. Knowledge of design thinking processes and methods was also a significant learning.	Design thinking methods and practices were important learning outcomes. The development of knowledge about the creative process was also identified as specifically beneficial, as was collaborative practice.	The course positively impacted students' creative and teamwork practices. Ability to collaborate was identified as a key learning outcome.
Design thinking expertise could be applied to their future studies and work and the design thinking model (template) was ideal for future design projects.	There was a strong potential for transfer of expertise to other courses that they were taking.	Creative practices could be utilised in their future work.	
Tendencies relating to overall design thinking outcomes			
Work outcomes (final ideas and concepts in relation to the brief) were strong, although portfolio documentation was generally thin.	Creative concepts were not as strong, i.e., not as creative nor as well developed and refined, as concepts produced by the product design students in Action Research Cycle One	Designed outcomes were good (not overly strong) overall with reasonable responses to the project brief.	
Portfolios appeared more thorough and comprehensive in the research stages.	Portfolios tended to have more focus on, and a greater volume and depth of work, in the earlier stages of the design thinking process, rather than the latter stages.		
		There appeared to be good engagement and documentation of brainstorming and other creative methods.	Student engaged strongly with Brainstorming, Lotus Blossom and other creative practices, as was evident with general high level of documentation of the creative process.
Outcomes, while strong, were very architectural, and spatial in orientation, with no service orientated proposals.	Concepts tended to be large scale and somewhat grandiose responses, rather than simple, innovative proposals. Some concepts incorporated service aspects.	Designed outcomes were mostly products, with no service orientated (or service augmented) proposals.	Final concepts tended to be service oriented ideas (such as providing types of services for students to enhance their safety), rather than graphic, spatial and product.
Tendencies relating to design thinking practices			
Empathic research practices (Investigate Stage)			
	There was lack of in depth understanding around the	It was challenging trying to get male group	

	purpose of the empathic research practices	colleagues to engage with the empathy research	
Observation, interviewing and roleplaying practices were difficult and challenging but had a significant impact on learning.	Design thinking empathic research practices were particularly challenging.	Interviewing and observation was personally challenging but also very rewarding.	Interviewing and observation were challenging.
	Many groups did not utilise the roleplaying practice during empathic research.	Most groups didn't engage with the roleplaying practice, even though it was highly recommended	Roleplaying was particularly challenging.
		Some groups weren't effective in their initial observation and interview work, and identified that they should have gone back and repeated the methods. Going through the empathy research methods twice would have helped students gain a much deeper understanding of people's perspective.	Groups could have pushed their observations further.
		Focusing on people with physical disabilities was identified as specifically meaningful and a key turning point in project	The interview practice was particularly useful, and specifically interviewing people who had very different needs and perspectives (such as those with disabilities) was very powerful for developing deep empathy.
		Having a better explanation of the rationale and the reasons for engaging with the various empathy research techniques and processes may have helped students focus more.	
Problem reframing practices (Reframe Stage)			
Personas dominated students' focus.	Students were very motivated and engaged when utilising the persona development practice.	The persona development practice was enjoyable, but it was also noted that it 'got a little out of hand'.	
There was a struggle to understand and identify a human need.	There was difficulty in 'unpacking' the findings of empathic research, and to dig beyond surface level observations and insights.		
Students struggled to write opportunity statement	Students struggled to reframe the original complex problem into a new opportunity statement. There was a lack of good research insights. There was an immediate impulse to jump to a solution rather than an opportunity statement. There was difficulty in writing an		

	opportunity statement clearly and succinctly		
Creative practices (Create Stage)			
			There was apprehensiveness and nervousness about the creative aspects of the course before it commenced.
	There was excitement and good engagement with the creative aspects of the course after the research practices.	There appeared to be excellent engagement with brainstorming and other creative practices, as was evident with general high level of documentation.	
Initial creative ideas and concepts were reasonable.	Initial ideas and concepts appeared naive and relatively unimaginative. Careful teaching interventions and facilitation, including the use of a new creative method, helped students push for more creative concepts.	Three of the five groups presented ideas that could be described as at a more radical end of the scale (i.e., very innovative and pushing the boundaries beyond existing ideas).	
	Divergent thinking processes were difficult, especially generating a wide variety of ideas and concepts.		
		The SCAMPER practice was identified as particularly challenging. Brainstorming method was both beneficial in the creative process, but also quite challenging.	The Brainstorming method was significant for the development of their creative thinking development. The use of Lotus Blossom was also significant and a positive turning point in the creative process.
			The development of knowledge of creative process was specifically beneficial to their creative thinking capabilities.
Concept development practices (Develop Stage)			
Drawing practices were relatively weak.	Drawing practices were very weak.	There was very little evidence of drawing and sketching in portfolios.	
		Shyness, and a lack of confidence about drawing was a barrier.	
There was generally a lack of intensive 3D prototyping in many groups	3D prototyping was one of the most fun, exciting and enjoyable aspects of the course		Prototyping was important in helping to 'see' and finalise concepts.
	Many students put too much effort into the model making, and were too 'precious' about changing ideas, when encouraged, i.e., not wanting to change or evolve their ideas once they had made a prototype.		
	There wasn't enough time		

	and support for the 3D prototyping practice.		
Collaborative practices			
	There were negative perceptions of teamwork and collaboration coming into the course. The high level of collaboration that was expected was something that many had not experienced before.		Students had low expectations of group work and the potential for success.
Experiences of collaboration significantly (sometime negatively) impacted their learning experiences.	Students' experiences of the whole course were closely linked to how they experienced their collaboration with their team. There was surprise about how well collaboration went, especially towards the end of the course when personal relationships had developed.	Students specifically enjoyed the collaborative group work. Some believed 'luck' was involved in successful group work.	Enjoyment of collaboration was emergent, and increased as the course evolved.
		There were issues around gender stereotypes and a female student noted struggles to overcome the attitudes of her teammates.	
		The emergence of group cohesion was emergent throughout the process.	
Socialisation, bonding and friendship were an important part of the collaboration process.		Friendship was identified as a significant component in the enjoyment and success of the collaboration.	Social relationships and friendship mechanisms were important in successful teams.
Problems with leadership negatively impacted some of the collaborative processes.	A lack of leadership and lack of motivation of some students negatively impacted other team members in a number of cases. Cultural misunderstandings negatively impacted some groups. Groups bigger than four or five members did not work well.	Problems with leadership and age (maturity) also negatively impacted some of the collaboration. The negotiation of creative differences, persuasion and compromise was as important as the creative aspects of teamwork.	Other students not pulling their weight negatively impacted group work. Competition between groups, while important in driving the groups along, seemed to ease towards the end of the course.
	Interventions and team facilitation by the teacher was essential in preventing one team from imploding.	Teacher and teaching interventions that positively impacted their collaboration.	There was a need for more structure and guidance on collaboration.
Reflective practices			
The self-reflection process was very unclear, problematic for many.	There were conflicting accounts of engagement with and usefulness of the reflective thinking aspects of the course from students. Many students hadn't grasped the fundamental concept, rationale, and importance of reflective thinking during learning.		
	The reflective thinking component (journal)		

	handed in by students was generally poor.		
Some students were not comfortable with public nature of online blog.			
Tendencies relating to curriculum structure			
Some students struggled with quickness of the pace of curriculum enactment, which impacted on their thinking.			
First half of the project appeared to have greater emphasis than the second half.	There was a stronger perceived weighting on the first half of the course.		
Tendencies relating to content			
There was a request for 'real world examples' and case studies of design thinking.			
	There was a request for more theory, and class discussions to help their conceptual learning .		
Tendencies relating to learning activities			
Lecturer presentations, videos, and class discussions were identified as particularly helpful for learning.			
Portfolio documentation was identified as less helpful for learning.			
Tendencies relating to teaching			
Teachers were enthusiastic, which was related to the new approach in department			
There were differing approaches between two teachers when team teaching was difficult to manage.			
The intensive style of teaching was quite stressful (a roller coaster journey). This was related to newness of approach in the department, and first time for the enactment of the curriculum. Teaching someone else's curriculum was identified as also difficult for teachers.		Teaching interventions were identified as significantly helpful in assisting groups work through problematic relationships and other problems and issues	
	Interventions and team facilitation by the teacher were identified as essential in assisting successful student collaboration.		
Assessment philosophy, activities and criteria			

were not delivered as effectively as they could have been.			
The ongoing debriefing (between the teaching staff and the researcher) was very useful for unpacking the 'journey', identifying issues and useful insights, and managing stress.	Ongoing discussion between teaching team was identified as essential to help debrief and identify issues, problems and opportunities for curriculum improvement.		
Tendencies relating to the physical environment			
Workspaces were not utilised well in first few weeks, especially a lack of effective use of wall space.			

9.7 Analysis of tendencies

In this section, I summarise key tendencies that were identified as occurring across a minimum of two or more cohorts of students.

9.7.1 Overall tendencies in student experiences

Students across all four cohorts reported very positive overall learning experiences following their participation in the programme.

There was, however, some variation in aspects of the curriculum that students enjoyed and a range of challenges and difficulties that impacted their experiences were identified. Both cohorts of product design students reported that they particularly enjoyed the 'tightness' of the curriculum structure and associated activities, while the third cohort (business students) particularly liked the interactive nature of the learning, which was in contrast to their previous learning experiences.

While all students reported very positive overall learning experiences, both cohorts of business students reported that they had found the first few weeks of the curriculum enactment challenging, and had difficulty in adjusting to the experiential learning approach. The business students' overall enjoyment of the curriculum, therefore, appeared more emergent than the product design students, and improved towards the end of the curriculum enactment when they had developed some basic conceptual knowledge and understanding of design thinking, which they didn't have before the course. In addition, the second cohort (business students), and the third cohort (product design students) reported that their focus, enthusiasm and momentum reduced during the mid-part of the curriculum enactment. This appeared related to students' difficulty in synthesising the findings of the empathic research practices, and with the practices associated with developing insights and reframing the problem. The students' mostly positive experiences of teamwork and collaboration were closely linked to the students' overall experiences of the curriculum enactment.

9.7.2 Overall tendencies in learning and expertise development

Students across all four cohorts reported that the curriculum very positively impacted their learning and development of design thinking expertise.

There was strong alignment across the views of the first three cohorts of students, who identified that the most important learning outcome for them was conceptual knowledge of design thinking, especially conceptual knowledge of the design thinking methodology in relation to design thinking methods, techniques and processes. The focus on conceptual knowledge development, rather than procedural, conditional and functioning knowledge, appeared to align with the novice-level of my initial expertise development framework (see 0: The 'Ideal' Design Thinking Curriculum, p. 106). Their development of conceptual knowledge related to creative practices, and was specifically identified as important by two cohorts, as was their conceptual knowledge of collaborative practices. Students in three of all four cohorts identified that they envisioned potential transferability of some or all aspects of design thinking to other areas of their study or practice.

9.7.3 Overall tendencies in design thinking outcomes

The student group portfolios from the first two cohorts demonstrated a greater emphasis on, and more documentation of, the orientation, empathic research and problem framing practices, rather than creative and concept development practices. This aligned with students' views in two cohorts that they perceived there was stronger emphasis by teachers on the first half of the curriculum. The content of the portfolios of the third and fourth cohorts suggested that they had given equal attention to content from across the programme when engaged in their design projects.

The overall quality, sophistication and refinement of design thinking work outcomes of both cohorts of product design students was generally higher than for the business students, although not necessarily more creative or innovative. This generally reflected the higher level of design (thinking) expertise of the product design students, pre-curriculum enactment. They were advanced beginners with respect to some aspects of design thinking.

There was variation in the types of 'designed' outcomes across all cohorts of students. The designed outcomes of the first two cohorts of students tended to be larger scale, and spatially and product orientated, while in contrast the outcomes of the third and fourth cohorts tended to be either product or service orientated.

9.7.4 Overall tendencies in design thinking practices

Themes and tendencies associated with various design thinking practices are outlined in the following sections.

9.7.4.1 Orientation practices (Orientate Stage)

As noted previously, both cohorts of business students reported having some difficulty in adjusting to the experiential learning approach. It is important to note that this was not reported by either set of product design students. Difficulties in the business students' adjustment appeared to be linked to the students' previous experiences of a more traditional lecture/tutorial based learning environment in the business faculty, which may have given students expectations of a more traditional learning environment, or a lack of preparedness for an experiential learning approach.

9.7.4.2 Empathic research practices (Investigate Stage)

Many students in all four cohorts experienced some difficulty in fully engaging with empathic research practices. This included finding interviewing and observing practices very challenging.

However, they reported that their engagement with these practices generally had an important and beneficial impact on learning. In addition, students of the third and fourth cohorts reported that they could have pushed further with their engagement with empathic research practices, or should have repeated them to help gain a much deeper understanding of the perspectives and needs of other people. The roleplaying practice was specifically identified as very challenging, with three of the four cohorts of students either engaging poorly with the practice, or not engaging at all.

There was a strong alignment between the third and fourth cohorts of students in relation to interviewing people with disabilities. This was identified as a very powerful and meaningful experience, and facilitated a key turning point in the students' empathic understanding of the perspectives and needs of other people.

9.7.4.3 Problem reframing practices (Reframe Stage)

While problem framing practices were not analysed in Action Research Cycle Three (Case Studies Three and Four) due to the need to limit the scope of the analysis, three key tendencies associated with problem reframing practices were identified.

Students of the first three cohorts engaged strongly with the persona development practices and seemed to enjoy using them to capture and to help understand the types and categories of people that they had observed and interviewed. The personas that they created however were often quite 'shallow' and were fictional accounts rather than truly representative of the people they had observed and talked with. Documentation of personas also featured very prominently in the group portfolios.

In contrast, many students in the first two cohorts struggled with identifying human needs, and seemed to lack the cognitive or empathic ability to go beyond surface level needs (e.g., a need to rest, or a need to take a photo), to identify deeper emotional and psychological needs. As noted, this also may be related to their life-stage development as young adults with limited wider life experiences. In addition, many students also had difficulty translating their insights into clearly written and succinct opportunity statements.

9.7.4.4 Creative practices (Create Stage)

In the second and third cohorts, there was good engagement with the creative practices, such as the brainstorming practice.

As noted previously, while the final creative concepts were more developed and resolved by the product design students, the initial ideas of the business students were either as good or better, and more innovative than the product design students. The use of the brainstorming practice was particularly important for cohorts three and four, and in addition, the use of the Lotus Blossom practice was also identified as particularly important for the fourth cohort.

9.7.4.4 Concept development practices (Develop Stage)

Drawing practices were identified as weak across all four cohorts of students, although the capabilities of the product design students were clearly better than those of the business students.

In contrast to drawing, there was better engagement with 3D prototyping practices from all cohorts, with the business students particularly enjoying the 3D prototyping process. While not a tendency that was identified across other cohorts, students in the second cohort (business students), while enjoying and actively engaged in prototyping, invested more time and effort in developing refined and 'finished' prototypes rather than using them as concept development tools.

9.7.4.5 Collaborative practices

Concepts, experiences and impacts of teamwork and collaboration featured prominently in the interviews with students.

As noted previously, students of three cohorts enjoyed the teamwork and collaborative aspects of the curriculum. Their experiences of collaboration appeared to be closely linked to how they experienced the curriculum overall.

In contrast to the generally overall positive experiences of collaboration, many of both cohorts of business students reported negative preconceptions of collaboration at the outset of the programme, and had low expectations about their potential to engage in successful collaborative learning. Enjoyment of collaboration was therefore emergent for both cohorts, and generally improved throughout the curriculum enactment. Linking with their low expectations pre-curriculum enactment, students of both cohorts of business students expressed some genuine surprise that their own experience of collaboration was positive.

For students of three cohorts, experiences of collaboration were strongly characterised by personal bonding, socialisation and the development of friendships. Negative aspects of collaboration were linked to a lack of leadership (first three cohorts) and lack of motivation of other students (cohorts two and four). Other negative aspects were associated with cultural misunderstandings, creative differences, and the difficulty of working in groups of more than five members.

9.7.4.6 Reflective practices

While reflective practices were not analysed in Action Research Cycle Three, one key tendency was identified with the first two cohorts of students.

The students' engagement with reflective practices was generally very mixed, with the self-reflection process very unclear for some, and many students not grasping the fundamental concept, rationale, and importance of reflective practices during the learning process.

9.7.5 Overall tendencies in reaction to curriculum structure

The first two cohorts generally perceived that there was a greater emphasis by teachers on the first half of the curriculum enactment, especially with regard to the Investigate stage (empathic research practices) and Reframe stage (problem framing practices). This was reflected in the student portfolio documentation, with a greater volume of work documented for the first half of the portfolios.

9.8 Conclusions

While the quantitative analysis indicated few significant differences, the qualitative data did highlight some contrasts between the cohorts that had significant implications for the decisions regarding the design of 'ideal' curriculum. This highlighted the benefits of having both forms of data available. For all cohorts, the level of pre-curriculum enactment questionnaire ratings on many items was relatively 'high' which meant that there was not scope for shifts in ratings that could be statistically significant.

There were potential limitations in the questionnaire rating items. One example is a question over how readily students could make accurate ratings of their capabilities on the related factors. On reflection, I noted that they may have attached different meanings to some item statements, and may have needed more clarification of some concepts. These would be considerations for future research.

The data provided a helpful reminder regarding the variation that could be expected across all classes/teaching groups that may be greater than differences that might be expected between categories of students, e.g., differences between product design and business students.

9.9 The next part

In the next part, I critically discuss the key outcomes of my research in relation to my secondary research questions. This includes more refined conceptualisations, informed by critical realism, of learning, learning environments and curriculum, a design thinking expertise framework, a 'signature' learning environment for design thinking at university and associated 'ideal curriculum', and my reflections of the use of action research, case studies and an action research methodology. The proposed 'signature' learning environment and ideal curriculum for design thinking specifically utilises and incorporates findings reported in this chapter.

PART THREE: DISCUSSION AND FINDINGS

CHAPTER TEN: DISCUSSION

10.1 INTRODUCTION

In this chapter, I critically discuss the key research outcomes in relation to my subsidiary research questions. The implications of these outcomes for my response to the main research question are presented and discussed in the following conclusions chapter.

In Section One, I describe updated and refined conceptualisations of learning, learning environments and curriculum that are informed by critical realism. These are used to support subsequent discussions in the chapter. I also discuss the contribution of these conceptualisations to the small, but growing, body of educational research using a critical realist perspective. These conceptualisations are used to help present and discuss a refined conceptualisation of design thinking, which I present and discuss in Section Two. In Section Three, I note key tendencies that are summarised in Chapter Twelve.

In Section Four, I present and discuss a 'signature' learning environment for design thinking, a design thinking expertise framework, along with implications for the design of an 'ideal' design thinking curriculum. In Section Five, I review and discuss issues, challenges and opportunities afforded by an application of a critical realist theorising methodology within case studies, which formed units of analysis within action research cycles. This includes a framework that I developed to analyse four key tendencies, which emerged from the curriculum enactment, and were identified in the comparative case studies.

SECTION ONE: CONCEPTUALISING LEARNING, LEARNING ENVIRONMENTS, AND CURRICULUM

How can learning, learning environments, and curriculum be conceptualised, designed and evaluated using critical realist frameworks and approaches?

One of the key goals of my research was to design and evaluate a design thinking curriculum using a critical realist perspective, and to further enhance it using an approach that integrated three methodologies: a critical realist theorising methodology, case study and action research. In designing and evaluating the curriculum, it was necessary for me to firstly conceptualise what a curriculum was, along with learning environments, as well as design thinking. It is important to note that my conceptualisations progressively evolved throughout each of the action research cycles, in parallel with my deepening critical understanding of critical realism.

These conceptualisations, and associated models, are presented as discrete findings of my thesis, and have been essential for subsequent discussions throughout the chapter.

10.2 Background

The conceptualisations presented in this section were essentially derived from the work of Roy Bhaskar (1978, 1979), the initiator and proponent of the critical realist movement (Shipway, 2010). Bhaskar provided much of the fundamental theory that positioned critical realism as an alternative to the long established paradigms of objectivism (positivism) and subjectivism (constructivism/constructionism) (Scott & Bhaskar, 2015). His concepts included important distinctions between a transitive realm of 'knowing', and an intransitive realm of 'being'. He also proposed that there are multiple perceptions about a single, mind-independent reality (Healy & Perry, 2000); knowledge is constructed and therefore fallible; and phenomena have a layered ontology. These propositions are an essential element of all the conceptualisations presented in this section. As noted in Chapter Three: Paradigm Position, Bhaskar's layered ontology model consists of the empirical layer (experiences), the actual layer (activities, events, and outcomes), and the real layer (objects or entities which have properties that give them powers [mechanisms]). When these powers are exercised, they generate effects that may or may not be observed or experienced within open systems (Scott & Bhaskar, 2015). Mechanisms themselves are not observable, but can be postulated, described and tested using retroductive and abductive reasoning. In a process of *discovery*, these reasoning processes can provide the researcher with a 'realistic' or 'practically adequate' understanding of the complex operation of phenomena.

10.2.1 Learning as a layered phenomenon

Figure 103 illustrates how I have applied Bhaskar's layered ontology model to the phenomena of learning. Layer One corresponds to the experiences of the learner, while Layer Two corresponds to the activities, processes and outcomes of the learning process. Layer Three corresponds to the generative mechanisms that operate interactively to generate emergent learning outcomes, and learner experiences, but are un-observable.

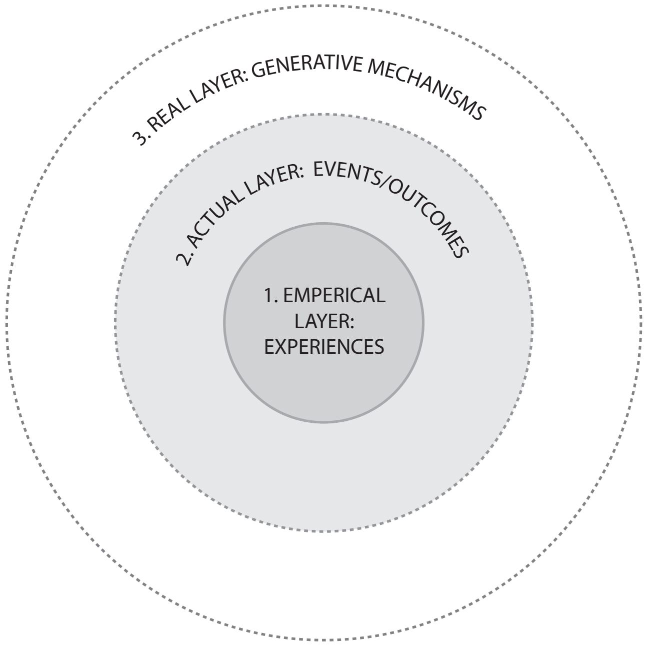


Figure 103. Layered ontological model of a learning environment

10.3 Conceptualising learning

Based on the outcomes of the current research and the concepts described above, the following statements represent my updated and more refined conceptualisations of learning.

(a) *Learning is a mechanism, or group of mechanisms, that gives people the power (empowers them) to change their own knowledge, mindset or sensory motor attributes.*

(b) *Learning is an outcome, which is a change in someone's knowledge, mindset (attitudes and values), or sensorimotor attributes that has occurred because they have exercised their learning mechanism/s.*

(c) *The purpose of learning is to help people realise or fulfil their ultimate potential.*

A number of other concepts and propositions underpin these conceptualisations. For example, a ‘general’ learning mechanism subsumes a range or group of more specific mechanisms and certain mechanisms can be aligned with certain attribute changes, and vice versa. Table 54 identifies examples of groups of learning mechanisms and their potential relationship to changed attributes.

Table 54. Examples of learning mechanisms and changed attributes

Learning mechanisms	Changed attribute
Such as *analytical* thinking, *reflective* thinking, and *reflexive* thinking etc.	Mindset
Such as *listening, looking, analytical thinking,* and *synthetic thinking*, etc.	Conceptual knowledge
Such as *making*, *constructing*, and *reflecting* etc.	Sensorimotor skill

Specific learning mechanisms may be enabled or constrained when the mechanisms of other entities (for example, teacher mechanisms) are exercised or activated. There are, therefore, contingent relationships between learning mechanisms and the mechanisms of other entities. The relationships between these mechanisms are also iterative and cyclic. Learning as an outcome cannot be attributed to the additive effects of all of the mechanisms involved. Rather, learning outcomes (changed attributes) represent emergent phenomena. Figure 104 illustrates the relationships between learning-related design thinking attributes and the influence of mechanisms of other entities.

In addition, the attributes of the learner may also influence (enable or constrain) their own potential to exercise specific learning mechanisms and, in turn, to change personal attributes. This reciprocal relationship, which is shown in Figure 104, acknowledges the reciprocal relationship that Bhaskar proposed to be occurring between structure and agency (Bhaskar, 1979).

While the existing attributes of a structure (entity) determine the mechanisms that it can exercise, agency gives people the power to change the attributes of structures, including their own. Changed attributes can lead to changed mechanisms.

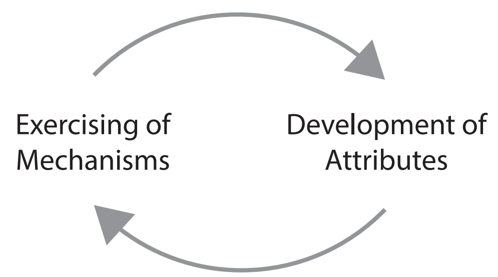


Figure 104. The reciprocal relationship between mechanisms and attributes

The following example illustrates how these concepts have been used to provide an account of events and outcomes in a particular design thinking learning situation.

> A student's exercising of their collaborative mechanisms (i.e., *meeting, befriending, negotiating, sharing, arguing, and critiquing*), along with their exercising of other learning mechanisms (i.e., *looking, seeing, and analytical thinking*), influences a change in their personal attribute/s. This could include a change in their conceptual knowledge concerning collaboration, and their collaborative mindsets. Their potential to exercise their collaboration mechanisms is also influenced (enabled or constrained) by the mechanisms of other entities, such as teacher mechanisms (i.e., *inspiring, and intervening*). The changed collaboration knowledge and mindsets, in turn, influences (enables or constrains) their ability to further exercise their collaborative mechanisms. The latter, in conjunction with other mechanisms, improve their ability to engage in collaborative design thinking practices.

10.3.1 Further discussion

These ideas and models provided me with a unique way of describing and explaining the complex and interactive process of learning from a critical realist perspective.

My critical realist conceptualisations of learning owe a great deal to the work of G. Brown (2007, 2009). Brown, building on the work of Bhaskar and others, proposed an 'ontological turn' in education, by challenging and integrating existing objectivist and subjectivist perspectives on education, and suggesting critical realism as an alternative. Most importantly for me, he described in rich detail the theoretical construct of a learning environment, which he defined as an assembly of entities, which have mechanisms that operate interactively to drive individual and collective learning. Brown also described the learning environment as having a layered ontology, whereby these mechanisms sit beyond experiences and observed outcomes, but can be postulated and their operation studied.

While G. Brown (2007, 2009) provides a rich description of a learning environment, he does not offer a detailed description of the internal learning process itself. A significant finding of the literature review in Chapter Two is that to date no authors and researchers have directly conceptualised learning as a *mechanism, or sets of mechanisms* per se, from a critical realist perspective. However, some authors have defined learning as an attribute development or change process from a critical realist perspective. For example, Scott and Bhaskar (2015) described learning as an epistemic or knowledge-producing process. Aligning closely with and validating my own conceptualisation, they described how knowledge development is central to three types of learning—cognitive (declarative, procedural or embodied), skill-based, and dispositional (habits of mind and body, and sensitivities). Case (2015) also identified morphogenesis (change) in the attribute of agency as an outcome of learning, in addition to knowledge development.

While not describing learning as a mechanism per se, other authors have explored the concept of mechanisms and their relationship to, or role in, the learning process (Crosthwaite et al., 2012; Huckle, 2004; Pratt & Gutteridge, 2006; Shipway, 2010). These authors have tended to focus on a realist social theory to develop a model of student learning. Kahn (2011), drew on and extended Archer's (2003) concept of *internal deliberation* (a learning mechanism) that, when triggered as a response to learning situations, could give rise to a variation in students' agency (an attribute). Kahn (2014) also explored mechanisms that contributed to *reflexivity* (including concepts of '*co-reflexivity*' or '*we reflexivity*'), *deliberation, motivation and metacognition* in higher education. These mechanisms are closely related to, and inform my understanding of, the collaborative practices that underpin the design thinking curriculum that I developed.

In addition to a focus on learning mechanisms and outcomes, my critical realist conceptualisations of learning also describe an emancipatory dimension (Easton, 2010; Kotta, 2011), which relates strongly to my own beliefs and values about the purpose and potential of education, and the conceptualisation of design thinking. A number of authors have also linked critical realist emancipatory concepts to education. For example, Bhaskar (2002) proposed it is "not so much learning of something outside, but as the unfolding of an implicit potential that human beings have" (Scott & Bhaskar, 2015, p. 60). Significantly for my own conceptualisation, Bhaskar also described people as being blessed with infinite potential (Scott & Bhaskar, 2015). Also validating my approach, Shipway (2010) proposed education and learning as an emancipatory endeavour, especially the "freedom of individual agents, not whole societies, for it is only through the former that the latter becomes possible" (p. 332). More recently, Kahn (2015) argued that the generative mechanisms of the methodologies utilised in higher education research have the potential to influence the emancipatory potential of higher education teaching. These views align with my own personal view that the purpose of education (and associated curriculum), and the role of educators and educational researchers, is to help people fulfil this emancipatory potential. These views also align with the emancipatory agenda of design thinking.

My work builds on and extends the generally theoretical work of a range of authors and researchers described above and offers concrete examples of the way critical realist constructs and propositions may be represented in a higher education context. These core concepts form the foundation of my more externally focused conceptualisations of learning and teaching environments and curriculum, discussed in the following sections.

10.4 Conceptualisations of learning environments

Building on my conceptualisation of learning, I define a learning environment as:

> *An open and dynamic system consisting of multiple entities, which have mechanisms that may enable or constrain learner mechanisms and therefore influence the probability that learning outcomes occur.*

This definition goes beyond views of learning environments as either the physical location of learning, or an ecosystemic process of learning. It can accommodate both views.

There are several other concepts and propositions that underpin this definition. For example, the entities within and beyond a learning environment are both numerous and layered. Examples of such entities include government tertiary education strategy, institutional learning and teaching plan, disciplinary perspective on university learning and teaching, the classroom physical environment, information and communication tools, teachers, other students, students' family members and friends. The mechanisms of these entities interact in very complex ways to influence the probability that learning mechanisms will be exercised by students, and learning outcomes will occur.

To help define the boundaries between layers in a learning environment, I utilised concepts of *macro*, *meso* and *micro* levels of influence proposed by Fanghanel (2004). Xiaomin (2010), referring to Fanghanel's concepts, described these layers of influence as being the *macro-level*, which includes a high-level global context, educational movements, and national educational policy; the *meso-level*, which includes discipline and department culture, colleagues, and teaching groups; and the *micro-level*, which includes epistemological knowledge, pedagogical beliefs, and personal reflections. In addition to these levels, Singh (2015) noted that there were also *individual* and *sub-individual* levels of influences on learning. Singh contended that the *individual-level* corresponds to pupils and their innate abilities, while the *sub-individual* level corresponds to subconscious motives (such as teacher or student motivation). I relate these to the attributes of students and teachers.

Figure 105 illustrates the layered relationship between entities and mechanisms in a learning environment. The entities and mechanisms within the immediate learning environment align with the micro-level, while mechanisms beyond the immediate general environment align with the meso and macro levels described above.

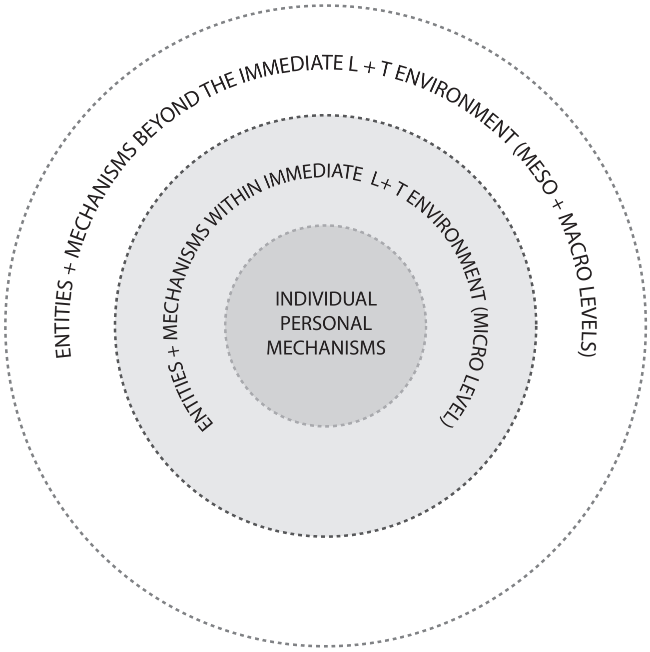


Figure 105. Layered view of entities and mechanisms within a learning environment

Table 55 provides examples of entities in the learning environment and their associated mechanisms that can be exercised or activated.

Table 55. Entities and mechanisms in a learning environment

L+T Environment Entity	Examples of Mechanisms (such as:)
Teacher	*Inspiring, providing information, guiding, intervening, discussing, and critiquing*.
Other Student/s	*Befriending, assisting, sharing, critiquing.*
Students' Friends	*Assisting.*
Learning Activity	*Informing, guiding, providing experience.*
Assessment Task	*Assessing and providing feedback.*
Learning Resources	*Informing and guiding.*
Physical Environment	*Providing space, warming, lighting, and support.*

It is also important to note that, given the large number of mechanisms and the complexity of their interactions, it was not feasible for me to investigate all mechanisms that may be 'in play' or operating in a learning environment. I therefore limited the scope of my investigation to key entities and mechanisms in the *meso*- and *micro*-level layers of the learning environment, with most attention given to those at the *micro*-level. I also focused in particular on mechanisms that I believed were mostly likely to directly influence students' exercising design thinking and learning mechanisms and that I could more readily influence or control.

The model presented in Figure 106 provides a further representation of this conceptualisation of the learning and development of design thinking expertise.

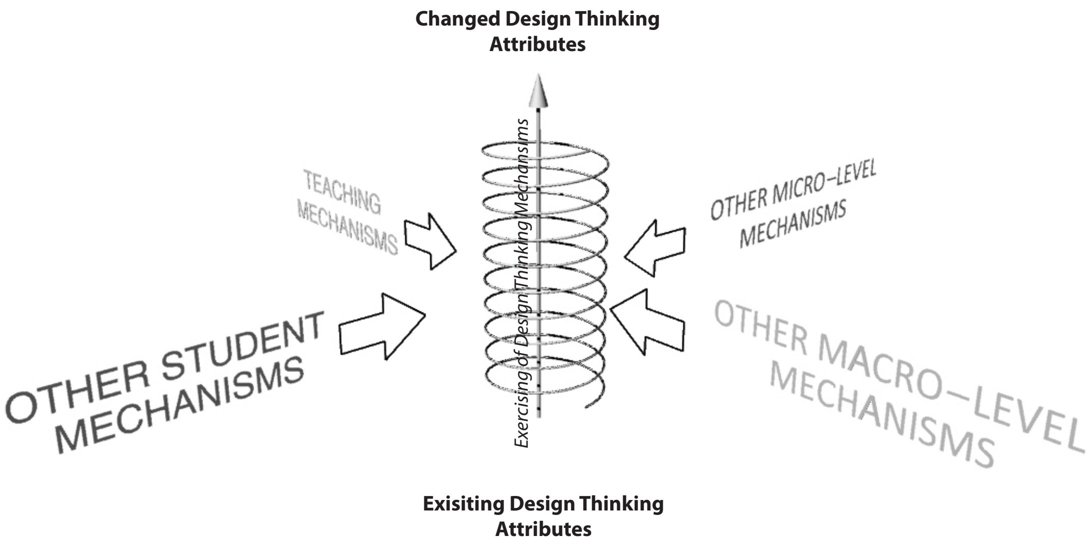


Figure 106. The influence of other mechanisms on the exercising of learning mechanisms, and learning outcomes

10.4.1 Further discussion

As noted previously, my conceptualisations of learning environments were essentially informed by the work of G.Brown (2007, 2008, 2009) and others (Crosthwaite et al., 2012; Scott & Bhaskar, 2015). Using critical realist concepts, Brown proposed that a learning environment is not just the physical location of learning, but is a porous, complex, open, and layered system, where learning outcomes are emergent, “enabled and constrained by multiple and often competing mechanisms”(p. 24), and with moral and ethical dimensions. While acknowledging Brown’s significant contribution, I identified opportunities to extend his primarily theoretical constructs, including the development of a critical realist model of learning (addressed in the previous section) and the development of a stronger link between the learning environment and the process of learning itself. In addition, I identified opportunities to develop a framework and descriptive model to help represent the range of entities and mechanisms that may be in operation. Most importantly, I identified the opportunity to apply these concepts to the further examination of an actual (‘live’) learning situation or context.

I noted that other authors have recently extended G.Brown’s (2007, 2008, 2009) conceptual model. For example, Nunez (2015) proposed a stratified, systemic model of a learning environment, with levels including a *micro-relation* level; an *emergent* level; through to a *normative* level; a *socio-cultural* level; and a *social-economic* level which, he argued, Brown left out. In a similar way, Tikly (2015) argued that it is important to consider levels and scales at which causality for learning needs to be considered, and proposed another layered model, from an *Individual* level (aligned with my own conceptualisation of individual learning), a *Microsystem* (aligning with my concept of a collaborative learning environment), through to an overall *Exosystem* level (comprising global and national policy). Both of these concepts helped me to further consider my conceptualisation of learning environment within a broader (structured) educational and social-cultural-economic context, all with causal mechanisms and influences that need to be considered. These models provide helpful variants of the levels or layers that Fanghanel (2004), Nunez (2015), and Tikly (2015) proposed.

Aligning with my own values-based views on learning (described in the previous section), I noted that other authors had also explored emancipatory views of learning environments such as Scott and Bhaskar (2015). In addition to G. Brown (2009), Mingers (2015) recently argued that a critical realism based learning environment in business schools can help students engage with 'real world' problems.

10.5 Conceptualising curriculum and curriculum design

Importantly, I conceptualise and define a curriculum as an entity separate from the learning environment, a view supported by G.Brown (2009). It is:

> *A socially constructed entity (a plan) that informs and guides the features of a learning environment (such as entities, attributes, mechanisms) that optimise the probability of effective student learning occurring.*

These views inform and guide decisions that teachers and students make about entities within the environment that they believe are open to their control or influence and that will help provide an optimal or 'ideal' environment. A curriculum is enacted when teachers and students act in response to the views; when they control or influence the properties and mechanisms of entities that are present (e.g., content, learning activities, learning resources and tools); and also respond to conditions such as alignment, location, sequence, timing and pace.

The following statement represents my conceptualisation of the curriculum design process.

> *The curriculum designer exercises design practices, with associated mechanisms to design a curriculum that defines the features (entities, properties and mechanisms) of an 'ideal' learning environment. The attributes of the designer that influence those mechanisms include their concept of a curriculum and their knowledge of curriculum design methodologies. The outcomes, when those mechanisms are exercised, will also be influenced by the designer's attributes —including their views about the purposes of*

education, their values, their theories about knowledge, learning and student development; and their disciplinary knowledge, pedagogical knowledge and pedagogical content knowledge.

This conceptualisation is represented in the following model (Figure 107), which also illustrates the relationship of action research to a design process.

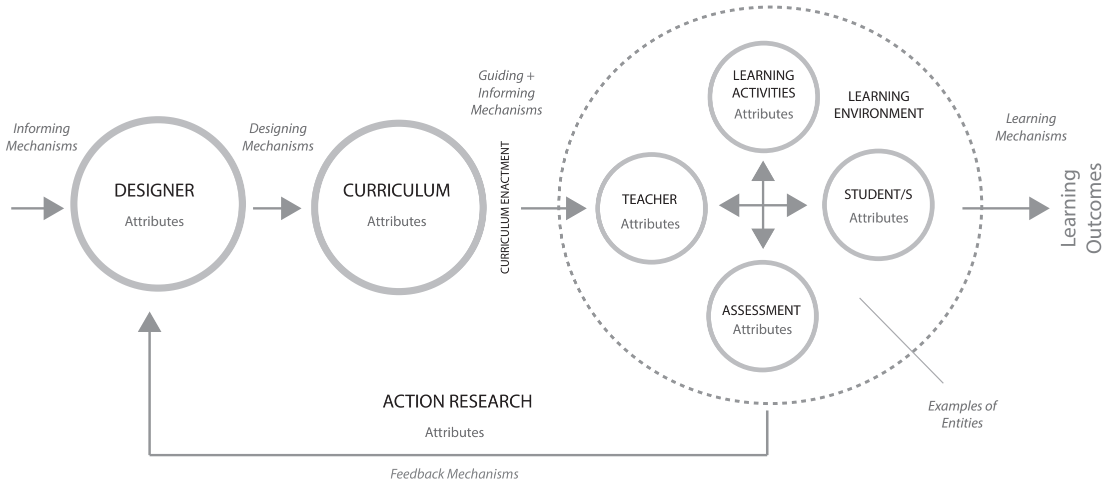


Figure 107. Relationships between the curriculum designer, curriculum and learning and teaching environments

While a number of researchers have explored specific aspects of curriculum from a critical realistic perspective (Case, 2015; Luckett & Luckett, 2009; Pereira, 2012; Singh, 2015; Vorster, 2010). In addition to G. Brown (2009), I identified only one other researcher who has specifically explored the curriculum design process from this perspective .

Vorster examined the cultural, structural and agential conditions that were taken into account and influenced the design of a curriculum for a journalist programme that integrated media studies and media production. She identified contrasting views on what a curriculum was; differing disciplinary perspectives; a range of specific design process mechanisms such as *collaboration* (consensus and compromise*)* and leadership (*leading*) and related considerations such as *timing;* and the role of agency in the development process. These conditions have parallels with the attributes and mechanisms that I have identified when defining a curriculum designer and the process that they engage in.

SECTION TWO: CONCEPTUALISING DESIGN THINKING

What is design thinking, when conceptualised from a critical realist perspective?

In this section, I present and discuss an updated and more integrated conceptualisation of design thinking that developed from my ongoing reflections, the outcomes of the research, and a further review of literature. This conceptualisation, which informed my decisions about the content and learning outcomes to be associated with the learning environment, is a discrete and significant finding from my research.

10.6 Conceptualising design thinking

The following statements represent my refined conceptualisation of design thinking. It includes views about design thinking as a methodology, the attributes required to apply the methodology and the intended outcomes of the methodology.

(a) *Design thinking is a methodology that incorporates a series of linked and iterative practices, which can be utilised by people to approach, reframe and solve ill-defined, 'real world' problems, across a diverse range of situations and contexts. These practices involve the exercise of specific design thinking mechanisms.*
(b) *Design thinkers are endowed with personal attributes including particular mindsets, knowledge and sensorimotor skills, which afford them the necessary mechanisms to apply a design thinking methodology.*
(c) *The outcomes of design thinking are defined as the optimal solution to a 'real world' problem. Designed outcomes can include, but are not limited to, products, spaces, graphics, services, business ideas, systems, organisations, experiences and processes.*

Some of these statements are now elaborated.

10.6.1 Design thinking methodology, practices and mechanisms

The concept of design thinking as a methodology which incorporates practices aligns with the view that design thinking is a structured process or methodology for innovation, underpinned by sequential or iterative stages, containing practices (sometimes referred to as methods) (G. Brown, 2008; T. Brown, 2008; Kumar, 2003; Liedtka & Ogilvie, 2011; Lockwood, 2010b). These practices may be utilised across or within individual stages.

Koria et al. (2011) presented an integrated framework that described practices, alongside cognitive approaches and mindsets, as the key components or elements of design thinking. Although not a structured design thinking methodology, this framework was developed from a literature review and interviews with key industry experts. These authors also argued that design thinking practices are related to the development of key competencies (or attributes as I describe them), which underpin cognitive approaches that result in the development of design thinking mindsets. This relationship between practices and the development of mindsets somewhat corresponds to my model of the reciprocal relationship (Figure , a couple of pages away).

In addition to the perspectives described above, Di Russo and Feast (2013); Kimbell (2009) have also defined design thinking as a practice, or way of practicing.

As noted earlier, I proposed that design thinking practices involve the exercise of interrelated mechanisms. Table 56 provides an example of a design thinking practice (3D prototyping) and identifies some, but not necessarily all, of the mechanisms that underpin the particular practice.

Table 56. Example of mechanisms underpinning a design thinking practice

	3D Prototyping
Mechanisms	Collaborating
	Reviewing/selecting
	Imagining/visualising
	Organising
	Constructing/joining
	Changing/reconfiguring/subtracting/adding

This view aligns with concepts of design thinking that emphasise the use of specific cognition and reasoning processes (Beckman & Barry, 2007; Cross, 2011b; Dorst, 2008; Goldman et al., 2012; Owen, 2007) and collaboration processes (Dym et al., 2006).

10.6.2 Attributes of design thinkers

Building on the L. Anderson et al. (2001) version of Bloom's (1965) learning outcome taxonomy, I have defined the attributes of a design thinker as the mindsets, types of knowledge, and sensorimotor skills which are necessary to the application of design thinking practices. It is important to note that my conceptualisation aligns closely with work by Nelson and Stolterman (2013), who proposed key competencies that a designer needs to develop: *mindset*, *knowledge set*, and *skill set*. Nelson and Stolterman also proposed a fourth competency, *tool set*. The concept of *tool set* aligns with the thinking methodology and set of practices I previously described in Section 11.6.1.

Design thinking attributes are developed by the designer thinker through the utilisation (experience) of design thinking practice(s) and the exercising of mechanisms. This view of design thinking aligns with Howard (2015), who in addition to mindsets and knowledge, included skills sets and tool sets when describing the utilisation of design thinking practices.

Table 57 presents examples of mindsets, which I concluded were core to design thinking.

Table 57. Design thinking mindsets, and associated definitions

Core design thinking mindsets	
Motivated	The personal motivation to utilise design thinking practices and cognitive processes
Optimistic	An optimistic outlook when approaching design thinking problems
Empathic	Sensitivity to the needs of others
Inquisitive	A motivation to ask questions and be inquisitive
Experimental	A personal drive to experiment, try and test new ideas and concepts
Emancipatory	A motivation to improve the lives of others

Each of these specific mindsets has also been identified by other researchers (T. Brown, 2008; Eagen et al., 2011; Hassi & Laakso, 2011; Koria et al., 2011; Owen, 2007). For example, Koria et al. (2011) identified experimental/explorative and optimistic mindsets as I have done.

While the above authors and researchers propose a range of mindsets, Howard (2015) and Howard, Senova, and Melles (2015) argued that there are two overarching mindsets: *design thinking as a way of work*, which is presented as a subset of *design thinking as a way of life*.

> Design thinking as a way of work is focused on the process of design thinking with the primary purpose of designing for outputs and innovation. Design thinking as a way of life is a holistic view of design thinking where the focus is on designing for transformation and creating positive change (Howard et al., 2015, p. 187).

Howard et al. (2015) argued that there is a range of individual design thinking characteristics that sit within these two key mindsets. For example, empathy, collaboration, creative thinking, visualisation and prototyping characteristics were included in the *design thinking as a way of work* mindset. Characteristics such as optimism, curiosity and holistic thinking characteristics were included in the *design thinking as a way of life* mindset. Importantly, and aligning with my research (see my expertise framework p. 113), they contextualised the two sets of mindsets within an expertise framework, or what they call the development of *maturity* in design thinking.

Based on my own experiences, and drawing on the Biggs' (1999) taxonomy of categories of knowledge, I identified the following types and examples of knowledge that design thinkers require (Table 58).

Table 58. Design thinking knowledge and definitions of the knowledge

Design thinking knowledge	
Conceptual (declarative) knowledge	Knowing the key concepts and principles of design thinking, what it is, why it is important, where it is useful, and what the attributes of a design thinker are.
Procedural knowledge	Knowing the design thinking process or methodology, key steps or stages, and key design thinking practices.
Conditional knowledge	Knowing when the conditions are appropriate to use and apply various design thinking practices (and to exercise associated design thinking mechanisms).
Functioning knowledge	Knowing why to employ, use and apply the design thinking methodology, and associated practices and mechanisms.

This view aligns with design thinking as having knowledge competencies (Howard, 2015; Howard et al., 2015; Nelson & Stolterman, 2013), or as knowledge development or construction process (Cross, 2011b; Howard et al., 2015; Müller & Thoring, 2010; Owen, 2007; Thoring & Müller, 2011).

As noted, while many researchers and authors refer to knowledge in the context of design thinking education, most do not explicitly describe types of design thinking knowledge as I do. Those that do identify several categories of knowledge include knowledge of methods and processes (Dym et al., 2006; Lugmayr et al., 2013), tacit knowledge (Dym et al., 2006; Rauth et al., 2010), knowledge about cognition (Tschimmel, 2006), creative knowledge (Rauth et al., 2010) and knowledge of how to implement design thinking (Lugmayr et al., 2013). Knowledge of methods and processes appeared to be the dominant knowledge type that researchers refer to.

Other than Thoring and Müller (2011) and Bruton (2010), I have not identified relevant and detailed examples of design thinking knowledge taxonomies similar to mine. For example, while Thoring and Müller (2011) proposed that design knowledge is developed (constructed), they describe knowledge at a physical level, such as embodied knowledge of 3D form, through four levels, which include a tacit level (intuitive design), and a symbolic level (the rules of design) through to a theoretical level. On the other hand, like me, Bruton (2010) identified the Biggs' (1999) knowledge taxonomy as useful in the context of a university-level curriculum, which in this instance was for a venture studio underpinned by design thinking. While referring to the Biggs' knowledge taxonomy, and the development of students' *functioning* knowledge of design thinking, he did not specifically outline how the Biggs' taxonomy nor levels of knowledge specifically relate to design thinking, nor how they might be developed by students in the studio curriculum, teaching or assessment processes.

10.7 Design thinking learning, learning environments and curriculum

Building on the concepts that I described in this section, and also in Section One, I summarise my conceptualisations of the learning of design thinking, learning environments for design thinking, and an 'ideal' design thinking curriculum.

10.7.1 Design thinking learning

The learning of design thinking is the:

(a) *Exercising of design thinking and learning mechanisms that facilitate the development of design thinking knowledge, mindsets and sensorimotor attributes.*

(b) *Change in knowledge, mindsets and sensorimotor skills that enable design thinking mechanisms to be exercised.*

There is a reciprocal relationship between processes and outcomes as represented in Figure 108. As design thinking mechanisms are exercised, design thinking attributes may change, and these changes in attributes may, in turn, enable new mechanisms to be exercised.

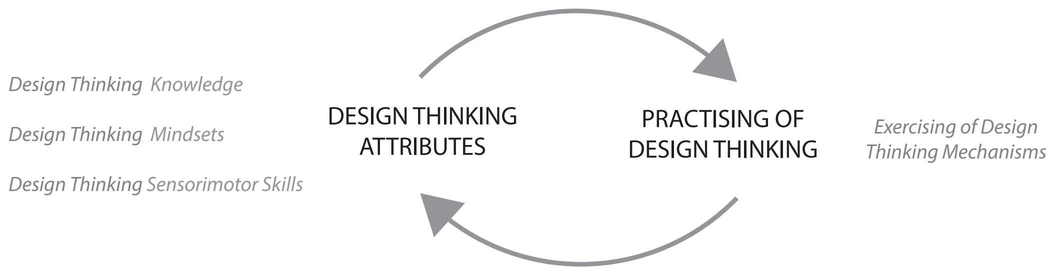
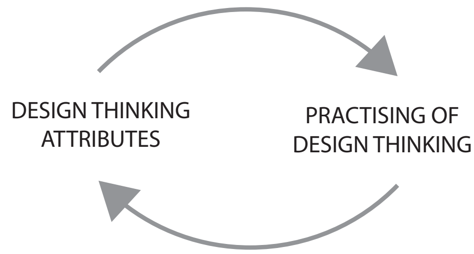


Figure 108. The reciprocal relationship between design thinking attributes and practices in the learning process.

This cyclical and reciprocal relationship model of learning can be further extended into a framework for analysing and describing relationships between the development of design thinking attributes (learning outcomes) and related practices (exercising of mechanisms).

Table 59. Example of the framework applied to prototyping practices

Prototyping practices		
Types of DT attributes		**Types of DT mechanisms**
1. Mindsets i.e., self-*efficacy and experimental mindsets.* 2. Knowledge i.e., *conceptual knowledge of materials and joining, and procedural knowledge of construction processes.* 3. Sensorimotor skills i.e., *hand-eye coordination.*		Such as *analytical thinking, organising, abductive thinking, creative thinking, selecting, cutting, joining, analysing, critiquing, discussing, rearranging, reflecting, and documenting*.

An ‘ideal’ learning environment for design thinking is:

> *An open and dynamic assembly of entities and associated mechanisms that positively influences the probability that students will develop design thinking expertise.*

An ‘ideal’ design thinking curriculum is:

> *A plan that informs and guides the features of a learning environment for design thinking that will make the probability of effective student learning as high as possible.*

10.8 Further discussion

Given its ability to bridge the socio-cultural and scientific domains, a critical realist perspective has allowed me to develop a unique, holistic (meta) and multi-dimensional conceptualisation of design thinking that incorporates, reinterprets and builds on other paradigm perspectives. For example, the critical realist perspective accommodates: (a) objectivist views of design thinking as a structured, analytical problem solving activity (Buchanan, 1992); (b) constructivist/constructionist views, which define design thinking as a ‘constructed’ process of knowledge development, or learning (Beckman & Barry, 2007; Conole & Alveizou, 2010; Cross, 2011b; Goldman et al., 2012; Lawson, 2006; van der Merwe, 2010); and (c) pragmatist views, which refer to the use of experiential knowledge and abductive thinking (Melles, 2008), situated logic of practice (Melles & Misic, 2011), emergence, transformation, the use of reflective practice (Dalsgaard, 2014), with the goal of practical and useful ‘designed’ outcomes. Critical realism has also highlighted the emancipatory orientation of design thinking, including a deep empathy for people, sometimes referred to as human-centredness (Eagen et al., 2011; Goldman et al., 2012).

In addition, a critical realist perspective allowed me to more deeply examine design thinking as a phenomena with a layered ontology, consisting of experiences, events and outcomes, which are emergent from the complex interaction of entities with generative mechanisms. Table 60 illustrates how this concept can be applied to the construction or modelling of a particular design thinking practice, which in this instance is brainstorming practice.

Table 60. Example of applying an ontological model to a design thinking practice

Layer	Description
Empirical (Recorded experiences)	The recorded experiences of individual designers, and the overall group that was involved.
Actual (Observed events, activities and outcomes)	The interactive process of Brainstorming, involving a group of design thinkers, in a particular physical location and environment. Outcomes include ideas and concepts in the form of sketches, notes, and models.
Real (Postulated mechanisms in play)	The interaction of the individual and collective mechanisms that the design thinkers exercise during the brainstorming process. These may include (but are not limited to) inspiring, sharing, talking, generating, abducting, synthesising, reflecting, challenging, critiquing, writing, drawing, and recording.

The perspective also assisted me to infer, describe and categorise many design thinking mechanisms, and group them into practices, which underpin an overall thinking process or methodology. It has also allowed me to describe and categorise the key attributes of design thinkers (that enables them to practice), and which form the basis of learning outcomes of an 'ideal' design thinking curriculum.

10.8.1 Relevant research

I identified one (unpublished) instance of another research project which investigated design thinking utilising a critical realist perspective (Di Russo & Feast, 2013)[13]. Di Russo and Feast applied key critical realists' concepts to the research and analysis of design practice. They described a research methodology that utilised retroduction to identify and describe generative mechanisms operating in a collaborative design process, conceived as having an ontological depth (level of layers from the empirical to the real). A limited number of mechanisms were identified including *difference, dynamic focus,* and *learning.* This research approach, while relatively limited, aligns with many of the concepts that I have developed.

[13] The paper was located on academia.edu website, and does not appear to have been formally published.

10.8.2 Summary

I believe that my holistic, integrated and multi-dimensional conceptualisation of design thinking is particularly useful as it provides an evidence-based response to recent suggestions that design thinking is too 'hyped' and uncritical (Stewart, 2011), and there is confusion about what it is, and how it is constructed (Carr et al., 2010). Critical realism has provided a framework to integrate existing (and sometimes contradicting) paradigm-based views, and has helped me achieve a deeper understanding of the design thinker, and their relevant attributes and the mechanisms they can exercise. Critical realism has also provided a useful and pragmatic tool for reframing the design thinking methodology as a set of practices that are applied through the exercise of specific mechanisms.

SECTION THREE: KEY TENDENCIES

What are key outcomes (tendencies) in relation to the enactment of a design thinking curriculum in a learning environment, students' experiences of the learning environment and their achievement of the intended learning outcomes?

How are those outcomes influenced by context differences, including the learning backgrounds of design and business students?

Key tendencies have been identified in the three chapters in which I report on the three action research cycles and in the previous comparative case studies chapter. The overall tendencies that were apparent across the three cycles and the case studies are also summarised in Chapter Twelve: Conclusions.

SECTION FOUR: TOWARDS AN 'IDEAL' DESIGN THINKING CURRICULUM

How do the attributes and associated mechanisms of a design thinking learning environment, informed by a curriculum, enable or constrain students' learning and development of design thinking expertise? What is a 'signature' design thinking learning environment, and associated 'ideal' design thinking curriculum?

In this section, I describe and discuss a 'signature' learning environment for design thinking, an updated and more detailed design thinking expertise framework, and an 'ideal' design thinking curriculum. I present the aims, content, framework for this curriculum, while the learning approaches and general recommendations for teaching strategies are presented in Appendix V.

10.9 'Signature' pedagogies

I decided that developing a 'signature' learning environment for design thinking would be an effective way to capture my learning, and express the key ideas and concepts that emerged from my research. To help establish my description of a 'signature' learning environment, I explored Shulman's (2005) concept of a signature pedagogy.

Shulman (2005) described a signature pedagogy as the characterisation of the educational approach, which most suits or aligns to the way a specific discipline or profession operates. Shulman contended that signature pedagogies are pervasive and routine, and have evolved because they facilitate student learning of professionally valued knowledge, and methods of doing things. Signature pedagogies therefore identify common learning and teaching approaches across groups of discipline areas, and distinctive practices (Horn, 2013; Shreeve, Sims, & Trowler, 2010; Shulman, 2005). For example, this may include the field trip used in geography, studio practice in architecture (Thomson, Hall, Jones, & Sefton, 2012), or the authoritative case dialogue method of teaching used in first-year law school (Shulman, 2005).

While acknowledging the virtue of well-defined and evolved professionally orientated approaches to learning, Shulman (2005) also warned that pedagogies can be dangerous sources of rigidity and perseveration, "forcing all kinds of learning to a limited range of teaching, necessarily distorts learning in some manner" (p. 56). In addition, Shulman noted that signature pedagogies can lead to a reinforcement of misaligned or poor approaches to teaching when they are based on teachers' own learnt experiences, or inertia that prevents approaches from evolving and changing.

I extended Shulman's conceptualisation of a 'signature' pedagogy to my concept of a 'signature' learning environment. I defined a 'signature' learning environment for design thinking as the optimal (i.e., the most appropriate and effective) assembly of entities and mechanisms that positively influence a student's development of design thinking expertise. A 'signature' pedagogy as Shulman described was therefore embedded within my concept of a 'signature' learning environment, i.e., the 'signature' pedagogy representing the values, learning approaches and teaching mechanisms within the learning environment. The 'signature' learning environment would be informed by my 'ideal' curriculum, and enacted by students and teachers.

10.10 'Signature' learning environments for design and business

To help me develop my final 'signature' learning environment, I believed it was useful for me to examine and briefly describe signature learning environments for both design and business education that have been described by other authors and researchers, and/or that I have experienced or observed. I utilised researchers' and authors' descriptions of 'signature' pedagogies of these discipline areas to help describe these learning environments.

10.10.1 A 'signature' learning environment for design

Acknowledging the broad range of design subjects and sub-disciplines associated with design, a signature learning environment for university-level design education could be generally described as one where students explore creativity through experiential learning approaches; produce diverse creative responses rather than the 'right answers' to design problems; learn in a studio space; experience a culture of ambiguity and risk taking (Shreeve et al., 2010); engage in experimentation and collaboration which is often unmediated by instructors; and engage with the design artefact as the focal point of instruction (Shulman, 2005). The studio environment often includes flexible workspaces shared with other students; open display of work with public discussion or critique as a key mode of instruction; intensive practice in hands-on work; under-defined briefs, such as assignments with minimal explanation for projects; and close working relationships with other students (Boling & Smith, 2014; Sims & Shreeve, 2012). Drawing, performance, recording of process and reflecting on the process were also noted. Other authors' characterisations of the signature pedagogy include the design brief as a way of structuring learning (Ozturk & Turkkan, 2006); iterative ideation; impromptu project reviews (Brandt et al., 2013); student centredness; personal physical spaces; field trips; access to experts; and formal juried reviews of project outcomes (Brocato, 2009).

These characterisations generally align with my own experiences of teaching design, and developing product design curriculum. I also identified a level of informality between teachers and students; projects lasting up to 12 weeks; learning activities such as short lectures; drawing and making sessions; intensive discussions and critique; one on one or small group conversations; reflective thinking; a focus on teamwork and collaboration; and assessment of design process as important characterisations of a signature learning for design education. Many of my characterisations, and the characterisations of others, generally aligned with dominant paradigm views of design, and therefore education as essentially subjectivist-constructivist (Conole & Alveizou, 2010; Cross, 2011a; Goldman et al., 2012; van der Merwe, 2010).

10.10.2 A 'signature' learning environment for business

While a wide array of learning and teaching approaches are adopted now in business education, some approaches have been identified as characteristic of some business-related subject areas. For example, in relation to business economics, Maier, McGoldrick, and Simpkins (2012) identified textbook-driven teaching; lecturing and whiteboard writing; and lecturer-student class discussions, rather than student-student discussions, as key aspects of a signature pedagogy. They also described learning approaches that emphasise teaching and learning about how economists 'actually think and practice', including through the use of abstract mathematical models and deductive reasoning which begin with assumptions about human behaviour rather than insights gathered inductively. Passive, content-focused learning sessions are prevalent. They did note some pedagogical change occurring over time, including the introduction of classroom experiments and more experiential learning approaches, such as classroom simulations of action markets. Hong, Essig, and Bridgstock (2012) identified guest lectures from entrepreneurs, case studies, business plan development and internships as key aspects of a signature learning environment for business entrepreneurship education. While over generalisation is a risk when 'signature' pedagogies/learning environments are proposed, some of these characterisations did align with educational approaches described by the business students in the informant interviews. When referring to approaches that they had experienced in business programmes and that were different from the ones they encountered in the design thinking programme, they noted highly structured learning sessions; lecture sessions with up to 300 students, followed by small tutorial groups; a concentration on the learning of information; limited interaction between teachers and students; a limited number of collaborative assignments; and exam-based assessments. These characterisations of others, in my view, generally aligned with paradigm views of business education as essentially objectivist/positivist.

10.11 A 'signature' learning environment for design thinking

A 'signature' learning environment for university-level design thinking is an environment where small groups of students collaboratively explore, reframe and propose solutions to 'real world' and ill-defined problems through project-based, augmented experiential learning approaches. Augmented experiential learning approaches align to students' level of design thinking expertise (see Section 11.6). For example, an experiential learning approach for a beginner-level of expertise includes tightly directed participatory workshops, learning activities, concise lectures, and/or video presentations. Students are supported with relatively extensive and detailed learning resources and supporting material such as case studies and theoretical models. For students who are at an advanced beginner or competent level of design thinking expertise, workshops and other learning activities are much less structured, with an emphasis on support and dialogue with teachers, rather than close direction. The approach acknowledges the need for 'scaffolding' which can be progressively reduced as students' design expertise develops.

Student-teacher relationships are informal and supportive, but also highly interactive and dynamic. Students from a non-design background who enter the learning environment for the first time, such as students who have only experienced a business 'signature' learning environment, are carefully and gently introduced and oriented to the design thinking learning environment through orientation activities and discussions.

The experiential learning approach is structured around engagement with and application of a structured design thinking methodology. The methodology consists of iterative and cyclic stages that contain individual design thinking practices. Students with a beginner level of expertise are introduced to each stage of the methodology and individual practices through the structured workshops and other learning activities, which encourage and support them to engage with and apply the practices. Extra support is given to students' engagement with, and application of, specific design thinking practices such as roleplaying, persona development and need identification practices.

Collaboration between members is carefully monitored and supported. Students are also supported to actively self-reflect on their learning in either a written journal or using an online blog. Assessment is based on evaluation of documented collaborative work outcomes, usefully aligning to each stage of the design thinking methodology, and should be presented in a group portfolio, which includes text and images. Individual self-reflections are also utilised as assessment events.

The physical environment for learning design thinking is a flexible and adaptable learning space that facilitates a range of workshop activities and other learning activities that are undertaken in collaborative groups, and support the learning approaches described above. For example, collaborative groups are supported to meet, plan and discuss ideas, as well as draw and sketch, and create simple 3D prototypes. Physical spaces have walls that allow for work practices outcomes, such as post-it note brainstorming, to be displayed and critiqued. The physical environment is as close as possible, within the limitations of university contexts, to a design studio.

10.12 Levels of design thinking expertise

As noted previously, the learning approaches that constitute entities within the learning environment should align with appropriate levels of student expertise. I therefore refined my initial design thinking expertise framework before I described my 'ideal' design thinking curriculum. The framework based on the H. Dreyfus and Dreyfus (1986); S. Dreyfus (2004) five-stage, novice to expert model was presented in Chapter 6: : The 'Ideal' Design Thinking Curriculum p. 106. The framework also draws on the L. Anderson et al. (2001) and the Biggs (1999) taxonomies of knowledge development. The framework presented in Table 61 describes the development of individual attributes of the design thinkers as they move from novice level to expert level.

Table 61. Updated design thinking expertise framework

Level	Description of design thinking attributes at expertise level
Novice Expertise (1 Year)	• Has fundamental conceptual knowledge of design thinking. This includes (but is not limited to) fundamental conceptual knowledge of what design thinking is, how design thinking developed and evolved, in what basic situations it can be utilised, and what constitutes the basic attributes of a design thinker. In addition, has fundamental conceptual knowledge of the underlying principles, methodology, stages and fundamental practices of design thinking. • Has fundamental procedural knowledge of an overall design thinking methodology. This includes procedural knowledge of the key stages of a basic design thinking methodology, and a limited range of fundamental practices that are associated with each stage. In addition, has knowledge of the very basic procedural 'rules' of the fundamental design thinking practices and in what order they should be utilised. • Is detached from the design thinking problem or situation. • Has a very basic human-centred/empathic outlook, and is developing a willingness to experiment and take creative risks. • Has very limited design thinking sensorimotor skills especially in regard to visual mapping, drawing and 3D prototyping practices.
Advanced Beginner Expertise (2 Years)	• Has good conceptual knowledge of design thinking, including (but not limited to) good knowledge of the principles of design thinking, the attributes of a design thinker, design thinking methodology, and associated range of design thinking practices. • Has good procedural knowledge of an overall design thinking methodology. This includes good procedural knowledge of the key stages of the design thinking methodology, and a procedural knowledge of a range of practices that are associated with each stage. In addition, has good knowledge of the 'rules' (steps and processes) of design thinking practices. • Is developing basic conditional knowledge of design thinking, such as beginning to know when and where to utilise design thinking. • Is still somewhat detached from the design thinking problem, and has limited situational awareness. • Is developing some optimism about personal ability to research, reframe and develop solutions to relatively complex design thinking problems.

	• Has a fundamental human-centred/empathic outlook, and a willingness to experiment and take risks with ideas through the creative process. • Has fundamental reflective thinking capabilities, and learns from reflection. • Fundamental visual mapping, drawing and 3D prototyping capabilities.
Competent Expertise (2-3 years)	• Has strong conceptual, procedural knowledge of design thinking. • Has very good conditional knowledge of design thinking. • Is developing basic functioning knowledge of design thinking. This includes basic knowledge of why/when/how to apply a design thinking methodology, and associated design thinking practices in relation to relatively complex, ill-defined problems • Feels emotionally involved and takes ownership of design thinking outcomes. • Is optimistic regarding personal ability, able to reframe and develop solutions to design thinking problems. • Has a strongly human-centred/empathic outlook, and is willing to experiment, take risks and be radical with ideas through the creative process. • Has strong visual mapping, drawing and 3D prototyping capabilities.
Proficient Expertise (3-5 years)	• Has very strong conceptual, procedural, conditional knowledge of design thinking. • Has strong functioning knowledge of design thinking in relation to complex, ill-defined problems. Acts in a rapid, fluid and involved manner. • Takes ownership of, and is deeply connected to, design thinking problems. • Perceives situations holistically, and is able to identify key features. • Intuitively adapts methodologies and practices from other areas, and creates own practices. • Is very optimistic regarding capability to reframe and solve relatively complex design thinking problems. • Has a very strong human-centred/empathic outlook, and can experiment, take risks and be radical with ideas throughout the creative process. • Is developing an emancipatory vision. • Has very strong and effective design thinking sensorimotor capabilities.
Expert Expertise (5+ Years)	• Works very holistically, intuitively, and relatively unconsciously, with deep tacit knowledge. • Adapts own practices to problem situations and works with high level of productivity. • Takes full ownership of, and deep emotional connection to, design thinking problems. • Has an emancipatory vision, and a strongly human-centred/empathic outlook, and is very experimental and radical with ideas. • Has expert-level sensorimotor capabilities across all areas.

10.12.1 Further discussion

I have not been able to identify other examples of the categorisation of design thinking expertise into levels, other than Howard (2015), and Howard et al. (2015). However, my framework does extend the work of other researchers who have conceptualised expertise in design (Cross, 2004, 2003; Cross et al., 1994; Dorst & Reymen, 2004; Lawson, 2004; Lawson & Dorst, 2009).

Dorst and Reymen (2004) identified a need to develop a good understanding of what design expertise was, and how this differed at various levels, as a basis for improving the teaching of design. They proposed that the H.Dreyfus and Dreyfus framework be used for this purpose with the proviso that it needed to be rigorously evaluated. More recently, Lawson and Dorst (2009) have warned that design is far more than a set of characteristics that can be reduced to such a simple framework. They do note, however, that by the time university design students have graduated, they would have moved from novices to more skilled designers. Cross (2004), building on previous research (Cross, 2003; Cross et al., 1994), described the difference between expert and novice designers. He noted that expert designers appear to be very good at problem scoping, very proactive in problem framing, and extremely productive, with little need to explore a wide range of ideas and concepts. This aligned with my description of expert design thinkers.

Recently, Howard (2015) and Howard et al. (2015) argued that there are variations between novice and expert design thinkers, and proposed a maturity matrix with quadrants relating to the two mindsets that they identified. For example, they noted that novice-level design thinkers who had a 'way of work' mindset were "new conceptually and practically to design thinking" and "novices in design knowledge, skills and experience" (Howard, 2015, p. 237). On the other hand, expert-level design thinkers had a 'way of life' mindset that recognised "…design thinking as a cognitive process discourse" and as "a discipline where a problem is understood and solution defined by moving through a design process" (Howard, 2015, p. 237).

While acknowledging parallels in the work of other researchers, the framework that I have developed provides an original and detailed description of design thinking expertise across the five categories proposed by Dreyfus and Dreyfus (1986). It assisted me to extend my own conceptualisation of design thinking; formulate realistic learning outcomes and assessment criteria and tasks; and make decisions about the sequencing and timing of learning activities and the extent to which students take responsibility for aspects of their learning. In addition, it has provided a basis for the future development of curriculum aimed at higher levels of design thinking expertise development.

10.13 Towards an 'ideal' design thinking curriculum

Drawing on the overall findings concerning students' learning tendencies, related student attributes and possible causal mechanisms, my conceptualisations of design thinking, design thinking expertise and a 'signature' design thinking learning environment, I have elaborated an 'end of project' 'ideal' curriculum. It is a curriculum that describes and informs the features of a learning environment that I believe can provide a high level of probability that students will develop a novice-level of design thinking expertise and that many will begin to demonstrate some of the features of advanced beginner expertise. However, as further discussed in the conclusion chapter, the curriculum cannot provide certainty that all students will achieve the intended outcomes. I present the initial components of 'ideal' curriculum below. The overall curriculum is presented in Appendix V.

Aim

The aim of the learning environment, and associated ideal curriculum, is to facilitate first-year, undergraduate students' development of novice-level design thinking expertise.

Content

The content of the 'ideal' curriculum is founded on my conceptualisations of design thinking, the attributes of a design thinker, which inform learning outcomes, and the methodology and individual practices that are required to undertake authentic design thinking project.

Student attributes

Table 62 presents the key attributes of a novice-level design thinker, which are derived from the design thinking expertise framework

Table 62. The attributes of a novice-level design thinker

Attitudes and mindsets
• Is developing a human-centred/empathic outlook. • Is developing a willingness to experiment with ideas and take creative risks.
Knowledge
Conceptual knowledge of: • What design thinking is, and the general principles that underpin it. • How design thinking developed and evolved, and where and how it can be effectively utilised. • Basic knowledge, mindsets, and sensorimotor attributes of a design thinker. • The key stages of a basic design thinking methodology, and fundamental design thinking practices within the stages. • Key cognitive and reasoning processes that underpin design thinking practices.
Procedural knowledge of: • A limited range of fundamental design thinking practices, and in what order they should be utilised.
Sensorimotor capabilities
• Is developing visual mapping, drawing and 3D prototyping capabilities.

Learning outcomes

At the end of the curriculum enactment (course or project), students will be able to:

1. Identify the key principles and purposes of design thinking.
2. Identify the key attributes of a design thinker, including fundamental attitudes and mindsets, knowledge and capabilities.
3. Apply the key stages of a design thinking methodology.
4. Select, sequence, and apply specific design thinking practices.
5. Apply fundamental cognitive and reasoning processes, including reflective thinking required to undertake specific design thinking practices.

As noted, I present the overall 'ideal' curriculum and associated detailed recommendations in Appendix V.

SECTION FIVE: REFLECTIONS ON THE RESEARCH METHODOLOGIES

What features of a critical realist theorising methodology, used in conjunction with case study and action research methodologies, enable or constrain the design and evaluation of university-level curriculum?

In this section, I discuss the critical realist theorising methodology, and the place that the methodology had within the case studies, which were embedded as units of analysis in the action research cycles.

10.14 Critical realist theorising methodology

As described earlier in Chapter Three, a critical realist position is characterised by the following:

- An ontological belief in an external world that exists and acts independently of our knowledge of it, or beliefs about it (Bhaskar, 1978).
- A *relativist* epistemological position that entails a belief that truth or reality is relative to the knower's conceptual scheme, is complex and changing (Pratt, 2011), is both *differentiated* and *stratified*, and is reality that is *imperfectly apprehensible* (Sobh & Perry, 2005).
- An emphasis on the importance of developing theory that explains unobservable structures and recognises the reality of associated causal mechanisms.

Given this position, I recognised that the development of explanatory theory about tendencies in data concerning students' response to the enactment of the curriculum that they experienced, was a necessary foundation for evaluations I made about the effect of curriculum enactments, and my subsequent decisions about potential enhancements that I might make to the curriculum. With this in mind, I applied a framework for developing explanatory theory that had close parallels with those proposed by (Danermark et al., 1997), and Bygstad and Munkvold (2011). When setting out to utilise the framework. I also noted that while there was only a very small body of researchers who had utilised critical realism in educational research (see Section 10.16 below), there were authors and researchers who were advocating for its use (G.Brown, 2007, 2009; Corson, 1995; Shipway, 2010).

As an emergent researcher, I was relatively naive about many aspects of critical realism when I embarked on the research, and encountered a number of difficulties and challenges when utilising the theorising methodology and associated concepts. In this section, I review and discuss these challenges. I also present an example of a key practical and applied teaching and curriculum analysis framework development that emerged from my understanding and use of a critical realism.

10.15 Language, terminology and concepts

An initial difficulty was the varied and inconsistent language and writing style that many authors had used to name and describe key concepts. For example, I noted that many authors used the term *structure* to describe phenomena. Other authors, however, referred to *entities, objects, assemblages,* and/or *semi-open systems.* As another example, I noted the term *mechanism* was central to the concept of causality, i.e. mechanisms make things happen. While many authors referred to *mechanisms*, others referred to *powers*, *forces, capabilities, affordances, liabilities,* and/or *'ways of acting'*. Other authors have noted the ambiguity and inconsistency of terms and definitions. For example, Fleetwood (2009) proposed a 'package' of related terms, through the exploration of various ontological perspectives, resulting in "a far less ambiguous concept of *powers*, firmly anchored in an ontology of *things*, *properties* and *powers* as a unity"(p. 1).

To overcome my own initial feeling of being somewhat overwhelmed and confused, I created visual models to help explain the learning environment that was central to the research question, and the various phenomena and their relationships within the environment. I then reviewed definitions used by other authors such as Fleetwood (2009), and selected the ones that I thought were most appropriate. I found however that as I developed a deeper understanding of critical realism throughout the research, the terms that I utilised changed, and my definitions evolved.

10.16 Relevant research and cases

At the outset of the project I noted that while there was a good range of researchers exploring the use of critical realist perspectives and approaches in wide-ranging fields, and a small group had explored and advocated for the use of critical realism in educational research (G.Brown, 2007; Corson, 1995; Shipway, 2010), there were very few researchers who had utilised and applied a critical realist theorising methodology to describe and explain a specific ‘real’ learning environment, or curriculum enactment, or the enactment and evaluation of a curriculum. The absence of clear and concrete examples meant that the learning curve in the early stages of the project was longer and more difficult than desirable. This project provides a case study that should assist other researchers.

I did identify a number of authors who had explored broader concepts of critical realism, learning and curriculum design (Christ, 2011; Crosthwaite et al., 2012; Huckle, 2004; Kahn, 2011; Kotta, 2011; Luckett & Luckett, 2009; Pereira, 2012; Priestly, 2011; Priestly & Miller, 2012; Vorster, 2010). And there has been a further advocacy for, and uptake of, critical realist approaches and methodologies in educational research (Case, 2015; Mingers, 2015; Nunez, 2015; Singh, 2015; Walker & Davies 2014).

The lack of concrete examples and cases of applied research using critical realism in analysing a learning environment meant that I had very few guides or reference points to help me identify and select my own methodology and data analysis methods, and to help me frame and locate my findings.

10.17 Complexity

While critical realism provided me with a methodology to deeply analyse and theorise the learning environments and their effects, especially the underlying and unobservable entities and causal mechanisms that were influencing students’ learning of design thinking, I had a growing realisation of the high-level of complexity related to the phenomena, and a somewhat overwhelming plethora of mechanisms and the other factors that were involved. In response to this, I made a pragmatic decision in Action Research Cycle Three to focus on a smaller number of design thinking practices that I had identified as particularly significant. I also decided to focus on further and more deeply exploring mechanisms that were specifically associated with teaching.

Other researchers have recognised that learning environments are systems with a high level of complexity. For example Davis and Sumara (2010) recognised this complexity and proposed that complexity theory offered a way of understanding the many overlapping, connecting, and nested systems within learning environments. Aligning with my own models, this included conceptualising learning environments as knowledge producing networks (with nodes, hubs and links), co-participation and co-emergence of knowledge, and developed not in a linear manner but as a process of recursive elaboration. Recently, Cochran-Smith et al. (2014) proposed that there is a strong relationship between complexity theory and critical realism in learning contexts. They proposed a hybrid approach to educational research, which incorporates complexity theory and critical realism (CT-CR). "We believe that CT-CR has promise for initial teacher education as a research platform that embraces complexity but also reclaims causality and, at the same time, helps examine the impact of intersecting systems of inequalities on how teacher candidates learn to teach" (Cochran-Smith et al., 2014, p. 119).

10.18 Developing and applying explanatory theory

While I encountered the conceptual and practical difficulties described above, the application of the theorising methodology proved to feasible as well as appropriate. Reflecting my increasing confidence in its use, I further developed a framework adapted from Sayer (2000, p. 15) (see Figure 96), which I utilised for developing theory about emergent and problematic tendencies (issues and problems) in students' responses to enactment of the curriculum, which could inform curriculum design decisions. The tendency analysis framework, presented in Figure 110, is one that teachers as well as researchers could employ. To demonstrate the value of this framework, it is described and applied in the following sections.

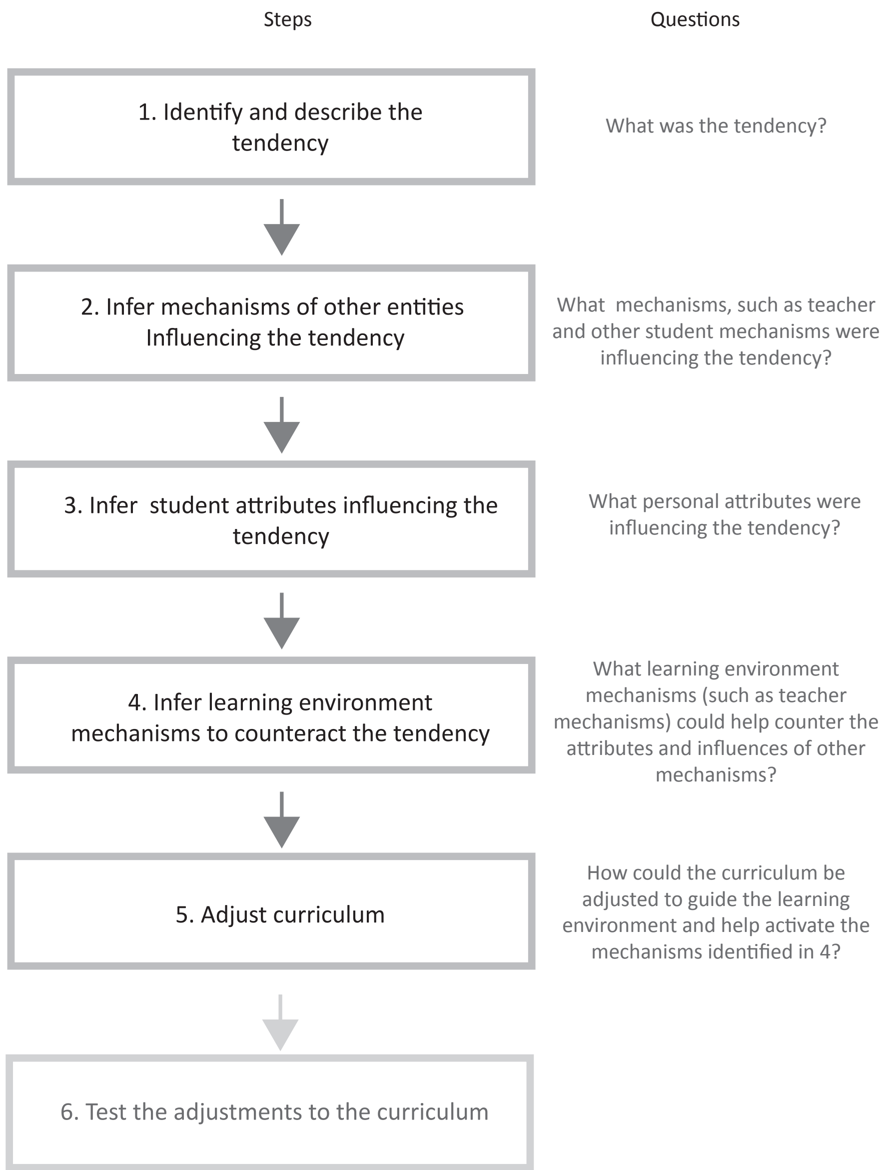


Figure 109. Tendency analysis framework

The framework involves the following steps. First, a student tendency that is problematic is identified (step one). For example, this could concern the manner in which the student responded to the pedagogy of the programme or a particular assessed learning outcome (e.g., application of a design thinking practice). Next (step two), abductive and retroductive reasoning are then used to infer (a) mechanisms of other entities in the learning environment that may have interacted with student mechanisms and thereby helped account for the tendency, and (b) student attributes that potentially accounted for their (in)ability to exercise mechanisms associated with the tendency (step three). The findings are then used to infer and describe teacher and other mechanisms in the learning environment which, when exercised, could potentially counteract, or help overcome the tendency, and therefore improve the opportunity for students' learning (step four). The findings of this process can be used to further develop and adjust the curriculum (step five) and, as required, to develop new teacher and student guides and resources. Finally, the effect of these adjustments can then be evaluated by implementing another action research cycle (step six).

Further analysis was undertaken of tendencies that were identified as worthy of further, more detailed analysis using the critical realist framework, including student engagement, negative experiences, or poor learning outcomes. These were then used to identify opportunities to adjust and improve the curriculum.

10.19 Examples of problematic tendency analysis

In the following tables, I summarise the outcomes for the first four steps when applied to four tendencies.

10.19.1 Tendency One

Table 63. First example of the analysis of a tendency using the critical realist framework

Step	Detailed description
1. Tendency	Business students had difficulty adjusting to the experiential learning and workshop-based approach in the first few weeks of enactment. Students reported feeling confused, out of their depth and slightly stressed. There was a drop in class attendance, and lack of group activity.
2. The mechanisms of other entities in the learning environment that were influencing the tendency	• Unfamiliar teaching mechanisms in the enacted curriculum, such as *facilitating* interactive discussions*, encouraging* and/or *directing* to actively participate in collaborative activities such as workshops*, demonstrating* and *modelling* processes and practices. • More familiar teaching mechanisms that the business students experience in other courses, such as *lecturing* and *tutoring.* • Mechanisms of other students such as *projecting anxiety, acting out stress, resisting talking, projecting uncertainty, not engaging* and *resisting collaborating.*
3. Personal attributes of students also influencing the tendency	• Lack of conceptual knowledge of what design or design thinking is, and about experiential and workshop-based approaches to learning and teaching. • Expectations of a lecture/tutorial based pedagogy. • Preconceptions of not being creative or collaborative. • Not being open to change i.e., not having an open mindset that helps adaption to a different learning approach. • Lack of knowledge about collaborative learning. • Lack of knowledge about relevant social processes and personal mechanisms (e.g., negotiating, envisioning, sharing, constructive arguing, understanding cultural and gender differences). • General lack of social confidence. • Lack of motivation and agency.

4. Possible teaching and other mechanisms that can be exercised or activated to counter the tendency	• *Describing, contrasting* and *explaining* the pedagogy. • *Presenting* more theoretical (versus practice) focused content initially. • *Facilitating* additional orientation activities, i.e., social icebreaking, group-bonding activities. • *Facilitating* additional introductory quick design thinking activities. • *Facilitating* individual and group reflection and discussion on their initial feelings and experiences. • *Facilitating* personal visioning and goal setting. • *Presenting* a video of other business students talking about their experiences of the curriculum.

10.19.2 Tendency Two

Table 64. Second example of the analysis of a tendency using the critical realist framework

Step	Detailed Description
1. Tendency	Lack of engagement with the roleplaying practice. Students generally avoiding engaging with the roleplaying practice, or not wanting to utilise the practice. Students feeling unconfident about the practice.
2. The mechanisms of other entities in the learning environment that were influencing the tendency	• Mechanisms of other students such as *projecting anxiety, acting out stress, resisting talking, projecting uncertainty, not engaging* and *resisting* roleplaying.
3. Personal attributes of students also influencing the tendency	• Poor conceptual knowledge of the value and benefits of the roleplaying practice. • Poor conditional, procedural and functional knowledge of when, why and how to utilise roleplaying practice. • Low tolerance for unfamiliar situations and activities. • Lack of confidence in ability to learn to use the practice. • Lack of desire to try out new skills in public.
4. Possible teaching and other mechanisms that can be exercised or activated to counter the tendency	• *Providing* an enhanced overview (theory) of the roleplaying practice including about the value and benefits of the practice. • *Emphasising* of importance and valued place of roleplaying practice alongside interviewing and observation practices. • *Facilitating* discussions with students regarding how they feel about roleplaying practice before and after engaging with it. • *Modelling* roleplaying practices, and *participating* with students in roleplaying activities. • *Observing groups in the field* and *intervening* and *providing* more support and encouragement if needed.

10.19.3 Tendency Three

Table 65. Third example of the analysis of a tendency using the critical realist framework

Step	Detailed Description
1. Tendency	Over-engagement with the persona development practice. Students enjoyed the practice and were highly engaged, and sometimes too engaged and avoiding other problem reframing practices. The personas produced were often ‘over blown’ and superficial stories of

	fictional characters with not much relationship to who had been observed.
2. The mechanisms of other entities in the learning environment that were influencing the tendency	• Mechanisms of other students such as *projecting excitement,* and *over enthusiasm.*
3. Personal attributes of students also influencing the tendency	• Poor conceptual knowledge of the persona development practice, what it is useful for, and what constitutes an appropriately constructed persona. • Poor conditional, procedural and functional knowledge of when, why and how to utilise personas. • A general lack of insight, not seeing personas as an effective way of analysing and communicating research findings.
4. Possible teaching and other mechanisms that can be exercised or activated to counter the tendency	• *Discussing* a tendency for students to get carried away with superficial application of the practice. • *Providing* an enhanced overview (theory) and clarification of the persona development practice. • *Presenting* better examples and case studies, and what makes an appropriately constructed, effective, well-developed persona. • *Modelling* persona development practices. • *Critiquing* the first personas that groups develop before more are developed. • *Facilitating* the testing and evaluation of the personas by taking back to the place of observation. • *Encouraging* students to use one of their personas to help with the roleplaying practice, and then reflect on its quality and usefulness. • *Facilitating* the critiquing of personas by other groups.

10.19.4 Tendency Four

Table 66. Fourth example of the analysis of a tendency using the critical realist framework

Step	Detailed Description
1. Tendency	The drawing/sketching practices of the business students were very poor, and many students did not undertake drawing. The drawing/sketching practices of the product design students were still relatively poor but demonstrated a higher level of expertise due to previous learning.
2. The mechanisms of other entities in the learning environment that were influencing the tendency	• Mechanisms of other students such as *projecting anxiety, acting out stress, resisting talking, projecting uncertainty, not engaging* and *resisting* sketching and drawing practices.
3. Personal attributes of students also influencing the tendency	• Preconceptions of not being able to draw, especially for the business students. This may link to preconceptions about not being creative. • Lack of sensorimotor (technical) drawing and sketching skills. • Lack of confidence in ability to learn to use the practice. • Not being open to change i.e., not having an open mindset that helps adaption to a new skill.

4. Possible teaching and other mechanisms that can be exercised or activated to counter the tendency	• *Emphasising* the importance and valued place of drawing and sketching in quick and effective development of concepts. • *Facilitating* drawing workshops, such as with 3D prototyping. This may not be appropriate for design students. • *Facilitating* quick interventions for students struggling in the development process to help students overcome inhibitions about drawing. • *Providing* effective drawing/sketching examples and resources.

10.19.5 Further discussion

The examples of my utilisation of the framework confirm that a critical realist analysis framework provided an effective tool to help to further interrogate selected tendencies that were an outcome of the curriculum enactment, and the operation of the learning environment. The framework allowed me to:

- 'Stand back', and more objectively reconceptualise and interrogate an issue or problem that concerned a complex and dynamic learning environment.
- More systematically infer relevant potential underlying causal factors and students' personal attributes.
- Identify specific ways in which I might change or influence the learning environment to address the problematic tendency.
- Plan for a follow-up cycle of trial and testing of changes to the learning environment.

10.20 The case studies and action research

As described in Chapter Four, action research is characterised by:

- A focus on action (Bryman & Bell, 2007; Gray, 2009), that drives "systemic inquiry that is collective, collaborative, self-reflective, critical and undertaken by participants in the inquiry" (McCutcheon & Jung, 1990, p. 148).
- A focus on development of solutions to 'real' problems in social contexts (Bradbury & Reason, 2003; Bryman & Bell, 2007), and facilitate change (Collins, 2010).

My decision to utilise a combination of action research and case study methodologies was based on my initial review of literature on curriculum design and evaluation, and my experiences as a teacher, curriculum designer and manager. The latter reflected my frustration at the often ad-hoc, reactionary, and very time constrained curriculum design processes that I had seen and had experienced myself, alongside my desire to create an optimal learning environment for design thinking based on rigorous research. I believe, based on my experiences in this research, that action research along with the use of case studies provides a very good structure and approach to curriculum design, evaluation and development. In reality, I was relatively naive about the many aspects of use of action research and case study methodologies when I embarked on the project and I did encounter issues and challenges when implementing them. These included responding to ethics requirements concerning the involvement of other teachers and negotiating their participation; ethics considerations and student participation; maintaining data gathering during the teaching cycles; and the impact of a short period of time between cycles on the scope and quality of data analysis and subsequent decision-making concerning the curriculum for the next cycle. I also had to understand how case studies could play a part in the theorising methodology, in particular as a retroduction strategy.

In this section, I review and discuss my reflections on these issues, as well as the opportunities that emerged from my use of action research and case study methodologies, in conjunction with the critical realist theorising methodology.

10.21 Ethical requirements and teacher participants

One of the most crucial aspects of the enactment of the curriculum was the need to involve other teachers in the curriculum enactment. Initially, I was precluded from a teaching role because of my position as Head of Department (HOD) and as line manager for these teachers. My original intention was to interview these teachers as a primary source of data. However, the AUT Ethics Committee indicated that this was not possible given my position in relation to these teachers. While I initially believed that this could limit the scope and quality of my data, I subsequently established that I could report on personal reflections that had been prompted by my observations of the teachers and my informal and spontaneous discussions with them that were an inevitable feature of everyday design and evaluation processes. The reflections constituted acceptable data. I also recognised that it was my reflections that were directly relevant to my design decisions. When I stepped down as HOD, I continued to focus on my own reflections and did not introduce interviews to obtain data from the teachers.

10.22 Micropolitics and power relationships

Eilertsen et al. (2008) noted that in action research it is important for researchers to be is to aware of micropolitics and power relationships within the organisation that they are studying, especially to identify potential conflicts of interest, facilitate collaboration from colleagues and participants, and to help manage tensions and relationships in light of the potential changes bought about by the outcomes of the research.

Given the the power relationships and micropolitical issues that I identified before and during the research I was careful to be mindful of and transparent with the staff members regarding the overall commitment I was asking them to make when negotiating their participation. In addition, I noted that it was very important that I understood their perspectives, including their existing knowledge of design thinking, and their motivations for participating, when seeking their contributions to the curriculum design they would enact. I also approached and conducted the interviews with students very carefully fully to ensure a sensitive interviewing style, including in the manner in which I introduced myself, explained why I was undertaking the research and the benefits for students, and how I asked questions.

I also developed a much deeper appreciation of teacher-student dynamics, and power relationships that are inherent in all learning environments. For example, I noted how micropotlitical and power relationships associated with *age*, *maturity*, *gender* and *cultural perspectives* within collaborative groups of students could impact learning outcomes. These relationships sometimes constrained students' exercise of design thinking (learning) mechanisms associated with collaborative practices, such as *planning*, *leading, discussing negotiating,* and with *decision-making*, which in turn impacted their development of design thinking expertise.

I believe that this understanding has also improved my own overall personal approach to teaching. For example, I am much more explicit with students about who I am, my position in the school, and the type of learning environment I want to create, as well as my own approach to teaching. I am also more sensitive as to how students might receive and interpret feedback that I give. In addition, I am much more aware of institutional-level power relationships, and their influence on the design, neogotiation of, and the undertaking of educational research, especially action research projects.

10.23 Realities of the research and research quality

I implemented three action research cycles across three succeeding semesters. In two cycles, the curriculum was enacted with two groups of students and concurrent with my associated research and teaching roles. I was still a full time member of staff with management and other teaching responsibilities. The period of time between cycles two and three was only six weeks. These realities presented challenges for the data gathering and analysis, as well as planning and preparing adjustments to the curriculum. During the curriculum enactment, I endeavoured to maintain my reflection diary and the pre- and post-surveys were implemented in this period. In the between semester period, while I was able to conduct all interviews, I struggled to deeply analyse the data and fully consider and incorporate all adjustments to the curriculum based on my findings. During this period, the student portfolios were also assessed.

This challenge was most acute during cycle one when I was still developing understanding and competency in using a critical realist theorising methodology. These challenges highlighted the clash that can occur when the researcher is concurrently wearing the hat of a teacher and primary researcher and there are institutionally determined timeframes for certain events. The teaching responsibilities must take priority at the possible expense of research standards.

I also recognised that I needed to be flexible and ready to adjust my research approach as it evolved. For example, while I had planned to utilise a second cohort of year three product design students in Action Research Cycle Two, and even though I had collected participant data, I made a decision at the time that this was too ambitious. I decided that I did not have the time and scope to analyse data and theorise from the cohort. While this resulted in an imbalance in cohorts between cycles, with one cohort in cycles one and two, and two cohorts in cycle three, I felt that this did not diminish the overall research approach.

I also started to note some repetition in tendencies (i.e., the findings from data were becoming saturated) between cycles two and three. During this time I also developed a deeper realisation of the high-level complexity of the factors within and beyond the learning environment that were potentially impacting students' learning. Both of these factors led me to be more selective in the aspects that I was interested in examining, and I needed to reduce the scope to deepen my analysis in Action Research Cycle Three (i.e. analytic resolution decisions). The decision to include a comparative case study methodology was another example of an adjustment that was made during the research process. In my initial conceptualisation of the research, I had only proposed use of an action research methodology. I decided that use of an explicit comparative case study methodology would be appropriate when I became aware of the contrasting patterns of tendencies that were occurring across cohorts and between cycles, and the relevance of case studies to the critical realist theorising methodology. I was also reading and discussing literature that emphasised the significance of context variations for the development of learning and teaching theory (e.g., Baskerfield, 1996).

10.24 Difficulties identified by other researchers

I noted that the challenges and issues that I identified with implementing action research were familiar to other educational practitioner researchers. This included insufficient time to undertake action research while fulfilling normal teaching responsibilities and other duties (I.

Brown, 2012; Burns, 1995; Denny, 2005); power differentials and teacher-student relationships (Appleby, 2013; Denny, 2005); deciding on the timing of the different stages of the research process (Denny, 2005); difficulties in obtaining ethical approval (Appleby, 2013; Baskerfield, 1996); difficulties handling large amounts of data; the need to narrow the focus of the research to generate research outcomes (Denny, 2005); and difficulty determining causality due to contextual complexity (Baskerfield, 1996). It is therefore important that researchers familiarise themselves with the issues identified in this commentary when planning educational research projects utilising action research.

10.25 The next chapter

In the final chapter of the thesis, I present my overall conclusions to the research in response to my research question. This includes a summary of the tendencies that I identified from the enactment of the curriculum, and a summary of the contributions that my research makes to related fields of scholarship. I also discuss the limitations of the research, and identify opportunities for future research.

CHAPTER ELEVEN: CONCLUSIONS

11.1 INTRODUCTION

In this chapter the overall conclusions of the research are presented and discussed. In Section One, I present and discuss the findings in relation to the overall research question. In Section Two, I discuss how the research has contributed knowledge to four interrelated fields of scholarship and the implications for other teachers, researchers and curriculum designers. This includes a summary of key tendencies that I identified from the enactment of the curriculum. In Section Three, I discuss the strengths and limitations of the research, and in Section Four I present opportunities for future research.

SECTION ONE: CONCLUSIONS

Can a university-level, design thinking curriculum that is developed and evaluated using critical realist perspectives and approaches, relevant theories and action research and case study methodologies enhance the design thinking expertise of university students?

My findings established that the curricula that I designed and enacted over the three cycles enabled me to design learning environments that enhanced the design thinking expertise of all students. Evidence of enhanced design thinking expertise was represented in students' self-assessment of their design thinking expertise, their views reported in informant interviews about their expertise development, the work outcomes in the group project portfolios, and my observations and reflections. The overall tendencies in students' responses to the curriculum/learning environments that I designed are summarised in the following table.

Table 67. Summary of tendencies

Description of key tendency
Students across all four cohorts reported very positive overall learning experiences after their participation in the curriculum enactment.
There was some variation in aspects of the curriculum that students enjoyed and a range of challenges and difficulties that impacted their experiences were identified.
Both cohorts of product design students reported that they particularly enjoyed the 'tightness' of the structure and associated activities, while the third cohort (business students) particularly liked the interactive nature of the learning, which was in contrast to their previous learning experiences.
The business students' overall enjoyment of the curriculum appeared more emergent than that of the product design students, and improved towards the end of the curriculum enactment when they had developed some basic conceptual knowledge and understanding of design thinking, which they didn't have before the course.
While reporting that they enjoyed the learning experience, the business students generally had difficulty adjusting to the experiential learning and workshop-based approach in the first few weeks

of curriculum enactment. Students reported feeling confused, out of their depth and slightly stressed. There was a drop in class attendance, and lack of group activity.
There was strong alignment across the views of the first three cohorts of students, who identified that the most important learning outcome for them was conceptual knowledge of design thinking, especially conceptual knowledge of the design thinking methodology in relation to design thinking methods, techniques and processes.
Students in three of the four cohorts identified that they envisioned potential transferability of some or all aspects of design thinking to other areas of their study or practice.
As noted previously, both cohorts of business students reported having some difficulty in adjusting to the experiential learning approach. It is important to note that this was not reported by either set of product design students.
Many students in all four cohorts experienced some difficulty in fully engaging with empathic research practices. This included finding interviewing and observing practices very challenging. However, they reported that their engagement with these practices generally had an important and beneficial impact on learning.
There was a lack of engagement with the roleplaying practice. Students generally avoided engaging with the roleplaying practice, or did not want to utilise the practice. Students reported feeling unconfident about the practice.
In contrast, many students in the first two cohorts struggled with identifying human needs, and seemed to lack the cognitive or empathic ability to go beyond surface level needs (e.g., a need to rest, or a need to take a photo), to identify deeper emotional and psychological needs.
There was an over-engagement with the persona development practice. Students enjoyed the practice and were highly engaged with it, sometimes too engaged and avoiding other problem reframing practices. The personas produced were often 'over blown' and superficial stories of fictional characters with not much relationship to those who had been observed.
There was generally good engagement with the creative practices, such as the brainstorming practice.
While the final creative concepts were more developed and resolved by the product design students, the initial ideas of the business students were either as good or better, and more innovative than those of the product design students.
The drawing/sketching practices of the business students were very poor, and many students did not undertake drawing. The drawing/sketching practices of the product design students were still relatively poor but demonstrated a higher level of expertise due to previous learning.
In contrast to drawing, there was better engagement with 3D prototyping practices from all cohorts, with the business students particularly enjoying the 3D prototyping process.
While not a tendency that was identified across other cohorts, students in the second cohort (business students) invested too much time and effort in developing refined and 'finished' prototypes rather than using them as concept development tools. They were generally reluctant to modify them as part of the creative process.
Concepts, experiences and the impacts of teamwork and collaboration featured prominently in the interviews with students.
Students generally enjoyed the teamwork and collaborative aspects of the curriculum. Their experiences of collaboration appeared to be closely linked to how they experienced the curriculum overall.
In contrast to the generally overall positive experiences of collaboration, many of the business students reported strong negative preconceptions about collaboration prior to the curriculum enactment, and had low expectations about their potential to engage in successful collaborative learning. This may have impacted their early experiences of collaboration.
For many students, experiences of collaboration were strongly characterised by personal bonding, socialisation and the development of friendships.
Negative aspects of collaboration were associated with a lack of leadership, a lack of motivation of other students, cultural misunderstandings, creative differences, and the difficulty in working in

groups bigger than five members.
Enjoyment of collaboration was therefore emergent for both cohorts, and generally improved throughout the curriculum enactment.
Overall, business students from both cohorts expressed some genuine surprise that their own experience of collaboration was positive.
The students' engagement with reflective practices was generally very mixed, with the self-reflection process very unclear for some, and many students not grasping the fundamental concept, rationale, and importance of reflective practices during the learning process.

Development of explanatory theory, based on critical realist ontological perspectives about these tendencies, and other tendencies that are documented in the thesis, informed the design of a 'signature' learning environment and 'ideal' design thinking curriculum outlined in Chapter Eleven. In addition to modifications documented throughout the action research cycles, the 'ideal' design thinking curriculum specifically took into account variations in students':

- Existing design thinking attributes, such as variation in their knowledge, mindsets and sensorimotor skills.
- Previous learning experiences, and their knowledge of, and orientation towards, a 'signature' learning environment for design thinking.
- Overall learning dispositions and levels of capability.

However, the findings do not indicate that students made gains in design thinking expertise that were greater in the succeeding two cycles. Two explanations are offered for this. First, as the level of expertise that most students achieved in cycle one was relatively high in relation to the anticipated level of expertise (learning outcomes), there may therefore have been limited scope for further significant gains in students' design thinking expertise. In other words, the learning environment and curriculum in the first cycle was already well optimised.

Second, while it was anticipated that the modifications to the curriculum, and therefore aspects of the learning environment, would lead to an overall increase in the level of expertise that students achieved, other unforeseen and uncontrollable factors (mechanisms) associated with changes to the attributes of entities in the learning environment between cohorts and cycles, could have had a negative influence on (constrained) students' learning. Such changes may have included a change in the time of week or time of year that the curriculum was enacted, changes in the room, and changes in the backgrounds and experiences of students coming into the learning environment. Unquestionably, the attributes of students varied across the cohorts and cycles. One example of the variability of attributes was a lower level of drawing attributes in the second cohort (business students) compared to the first cohort (product design students). In addition, there were also different teachers enacting the curriculum to each of the cohorts, and they had varying levels of expertise (attributes) associated with teaching.

Given the ‘instabilities’ that I observed across contexts (i.e. cohorts, curriculum iterations, cycles), it is difficult however to anticipate or predict with any real certainty the effect of changes to specific entities within learning environments, let alone the influence of changes to several entities, over time and across contexts. From my perspective, they also reinforced the conceptualisation of learning environments as complex, open and dynamic systems that are characterised by variability, uncertainty, change and emergence. Given this ontological reality, it will never be possible to design a ‘fool-proof’ curriculum: a curriculum that describes a learning environment that, when consistently enacted over time, will ensure students achievement of intended learning outcomes.

Other researchers have proposed similar implications of this representation of learning environments. For example Gibbs (2010), a prominent tertiary researcher and educator, observed that after 35 years of undertaking pedagogic research, he had belatedly realised the significance of context, such as the uniqueness of every context and how that may preclude generalisations about the effectiveness of particular curriculum/learning environments.

> Many context variables are so influential that extrapolation from one context to another is fraught with difficulties and leads to many errors and confusions, including the adoption of contextually inappropriate educational practices, wrong-headed explanations of local pedagogic phenomena, the alienation of teachers who know more about the crucial features of their context than do the pedagogic researchers, and a retreat into methodological obscurantism on the part of researchers, in an attempt to explain apparently inconsistent findings which are more likely due to unnoticed contextual variables. (Gibbs, 2010, p.1)

Gibbs was echoing a point of view that had been expressed many years earlier by critics of *process-product* teaching, and learning research that originated in the 1960s. The aim of *process-product* research was to uncover “…’processes’ (teacher behaviours and characteristics), in the form of teaching styles, methods, models or strategies that predict and preferably cause ‘products’ that is educational outcomes in the form of student achievement and attitudes” (Gage, 1978, p. 69). Reviews of several decades of *process-product* research emphasised the consistency of inconsistent findings which critics attributed in part to the lack of consideration of context variables. As a response Dunkin and Biddle (1974) proposed two further categories of variable: *presage* and *context*. They defined the latter as *“*the conditions to which the teacher must adjust – characteristics of the environment about which teachers, school administrators, and teacher-educators can do very little" (p. 41).

While the need to consider contextual phenomena is unlikely to be a contentious view now, my findings and associated theory do emphasise the need to give this more than 'lip service'.

This does not preclude the need to have a set of 'aspirational' learning outcomes, nor does it mean that it is impossible to identify some features of a learning environment that more often than not make a contribution to students' achievement of those outcomes, and are therefore a reasonable starting point when learning and teaching occasions are initiated. As Cochran-Smith et al. (2014) stated when considering the implications for teacher education of an approach that brings together complexity theory and critical realism**:**

> Rejecting linear causal logic, however, does not mean that we cannot investigate causality or the processes through which agents endeavor to initiate causal sequences. As a research framework for teacher education, CT-CR offers a way to focus on the initial conditions, contexts and circumstances within which teacher candidates' learning emerges in open systems. This is widely variable and unpredictable, but *not* random and *not* inexplicable. Rather this requires complex and contingent notions of causality and responsibility that depend on deep understandings of the local (e.g., initial conditions, sequences, and transformative events) linked to larger understandings of processes and outcomes at various intersecting systems levels. (p. 111)

This therefore makes the case for ongoing and iterative evaluation of curriculum enactment through a number of cycles to establish whether relatively 'stable' (recurrent) tendencies in learning outcomes do occur, as well as to make 'best guesses' about causal mechanisms that may influence this stability, as well as account for inevitable variability.

The findings from each cycle and student cohort allowed me to identify aspects of the learning environment/curriculum that either seemed to consistently strengthen the probability of some or all students developing particular aspects of design expertise, or that were 'problematic'. These findings led me to keep some aspects of the curriculum relatively constant across the three cycles (e.g., the overall approach and structure of the experiential workshops remained the same because they were effective in introducing and engaging students with practices, and students generally reported positive learning experiences associated with the workshops). Alternatively, other aspects were modified, and changes implemented and evaluated (e.g., a design thinking practice for identifying human needs was developed and introduced because many students were struggling to identify, classify and understand the potential needs of the people that they were observing and interviewing as part of the Investigate Stage.

My efforts to explain positive and problematic tendencies provided me with further awareness of, and deeper insights into, the level of complexity involved in learning environments. I became much more aware of the number and types of entities present, their attributes, and the mechanisms that were in operation. I recognised that the attributes of entities, such as student knowledge, could be more or less stable and open to change. I had clearer glimpses of the high level of complexity apparent in the way mechanisms within and between entities could interact to ‘cause’ learning outcomes. While I was able to develop a basic model of this process, the complex and often contingent relationships involved could make it difficult to predict these emergent outcomes.

I also recognised that the attributes and mechanisms of some influential entities were outside of my control or influence. And, there were simply too many entities potentially involved in a learning environment to consider and make decisions about, especially within everyday teaching timeframes. However, the research findings and associated causal analyses concerning the most consistent student learning tendencies did help me decide what to prioritise, from both teaching and research perspectives. They enabled me to make necessary continuing adjustments to the curriculum and the learning environment, to respond to variations in students’ entry-level expertise, their experiences of previous learning environments, their learning and teaching preferences and emergent learning challenges and difficulties. The necessity for such adjustments does pose challenges given the institutional expectation and requirement that a curriculum is ‘fixed’ for a period of time. There is also the challenge of achieving a necessary degree of stability in the learning environment, while allowing for and promoting instability that enables emergence with respect to learning outcomes.

Three interrelated concepts from complexity theory provide a helpful way of describing this consideration: *enabling constraints, coherence, randomness* (Brent Davis & Sumara, 2006; Newell, 2008). Enabling constraints in a learning environment or situation can be considered the “conditions that help to determine the balance between sources of coherence that allow a collective to maintain a focus of purpose/identity and sources of disruption and randomness that compel the collective to constantly adjust and adapt.” (Brent Davis & Sumara, 2006, p. 145). Newell (2008) described enabling constraints as the balance between the “narrowness of prescription and the ambiguity of having no constraints whatsoever” (p. 12), or “a delicate balance between sufficient organisation to orient agents’ actions and sufficient randomness to allow for varied and flexible response" (Brent Davis & Simmt, 2003, p. 155). These concepts have been explored and utilised by other researchers who have investigated curriculum design (Hetherington, 2012; Hussain, Connor, & Mayo, 2014; Jess, Atencio, & Thorburn, 2008).

The research process and outcomes also highlighted the dynamic, reciprocal relationship that occurred between student attributes and mechanisms that they might be able to exercise or acquire during learning. Attributes could determine the mechanism they could activate, and the mechanisms they activated could change their attributes, and in turn latent mechanisms. The findings emphasised that agency was a key attribute that underpinned and helped account for the way this relationship played out.

In addition to the above findings, I also noted that my own conceptual, procedural and functional knowledge concerning the design and organisation of curricula and learning environments developed significantly through the research process. I increased my professional competence in this specific area of expertise. Alongside this competence, I also increased my overall teaching expertise, where I usually operated at the proficient and expert levels.

SECTION TWO: CONTRIBUTIONS

I believe that my research has contributed significant knowledge to four discipline-related areas: design thinking; curriculum design; curriculum evaluation; and design thinking education. My research has also contributed to the emerging body of scholarship on the utilisation of critical realist perspectives and approaches in education research, and as a foundation for learning and teaching theory.

11.2 Design thinking

This research has contributed to the development of conceptualisations, and associated definitions, of design thinking, which build on those developed previously by others, and embody a critical realist perspective. This perspective distinguishes two interrelated dimensions of design thinking: (a) the knowledge, mindset, and sensorimotor attributes of design thinkers that enable them to exercise design thinking, and (b) design thinking practices and associated design thinking mechanisms, that constitute a design thinking methodology. It also distinguishes the emancipatory potential of design thinking.

Building on these conceptualisations, this research contributes a comprehensive design thinking expertise framework that is based on the H. Dreyfus and Dreyfus (1986) expertise framework, the L. Anderson et al. (2001) taxonomy of learning, and the Biggs' (1999) taxonomy. My framework extends previous design expertise frameworks, but is specifically contextualised for levels of design thinking expertise from novice to expert. I contend that these conceptualisations and the expertise framework, provide unique, comprehensive and coherent ways of describing design thinking which, as a whole, improve upon the many existing and often contradictory descriptions. While the methodological dimension generally aligns with existing descriptions, the critical realist perspective helps highlight and categorise the underlying mechanisms that design thinkers exercise, and their complex interrelationships. In addition, the attribute dimension, along with the expertise framework, specifically locate design thinking within a learning context: a relationship is established between the development of attributes and the outcomes of a learning programme.

11.3 Curriculum design

This research has contributed new conceptualisations of curriculum and related concepts, including learning, and learning environments, from a critical realist perspective. These build on and integrate a number of existing concepts. Learning is conceptualised as a mechanism, or set of mechanisms, that gives people the power to change their own knowledge, mindset or sensorimotor attributes, and also as an outcome, which is a change in someone's attributes. Learning environments are conceptualised as open and dynamic systems consisting of multiple entities, which have mechanisms that may enable or constrain learner mechanisms and therefore influence the probability that learning outcomes occur. Notably, a curriculum is conceptualised as an entity that is separate from those involved in a learning environment, and as consisting of mechanisms that inform and guide decisions about a learning environment.

This research has also contributed a curriculum design framework that is based on the concepts described above, as well as existing frameworks. Curriculum design decisions concern the attributes and associated mechanisms of entities in the learning environment that can be controlled or influenced, and their interrelationships and alignment - while account is also taken of uncontrollable entities in the environment.

I contend that when presented together, the conceptualisations provide a comprehensive and coherent design framework. For example, a clear and concise concept of learning is often overlooked by teachers and curriculum designers, and is essential when conceiving learning environments, curriculum, and therefore the design of student learning opportunities. The research provides a comprehensive and detailed case study of implementation of the framnework that can assist other curriculum designers.

11.4 Curriculum evaluation

This research has demonstrated the value of an approach to curriculum development and evaluation that integrates critical realist, (comparative) case study and action research methodologies. It appears that there has been no previous research which has combined these methodologies and methods for this purpose. Action research allows for investigation over time and across contexts, while case study methodology allows for the capture, documentation and initial qualitative and quantitative analysis of the enactment of curriculum with individual and contrastive cohorts of students. The critical realist-based methods ensured that the analysis went beyond descriptions of student learning tendencies to infer complex and dynamic operation of entities, and their mechanisms, in the learning environment that might account for these tendencies. Comparative case studies enabled the systematic exploration and identification of both overarching tendencies and variations in tendencies that might be attributed to differences in students' learning backgrounds (attributes and mechanisms) and histories. The combination of these methodological approaches enabled a richer understanding of the relationship between student experience and the operation of the learning environment. That understanding provided necessary insights into ways in which the environment, and therefore the curriculum, might be improved.

This research has also contributed a pragmatic and useful analysis framework for interrogating emergent problematic tendencies and the identification of adjustments to the environment that may counter the them. Thus, a critical realist analysis framework provides teachers and curriculum designers with a pragmatic and useful tool for supporting teaching and improving students' learning.

The two methodologies, while complementary, when combined with a critical realist perspective, provide a well-balanced, systematic and deep approach to the evaluation of curriculum.

11.5 Design thinking education

Building on the conceptualisations and findings from the research, an 'ideal' curriculum for design thinking education at undergraduate level and for novice design thinkers has been designed (see Appendix V, p. 381). This curriculum integrates my conclusions regarding the composition of a 'signature' learning environment for design thinking and ways in which a learning environment could be adjusted to respond to differences in students' learning backgrounds and previous learning experiences, and their entry level design thinking expertise.

The findings, which acknowledge the findings and theories from other research, emphasise the need for flexibility in the curriculum and learning environment, and highlight the need for on-going evaluation and enhancement. The usefulness and value of research-based approaches to the latter has been demonstrated, and my own commitment to research-informed teaching has been reinforced. The possible challenges of using such approaches are also highlighted, as well as the complexity that is inherent in learning and teaching.

This research also provides comphrehensive information for other teachers and curriculum designers, about the potential response of students to specific aspects of the curriculum, and accompanying theories about student attributes and explanatory mechanisms, which can inform their own decision-making. There are many case studies provided.

Overall, the research findings provide current and future teachers of design thinking with useful, pragmatic insights and findings that will assist them to reflect on their own design thinking curricula and teaching, and will assist them to improve them. In addition, I anticipate that curriculum designers, and/or academic decision makers who are considering developing design thinking curricula, will find these insights and findings useful in their decision-making processes, and will provide an effective platform for the design, enactment and evaluation of new design thinking curricula.

SECTION THREE: STRENGTHS AND LIMITATIONS OF THE RESEARCH

In the previous section, I have noted several strengths of the research. In summary, these include:

- A longitudinal approach to the collection of data, such as the gathering of data pre- and post-curriculum enactment, and across cycles of curriculum enactment to identify change in students' design thinking attributes.
- The utilisation of multiple data sources, data types (qualitative and quantitative), and mixed methods to provide a rich set of data.
- The utilisation of triangulation to increase confidence in the findings of the data analysis such as emergent tendencies in students' learning experiences and their learning outcomes.
- The utilisation of research methodologies and methods that aligned with my ontological and epistemological perspectives, such as the use of abductive and retroductive analysis to further analyse tendencies, and gain a deep knowledge about the interconnected workings of complex phenomena.

- Rich and detailed documentation of all aspects of the research process, including data gathering, data analysis, findings and subsequent modifications to the design thinking curriculum.
- My reflexivity, which assisted me to reflect on the way my existing beliefs, assumptions, points of view and values may have effected my decisions during all phases of the project. I used my research blog to maintain a private record of on-going reflections which I regularly discussed with my supervisors.

I identified a number of limitations in my research.

While I had individual student self-rating data on the status of their pre- and post-programme levels of design thinking expertise, it was not possible to statistically analyse the significance of differences in ratings. Anonymous identifiers were not assigned to the online survey forms or interview transcripts that would enable data sets to be compiled for each participant. However, I also recognised that even if this data were available, it would be difficult to establish the weighting of the contribution that adjustments to the curriculum made to increases or decreases in learning/expertise gains across the cycles. The complexity of learning environments accounted for this difficulty. The properties of entities in the learning environment, including students and teachers, could and did change across the three cycles. And, for some of these entities, it was not possible to influence or control their attributes (properties). It was also impossible to take into account all of the entities in the learning environment that had contingent relationships which caused particular learning effects and outcomes.

Two key ethics requirements limited the scope of the data. This included a requirement not to enlist students of any of the classes that I was teaching as participants in informant interviews, and a requirement not to enlist as participants the teachers who were enacting the curriculum. This also added a level of complication to the research design including increased time and effort needed to enlist other teachers to enact the curriculum and negotiate approval to approach their students to recruit as participants.

Prior to my research, there were very few researchers who had utilised and applied a critical realist perspective in research projects similar to my own. The lack of peer reviewed published examples meant that I had limited guides or reference points to help identify and select my methodology and data analysis methods, and to help frame and locate findings.

While action research provided an appropriate methodology for the research, as noted the realities associated with its utilisation in a 'real world' university context and timetable limited its overall effectiveness. For example, the short period of time between cycles two and three (six weeks between semesters) limited the amount of curriculum development that was achievable. This was in contrast to the (on reflection) ambitious goals that I had set in the initial research plan.

Given the novice-level expertise of many students, a more extensive trial of survey and interview instruments should have been done to check whether for example, questions were interpreted as intended and students were capable of making the requested ratings.

The comparative case studies using the Mann Whitney U Test (correlational analysis of survey data) were limited to four key examples dues to time and resource constraints. This precluded comparing cases one and four, such as the first cohort of product students with the second cohort of business students. This potentially limited my identification of some contextual differences between particular groups of design and business students.

Ethics requirements precluded my ability to access course or project grades given to whole cohorts or individual students post curriculum enactment. As a result, I was unable to compare or contrast student-reported levels of expertise development, with the expertise development assessed by the teachers. I also noted limitations in the student self-reported survey data, including the idiosyncrasy of participant views a, lack of truthfulness, and/or answers or discussion that participants believed that the researcher may want to hear. I also noted that participants might not be able to provide the level of detail, or the concepts that I (the researcher) was interested in.

In addition to the limitations identified above, for three out of the four cohorts, there was attrition in the number of students who completed the post-curriculum survey. This resulted in variable numbers of students between surveys, including a drop-off from 12 students who completed the pre-curriculum survey to five students who completed the post-curriculum survey. While this somewhat limited the overall power of the statistical comparison, these numbers were still inside the recommended parameters of the Mann Whitney U Test.

While acknowledging the above limitations, the research methods and approaches used in this research provided findings that have practical adequacy for curriculum design and enactment decisions.

SECTION FOUR: FUTURE RESEARCH

Based on my reflections, the strengths and limitations of the research noted, and building on the findings, I identified a number of future research opportunities.

- Continued enactment and evaluation of the 'ideal' curriculum developed in this research project. I recommend that in response to the limitations that I identified, the evaluation should be based on a refinement of the research approach, and associated methodologies and analysis methods. This could include: enhanced preparation of students for their self-assessment of design thinking expertise pre-curriculum enactment; reduction of the number of questions in the survey; obtaining ethical permission to utilise grades as a data source; and systematic comparison of individual responses between the survey and interviews. If the curriculum is to be enacted and evaluated multiple times, note should also be taken of the practical limitations and challenges of action research in a university context. It may be possible to reduce some of the challenges when planning the timeframes for phases of the research.
- Further analysis of curriculum enactment may focus on specific tendencies identified and a more detailed evaluation of the modifications made.
- Enactment of the curriculum, and evaluation of tendencies and outcomes with cohorts of students from other discipline areas, such as engineering, applied sciences, and medicine. This would provide a broader data set, and enhanced comparison of the impact of previous learning experiences, and students' knowledge of, and orientation towards, a 'signature' learning environment for design thinking.
- Longitudinal examination of the longer term impacts of the curriculum on individual students' learning. For example, this could include a longitudinal research project that asks students to report on the transferability of their learning over time and contexts, such as the impact on their performance and outcomes in other classes of the design thinking expertise (or aspects of their expertise) they developed.
- Developing more focused and deeper research into individual aspects of design thinking expertise development. For example, this might include research into mindset development. Outcomes may include the development of an enhanced expertise framework and taxonomy of mindsets.
- Exploring more deeply the mechanisms that are closely associated with individual design thinking practices. This may include more thoroughly identifying student-related mechanisms that are associated with each design thinking practice, and inferring and closely examining and how specific mechanisms dynamically interact with one another in the learning process.
- Investigating the relationship between coherence and randomness in learning environments and the implications for curriculum design.
- Developing a more detailed design expertise framework and utilising it to develop more 'advanced' programmes for university students. This could include curricula

aimed at students who were at advanced-beginner, competent or proficient levels of design thinking when entering the programme. The curricula developed for these classes could also be evaluated and enhanced through action research.

- Developing a theoretically based research project that explores how critical realism could be clearly located in relation to established and dominant learning theories such as behaviourism, cognitivism and constructivism. This could include exploring how this research project extends thinking about learning in the critical realism paradigm, and to what extent it offers insights that are different and 'unique' in relation to the dominant perspectives.

In addition to the opportunities identified above, I believe that there is an opportunity to further utilise and evaluate the problematic tendency analysis framework that I developed and utilised in this research project. This could include trialling its use with other teaching staff, and in classes in other discipline areas. Evaluation criteria would include usefulness as a teaching diagnosis and improvement tool, and evaluation could contribute to further development of the tool.

In summary, this thesis has demonstrated that a combination of critical realist perspectives and approaches, and action research and comparative case studies methodologies, can facilitate the development of a curriculum intended to guide enactment of a design thinking learning environment. The thesis has also demonstrated that the enactment of the curriculum, and subsequent enacted learning environment, can be evaluated to identify tendencies in students' experiences and their learning outcomes. Those tendencies can be further analysed using abductive and retroductive analysis to develop deep insights into the complex and dynamic operation of entities, and their mechanisms, and their potential to influence students' learning. While acknowledging the complexity of learning environments, and the large number and variability of factors involved, the insights and findings of the evaluation can be used to make 'best guesses' as to how to modify curriculum to enhance the probability of students' learning.

In conclusion, I strongly believe that design thinking should be taught at university level to enhance and extend existing learning programmes, and to facilitate students' development of attributes associated with design thinking. Design thinking attributes, utilised in conjunction with other attributes, provide students with the capabilities and the mechanisms to engage with, reframe, and propose solutions to, 'wicked', complex and authentic problems.

In addition, as Shipway (2004) stated, “critical realism provides a rigorous, yet sensitive and nuanced way to think about education – the implications of which are far-reaching and all-pervasive” (p. 16). As presented in this thesis, that ‘nuanced way’ enabled me to design, enact and evaluate a curriculum and learning environment that did enhance students’ learning experiences and optimised their learning outcomes. It also provided me with views and approaches that will have an important and ongoing impact on my professional career as a teacher and as a researcher.

APPENDICES

APPENDIX I: VISIT TO THE STANFORD UNIVERSITY, HASSO PLATTNER D.SCHOOL

I visited the Hasso Plattner d.school at Stanford University to observe two sessions of a design thinking workshop as it was being delivered to 120 corporate executives.

While the d.school does not award degree qualifications, it enrols approximately 700 students a year from across Stanford University (Korn & Silverman, 2012). It is closely associated with the Stanford multi-disciplinary engineering, design, and business schools. Academic courses are offered to students across the campus, such as engineering, medicine and business students, and include various ‘pop-up’ courses (short, non-credit bearing courses) for postgraduate students (*Take a d.school class*, 2013). In addition, the d.school runs workshops orientated to professional non-designers. They include an executive three-day intensive, experiential workshop for company executives. The d.school has also published a range of freely available resources closely tied to the design thinking courses offered.

During my visit, I was also able to view facilities, key resources and the general learning environment of the school. The visit provided valuable insights into the general approach, and learning and teaching methodologies utilised by the d.school. I noted that the workshop appeared to be carefully ‘designed’, and was underpinned by:

- A collaborative, ‘hands on’ approach where participants developed design thinking expertise by actively undertaking an authentic design thinking project.
- Clearly defined, well managed, and carefully timed sessions. In each session, two session leaders provided an introductory talk, with an accompanying video used to outline ‘authentic’ case studies. In some cases, the leaders or group facilitators modelled a method or process. The talk was followed by groups undertaking a practical activity. At the end of each session, groups presented the results of the activity.
- A facilitation process that was very upbeat and lively, and very engaging with participants. Participants were encouraged to actively comment on work, provide feedback and vocally acknowledge the success of other people and groups. The facilitators appeared to be very active in demonstrating and roleplaying and explained each step in the process with individual groups.
- Concepts of *empathy* and *emotion*, which were emphasised by facilitators to underpin the design thinking process.
- A physical teaching environment that was carefully aligned to assist and support the

design thinking workshop process. This included flexible and transformable furniture.

- The workshops, while well planned and carefully managed, appeared also to be very supportive and learner-focused.

APPENDIX II: REVIEW OF OTHER DESIGN THINKING EDUCATIONAL OFFERINGS

I noted that several researchers had identified and examined various design thinking programmes and courses. For example, Melles et al. (2012) used a survey of five existing programmes to help develop a design thinking course at Swinburne University. In their findings, they noted variations in approaches and frameworks used, including the differences in readings between courses, many still employing design-oriented texts, lectures that were focused on design innovation issues, and varying degrees of industry involvement. They also noted that “a common feature in practice and in courses is also the use of visualisation tools and other strategies, including prototyping, familiar to design students” (Melles et al., 2012, p. 164).

Building on the work of Melles et al. (2012), I developed a web-based audit to examine the breadth and depth of design thinking education to identify existing approaches to learning and teaching. A categorisation model, building on the work of Melles and colleagues, was utilised to organise the different types of education offerings. Eight key categories of design thinking education were identified and are presented in Table 68.

Table 68. Categories of design thinking education

#	Category
1.	Professionally orientated workshops, short courses and seminars in Design Thinking
2.	Full academic qualifications (i.e., bachelor’s/master’s degrees) in Design Thinking
3.	Postgraduate academic courses/papers in Design Thinking
4.	Undergraduate courses/papers in Design Thinking
5.	Online course
6.	Programme under development
7.	MBA and other postgraduate programmes underpinned by a design thinking approach and philosophy
8.	University Research Laboratories in Design Thinking

Overall, 65 individual educational offerings in design thinking were identified and examined. Further analysis sought to identify programmes that were undergraduate, one-semester courses delivered in universities or institutions of higher education. Nine educational offerings were identified and summarised in Table 69 .

Table 69: Summary of undergraduate design thinking educational offerings

Title/Institution	Descriptor
ENGS 12 - Design Thinking Dartmouth University, UK	"A foundation course on the cognitive strategies and methodologies that form the basis of creative design practice. Design thinking applies to innovation across the built environment, including the design of products, services, interactive technology, environments, and experiences. Topics include design principles, human need-finding, formal methodologies, brainstorming, heuristics, thinking by analogy, scenario building, visual thinking, and study of experienced thinkers. Weekly projects and exercises in a variety of media provide practice and development of students' personal creative abilities. Enrollment is limited to 20 students". http://engineering.dartmouth.edu/academics/courses/engs12/
DDD30006 – Design Thinking Swinburne University, Australia	"This introductory unit will complement the other issues addressed in the design management minor and concepts and practices in Business and Management. Students will have the opportunity to develop their design thinking competence through application to real world projects". http://www.future.swinburne.edu.au/units/Design-Thinking-HDC011/local
IDEA9106 - Design Thinking University of Sydney, Australia	"This unit of study aims to introduce students to design thinking and how it can be productively applied to different design situations, in both traditional design contexts and to the broader issues faced in contemporary society. Students will acquire the following learning outcomes: 1. An appreciation of the role of design thinking and strategy in traditional and cross-disciplinary contexts 2. Theoretical and practical understanding and application of design theories, methodologies and methods, with a particular emphasis on human-centred design 3. Demonstration of ideation and concept development to innovate solutions to complex problems 4. Awareness of design processes and cognition in collaborative, inter-disciplinary teams." http://sydney.edu.au/courses/uos/IDEA9106/design-thinking
PDSGN 110 - Design Thinking University of Nebraska, Lincoln, USA	"Introduction to an approach to problems employing a user-focused, iterative, team-based process. Through experiential labs, lectures, workshops, and class discussions students practice design thinking to promote innovation in a wide variety of disciplines" http://bulletin.unl.edu/courses/DSGN/110
DHA 1101w: Introduction to Design Thinking University of Minnesota, USA	"A first year course, which is an introduction to the theories and processes that underpin Design Thinking and practice. Topics include processes, methods, philosophies, theories and special topics in Design Thinking". http://graphic.design.umn.edu/documents/DHA1101ws09sylandschedcomplete-1.pdf
U101 - Design thinking Open University, UK	"This key introductory Level 1 course, packed with new learning innovation, will change your way of seeing and solving complex problems forever. Through a mix of academic and practical work you'll develop an understanding of design, acquire new designing skills and build a portfolio of design projects as a strong foundation for future study or work experience. This online course looks at

	common principles of design and ways of thinking that lead to ideas and creative solutions. Within a specially created virtual design studio you'll complete many hands-on activities and interact with your fellow students as you experience a completely different way of learning". http://www3.open.ac.uk/study/undergraduate/course/u101.htm
Design Thinking and Concept Development Rochester Institute of Technology, USA	"Design thinking is a process that aids collaboration among designers, technologists, and business professionals. The process provides a structured creative process for discovering and developing products and services for profit and non-profit applications. Students will apply a wide range of design tools in a hands-on project. Topics include problem-framing, end-user research, visualization, methods for creative idea generation, and rapid prototyping". http://register.rit.edu/courseSchedule/0102421
D100 - Design Thinking I *D101 - Design Thinking II* North Carolina State University, USA	Design Thinking I: "Design topics including: processes, methods, philosophies, theories and special topics such as making choices in a consensus driven organization or in a collaborative venture. A companion course to the second semester discipline specific Fundamental Studios". Design Thinking II: "This course evolves from the direct application of design thinking principles in the various design disciplines. It is intended to give a variety of perspectives from which to proceed into the design process. Students are expected to write reflections on the material presented in class, to develop a personal philosophy of design statement and to conclude with the construction of a design thought model that represents each student's thinking process. A review of relevant films and invited lecturers from the design disciplines". http://www2.acs.ncsu.edu/reg_records/crs_cat/D.html
TECH 124 – Design Thinking Simon Fraser University, BC, Canada	"Design Thinking is an applied critical thinking course. It investigates the pervasive role that design and designers play in the world around us and explores how design facilitates our understanding of our environment. Design Thinking also explores the conversational role of design in facilitating communication between individuals and groups while introducing students to often-contentious debates between various disciplines, professions, and everyday individuals regarding who is a "designer" and what activities constitute 'design'". "Investigates the role that design and the designer play in the world around us, and explores how design facilitates our understanding of our environment and facilitates communication with others. Examines the importance of precedent in design and how examples, models, patterns or standards reflect learning and critical thinking. Throughout the course students will, individually and in teams, use design questioning processes as tools to develop their critical thinking skills and to explore the role that design plays in their lives and the daily functioning of their communities.". http://www.sfu.ca/students/calendar/2013/summer/tech-one/tech-courses.html

The information publicly available on university websites was relatively limited, and only brief course descriptors were available. A brief analysis was undertaken of the online course descriptors, using coding to identify themes. The results revealed a number of insights:

- The prevailing theme across the descriptors focused on the cognitive aspects of design thinking, and the potential for students to develop various cognitive skills and processes in the courses. This theme was identified 22 times. Key references included, but were not limited to, cognitive strategies, way of seeing, design questioning processes, ways of thinking, construction of a design thought, problem-framing, and approach to problems.
- The next prevailing theme was the reference to processes, tools, methods, and processes. This was referred to 12 times. Key references included, but were not limited to, design process, design tools, processes, methodologies and methods, concept development, methods, rapid prototyping and visualisation.
- Another prevailing theme was the reference to collaboration, and the interdisciplinary nature of design thinking. This was referred to 10 times. Key references included, but were not limited to, cross-disciplinary contexts, interaction with fellow students, aiding collaboration, communication with others in teams, class discussions, and collaborative consensus.
- In addition, three other themes were identified. Theory and principles were referred to seven times, innovation was referred to four times, and social context was referred to three times, as were human-centred and real world/authentic.

Overall, the cognitive and social (collaboration, human-centred, social context) dimensions of design thinking dominated the nine course descriptors.

APPENDIX III: SUMMARY OF MODIFICATIONS TO THE CURRICULUM FOR ACTION RESEARCH CYCLE TWO

In addition to the modifications undertaken to accommodate the new group of students and the new enactment context, a number of modifications were made to the course based on the findings of Action Research Cycle One. It is important to note that due to the very limited time between the first enactment and the second, not all opportunities identified in the previous cycle were implemented. Only the potential improvements that were acted on are listed in this Table 70.

Table 70. Summary of improvements acted on for second iteration of the curriculum

Curriculum entity	Description of potential response	Actual response
Framework		
Process alignment	Develop a better balance between the first and second halves of the design thinking process. In particular, emphasise the second half of the design thinking process more (the last few weeks) to improve concept development, communication and reflection.	Updated the design thinking process model to better balance and match the course. This included creating a Reframe stage, moving the Generate stage into the second half of the process, and merging the Ideate with the Evaluate stage and renaming as Develop. Also developed an enhanced set of practices (methods) in the Communicate stage.
Duration of the curriculum	Increase project length from 4 weeks to 6 weeks (but keep 12 sessions). This better aligns the structure to the university semester length of 12 weeks.	A 12-session, 12-week structure was developed. This also reflected the different context (course rather than project) and structure.
Flexibility of structure	Explore ways of providing a better balance between providing an effective structure (and content), and allowing more freedom for teachers to add in own personalities, viewpoint, conceptualisations etc.	A new simplified teaching template was developed, that would be easier for teachers to adapt and personalise.
Timing of the project	Move the curriculum project earlier in the first year (to the beginning of the semester) for the product design students.	Not relevant for this iteration, but note for Action Research Cycle Three.
Pace of curriculum enactment	Identify and support students who are struggling with the quickness of the workshop style pace.	I made a note to be mindful of this, and discussed strategies with the other teacher.
Learning activities		
Project brief	Redevelop the project topic to one that has less of a focus on (potential for) final design outcomes that are so architecturally orientated.	A new project brief was developed.
Introduction to collaboration	Develop more focus on the first few days, and support students better with the group bonding, and the alignment of each team. This may include the development of methods to support collaboration and group work.	The assumption mapping practice was revised and enhanced, as were collaboration resources and introductory activities. This included introducing some theoretical models related to successful teamwork.
Portfolio documentation	Develop better communication about expectations, and develop models, and/or examples or case studies.	The portfolio template was simplified, and the language refined for the business students.
Student self-reflection process	Develop better models for the self-reflection process.	A new reflective practice method was developed (based on the

		Atkins and Murphy model) and this was incorporated into the teaching programme, reflective assessment events and the *Design Thinking Methods* resource.
	Develop journal document style approach to self-reflection rather than online blog.	The reflective brief was changed from blog to written journal format.
	Develop student briefing sessions and workshops on self-reflection.	A mini workshop was developed, in conjunction with the updated reflective practice method.
Teaching		
Teacher presentations	Shorten, and improve presentation layout and communication.	All teacher presentations were reviewed, and simplified.
Presentation upload	Upload presentations online more promptly after each teaching session.	I made a note to do this.
Prototyping/testing	Encourage more use of 3D models and full size testing through the later stages of the design thinking process.	I made a note to do this.
Class discussions/debriefing	Schedule time for class to discuss and debrief after each session.	I made a note to do this.
Teaching guide	Reconceptualise the teaching template so teaching staff can respond to and more effectively engage with a wide range of teaching approaches.	The overall and individual session planning templates were translated into a new format (Microsoft Word documents) and the layout was simplified. This template was shared with the other teacher for his own planning uses.
Teacher debriefing	Enhance the staff debriefing and shared reflection process. It may include identifying how staff reflections can be better captured, analysed and responded to.	I made a note to actively engage with the other teacher, so that we could share reflections, and identify strategies for improving the curriculum.
Teaching technologies	Simplify the use of presentation technologies (such as Apple iPads as primary teaching device) used in the teaching process.	Teaching from iPads was dropped.
Assessment		
Assessment criteria	Revisit assessment criteria.	Assessment criteria were redeveloped.
Assessment process	Provide more clarity around achievement, especially as it relates to self-reflection. Communicate criteria and expectations better.	A 50% mid-project assessment event was added.
Resources		
Design thinking resource	Evaluate how students are using the resource in relation to their work and look at ways of getting students to better engage. This may include better communication (briefing of students) and improving layout and content of	Version two of the *Design Thinking Methods* resource was developed and the layout improved. Some extra content was added, including new examples and case studies videos.

	the resource.	
Physical environment		
Physical environment	Developing a new physical teaching environment, and associated resources, that are designed specifically for design thinking type activities.	A completely new flexible teaching space with mobile tables and white boards (see image below) for groups to use in classroom. In addition, provided groups with pin boards to use with post-it notes (see Figure 110).

Examples of curriculum modifications

The following are some selected examples of improvements to the curriculum.

Updated process model

Figure 110. Updated process model

Updated teaching planner

The teaching planner was simplified, restructured and updated. The goal was to allow the teaching staff to be able to more easily adjust, adapt and personalise their teaching programme.

Design Thinking: Teaching Guide

Session 3

Objectives:
1. Applied Project briefing;
2. Introduce Initiate Stage to get students in right frame of mind before they start the applied project.

It is important to get students oriented to the project.

Time	Activity	Presentation	Exercise	Notes
Hour 1	**Week 2 Recap** (approx. 10 minutes)	No	No	Revisit brief from last week – and any clarifications. Also talk generally about the brief – allude to assumptions we make – and mindsets.
	Project 1 Briefing (approx. 20 minutes)	Yes	No	Introduce the brief – emphasize the key ideas again. Talk through key issues i.e. ethics in research etc.
	Introduction to **INITIATE** (approx. 5 minutes)	Yes	Yes	Background to the rationale to getting in the right frame of mind before a starting a project.
	Introduction to **Collaboration** method (approx. 25 minutes)	Yes	Yes	Put students into groups of 4 – randomly. Students to go away and do exercise on collaboration. Hand out locations to each group. Task 1 - select leader: Task 2 – 10 ideas for creating an 'aligned' team.
Hour 2	Continue **Collaboration** method (approx. 10minutes)		Yes	Task 3 – Skills audit.
	Introduction to **Assumption Mapping** method (40 minutes)	Yes	Yes	Get students to map all the assumptions that they have re the project. Task 1 – mind map 'What's There'?: Task 2 – mind map 'Who are these Tourists'.
	Break (10 minutes)			
Hour 3	Continue **Assumption Mapping** method (approx. 10minutes)		Yes	Task 3 – mind map 'Improving experience of one user group') - map as many ideas as possible. Reinforce that this is just a start – to get a clean slate. Part of the idea of going through cycles of Design Thinking – will repeat again.
	Introduction to **Beginners Outlook** method (approx. 20 minutes)	Yes	Yes	Show video – some quite time here after the video – pick up the curiosity theme and reinforce.
	Reflective Time (approx. 10 minutes)			Spend time to reflect on significant learning from the day. Use Atkins and Murphy model.
	By next week.	Meet in groups to get to know each other better – find a cause – or a purpose – will be important for successful team.		

Figure 111. Updated teaching planner

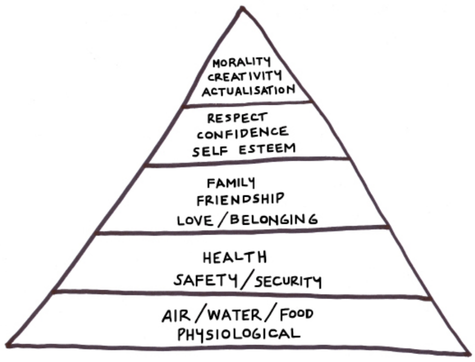
Identifying needs practice

A new design thinking practice, utilising Maslow's (1995) Hierarchy of Needs framework, was developed to help clarify and assist students in understanding, identifying and classifying human needs, as part of the empathic research practice.

Overview

NEEDS

Needs are physical or emotional necessities (and this also includes wants/desires........) which can vary widely among individuals and their environments. A need often comes from a problem – and is not a solution - be very careful there! The identification of un-met needs is a core component of any project.



Types

Maslow's Hierarchy of Needs
In 1943, American psychologist Abraham Maslow wrote a paper called "A Theory of Human Motivation". In it he described a hierarchy of human needs which is now known as Maslow's Hierarchy of Needs. From a Design Thinking perspective, understanding how these needs relate to each other puts you in a better position to spot the needs which will impact your project the most. They are as follows:

Physiological: The foundation of our basic needs is physiological including air to breathe, water to drink and food to keep us alive.

Safety : After taking care of our physiological needs, we need to maintain our lives and retain energy. This comes in the form of clothing and shelter to keep us warm and safe.

Relationships: Once our basic survival needs are met, our secondary needs include relationships with others. The love we receive from family and friends is very important along with our ability to communicate and form new relationships in determining the quality of our lives.

Esteem: Happiness and a feeling of well-being, confidence and respect (for oneself and others) as well as a sense of accomplishment represent the next level of our basic needs.

Actualisation: The highest level of our needs is actualisation. This includes our sense of morality, our creativity and sense of aesthetics, our ability to solve problems and express ourselves.

Focusing on higher level needs: There are many examples of great projects which meet basic needs- like water purification (see first video on page 4). For the purposes of your Design Thinking project, you will likely be focusing on needs which are at the upper levels of Maslow's Hierarchy.

Design Thinking Practices

Figure 112. Identifying Needs method as presented in *Design Thinking Practices* resource

New learning space

A new learning space was developed specifically for the teaching of design thinking. This space was included in the development of a set of new learning spaces in the Industrial Design and Innovation department. The goal was to develop a space that was adaptable, flexible, and best suited to the teaching of design thinking. The space included a set of mobile furniture such as mobile tables, whiteboards and presentation equipment.

Figure 113. New teaching space under development

APPENDIX IV: SUMMARY OF MODIFICATIONS TO THE CURRICULUM FOR ACTION RESEARCH CYCLE THREE

A number of changes were made to the curriculum based on the findings of Action Research Cycle Two. It is important to note that given the short amount of time between cycles, many suggested changes were noted, and deferred until the final iteration of the curriculum. Significant changes that were undertaken for this cycle are identified in Table 71.

Table 71. Summary of improvements acted on for third iteration of the curriculum

Curriculum entity	Description of potential response	Actual response
Framework		
Experiential learning approach	Clarify and more clearly capture (map) the experiential learning approach/pedagogy that underpins the curriculum.	Key aspects of experiential learning pedagogy were clarified and mapped, and findings were used to help guide other improvements to the curriculum.
Cyclic process model	Develop an overarching cyclic approach for the design thinking process model.	The curriculum process model was further evolved to encourage students to repeat various design thinking practices if needed.
Theoretical content	Provide more theoretical papers and other academic texts to provide enhanced back–up of the experiential learning process.	Papers and texts added to curriculum, and associated resources.
Learning activities		
Project briefs	Further refine project briefs.	Projects briefs for both groups were updated.
Orientation	Develop an enhanced orientation to the course, including discussions and activities, to assist the transition to what is a conceptually very different learning and teaching approach for business students.	The orientation (especially the first day) was updated with a section on experiential learning (what/why/how) with associated class discussion on the implications for students not used to this learning approach.
	Revise the group orientation process to develop a better foundation for the collaborative aspects of the project.	A framework was developed to help with the communication of, and discussion with, students about their preconceptions, previous experiences of group work, and student and teacher expectations.
Empathic research practices	Reorder the research practices so that students engage with roleplaying before other methods such as observation, in order for them to experience and gain a deeper personal understanding, connection and insight into the perspectives of other people,	The process was re-ordered and the teaching plans were updated.

	before observing and talking with them.	
Empathic research exercises	Create a brief series of introductory, in-class exercises to help students better engage with observation, interviewing and roleplaying practices in a more controlled and 'safer' environment, before undertaking more extensive empathic research in the field.	A set of introductory, empathic research exercises was developed.
Iterative creative practices	Develop iterative learning activities where students respond creatively using brainstorming (or similar method) to get some initial ideas out in response to their opportunity statements, and then revisit the problem statement (i.e., moving between the problem/solution space).	The learning activities were updated to reflect a more iterative creative process between problem/solution spaces.
Scamper method	Further develop and refine Scamper as a creative practice/method to help push ideas and process.	Scamper was developed into a method/practice and added to the curriculum resources.
Concept critiquing practice	Develop a practice/method for mapping, analysing, critiquing and challenging initial creative ideas and concepts.	A new idea mapping method/practice was developed (see Figure 115).
Prototyping examples and case studies	Develop better examples and case studies of the range of appropriate prototypes, especially low-fidelity examples.	A number of case studies were developed. Associated resources were updated.
Teacher/group facilitation	Develop a programme of teacher/each group facilitation learning activities throughout the semester.	A series of teacher/group facilitation activities were developed and scheduled in the teaching planners.
New problem reframing practice	Integrate existing problem reframing activities into one (new) practice from analysis to the opportunity statement.	A new integrated problem reframing method/practice was developed.
Reflection questions	Provide students with better reflective questions to explore and ask themselves at different stages of the design thinking process. Differentiate questions from reflections on design thinking, and those directly about learning.	A set of reflective questions was developed, and categorised as either reflection on design thinking or learning.
Teaching		
Facilitating empathic research analysis	Refine the teaching and facilitation process to help students to unpack research findings, and identify people's needs.	A series of steps was developed to help the teaching process, and included in the teaching guide.

Problem reframing discussion and facilitation	Discuss with students, both the importance and complexity of the problem reframing process, and facilitate a more integrated approach in relation to the learning activities.	Noted in the teaching guide.
Unpacking creative processes	Unpack and discuss the creative process (including underlying process, mechanisms and contextual factors) with students before engaging them with the creative methods.	Noted in the teaching guide.
Prototyping discussions	Create better discussion with students regarding the role of 3D prototyping, especially the use of low-fidelity prototyping to drive quick and effective exploration and evaluation of ideas.	Noted in the teaching guide.
Group participant allocation	Develop a process for identifying disciplinary and cultural perspectives, and the learning strengths of students, and use to help facilitate the formation of more diverse teams.	Noted in the teaching guide.
Prioritise reflective practice	Prioritise the building of students' engagement and understanding of reflective practice. This includes prioritising students' reflections in the (experiential) learning and teaching approach.	Teachers were encouraged to prioritise reflective learning, along with other changes made to this reflective practice.
Teaching guide	Use the findings of the research to enhance teaching guide overall.	Teaching guide was updated, for example assisting teachers to be more aware of the influence of various student attributes on their abilities to exercise empathy research mechanisms.
Resources		
Online resources	Update all teaching resources.	All resources updated to reflect changes and improvements identified in this table.

Examples of curriculum modifications

SCAMPER practice

The SCAMPER creative practice was refined from the version introduced 'on the fly' in the previous cycle, and incorporated in the teaching guide and the *Design Thinking Practices* resource.

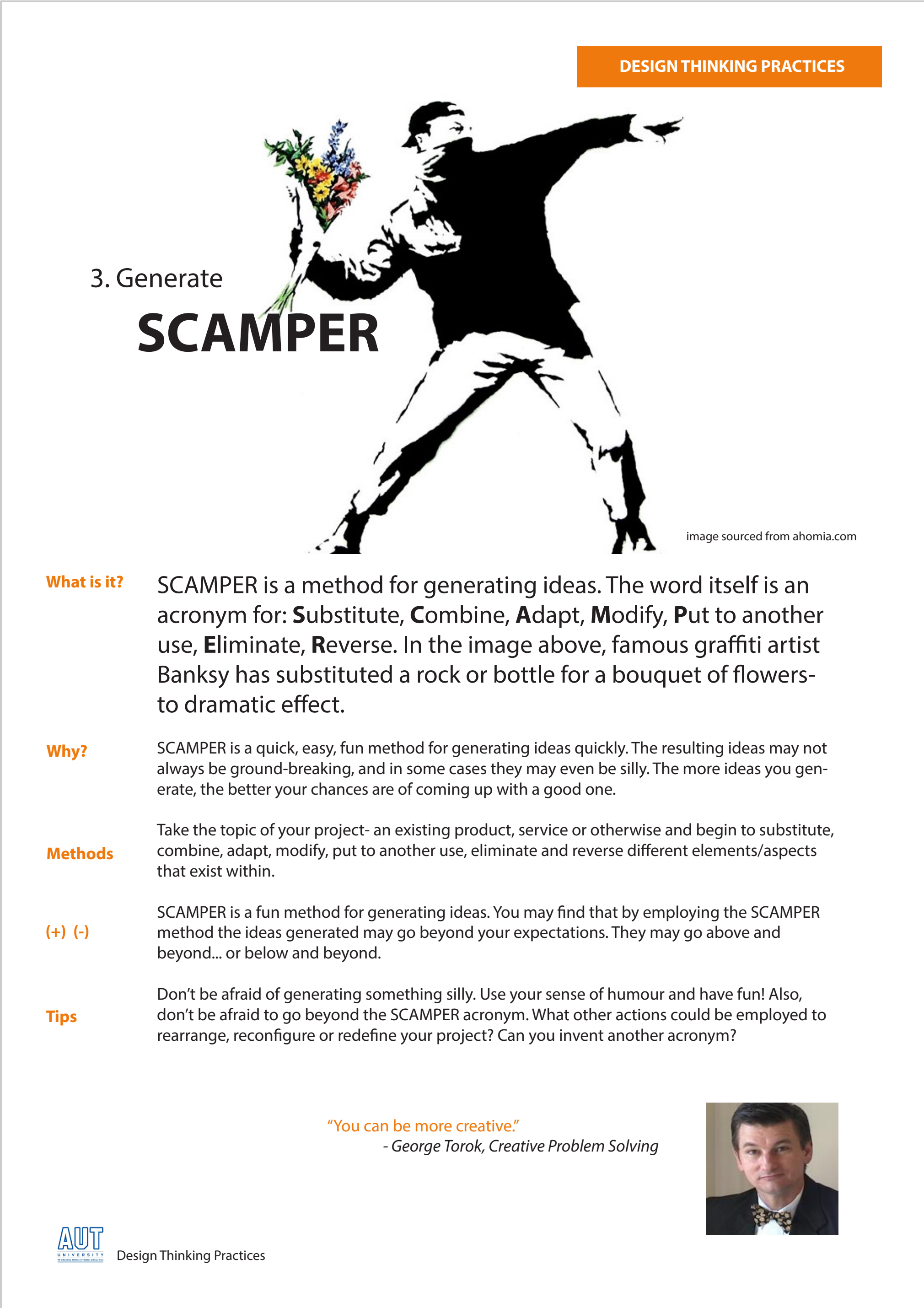
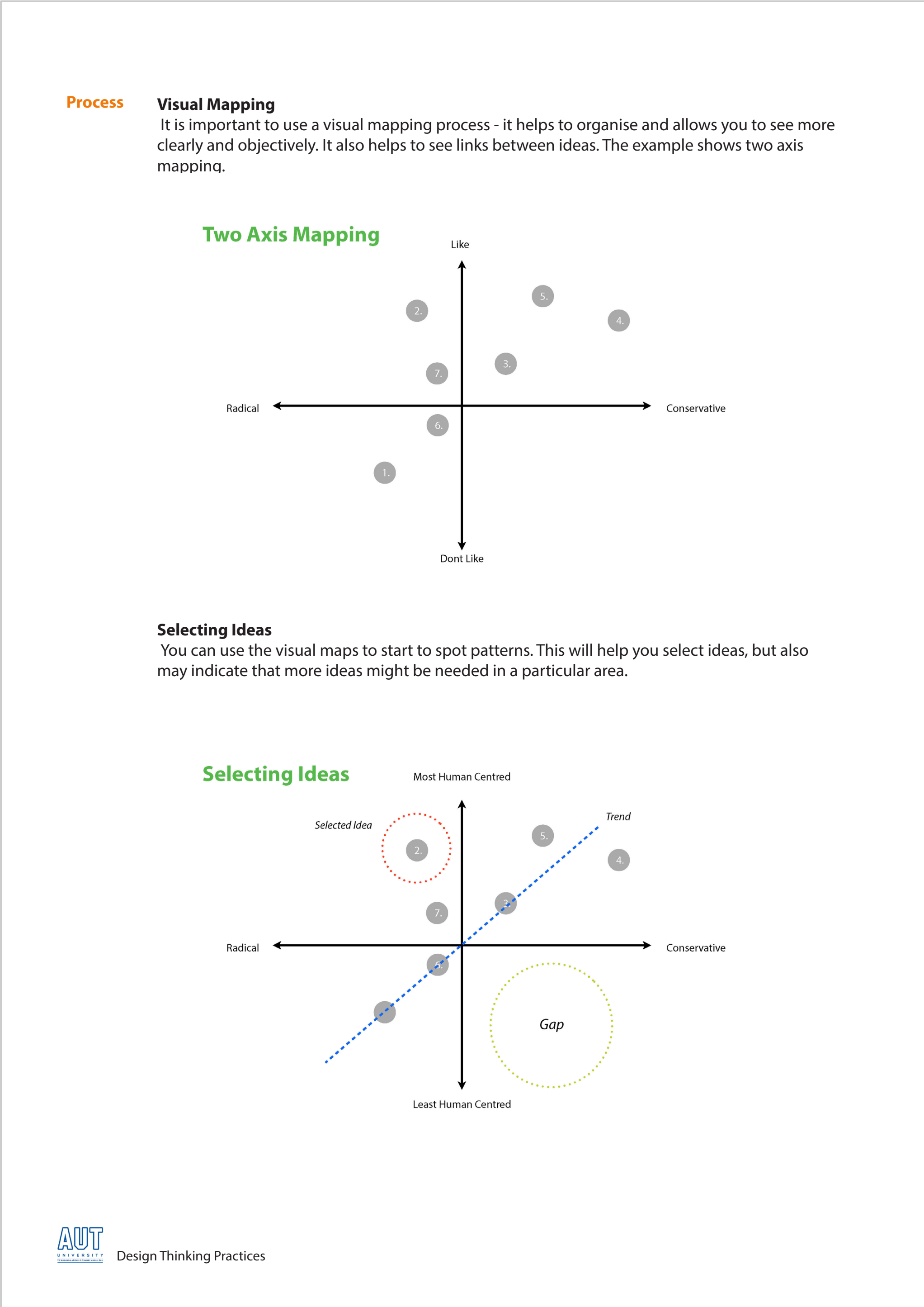


Figure 114. Updated SCAMPER creative method/practice

Idea Mapping practice

An idea/concept mapping method/practice was added to the Generate stage to assist teachers and students to unpack, organise and evaluate initial ideas from brainstorming and other creative practices. The goal was to help students identify limitations in initial ideas, and encourage more divergent thinking. This method was incorporated in the teaching guide and the *Design Thinking Methods* resource.



Process

Visual Mapping
It is important to use a visual mapping process - it helps to organise and allows you to see more clearly and objectively. It also helps to see links between ideas. The example shows two axis mapping.

Two Axis Mapping

Selecting Ideas
You can use the visual maps to start to spot patterns. This will help you select ideas, but also may indicate that more ideas might be needed in a particular area.

Selecting Ideas

Design Thinking Practices

Figure 115. New Idea mapping practice

Updated project briefs

In addition to other changes described above, the project briefs for both groups of students were significantly revised. The project briefs were revised to ensure that both groups of students had an accessible and manageable problem that was also complex enough to allow a good reframing process. In essence, both problems were brought closer to the university campus.

1. The Bachelor of Business students were asked to apply design thinking to improve and enhance the experience of AUT students on campus.

2. The Product Design students were asked to apply design thinking to enhance the experience of pedestrians crossing the intersection of Queen Street and Victoria Street, Auckland.

APPENDIX V: COMPLETE END–OF-PROJECT 'IDEAL' CURRICULUM AND ASSOCIATED RECOMMENDATIONS

Aim

The aim of the learning environment, and associated ideal curriculum, is to facilitate first-year, undergraduate students' development of novice-level design thinking expertise.

Content

The content of the 'ideal' curriculum is founded on my conceptualisations of design thinking and the attributes of a design thinker, which inform learning outcomes and the methodology and individual practices that are required to undertake an authentic design thinking project.

Student attributes

Table 72 presents the key attributes of a novice-level design thinker, which are derived from the design thinking expertise framework.

Table 72. The attributes of a novice-level design thinker

Attitudes and mindsets
• Is developing a human-centred/empathic outlook. • Is developing a willingness to experiment with ideas and take creative risks.
Knowledge
Conceptual knowledge of: • What design thinking is, and the general principles that underpin it. • How design thinking developed and evolved, and where and how it can be effectively utilised. • Basic knowledge, mindset, and sensorimotor attributes of a design thinker. • The key stages of a basic design thinking methodology, and fundamental design thinking practices within the stages. • Key cognitive and reasoning processes that underpin design thinking practices.
Procedural knowledge of: • A limited range of fundamental design thinking practices, and in what order they should be utilised.
Sensorimotor capabilities
• Is developing visual mapping, drawing and 3D prototyping capabilities.

Learning outcomes

Students will be able to:

1. Describe the key principles and purposes of design thinking.

2. Describe the key attributes of a design thinker including fundamental attitudes and mindsets, knowledge and capabilities.
3. Describe the key stages of a design thinking methodology.
4. Describe, select, sequence, and apply specific design thinking practices.
5. Apply fundamental cognitive and reasoning processes, including reflective thinking required to undertake specific design thinking practices.

Framework

In this section I explore my recommended framework that underpins the learning environment.

Design thinking methodology

Figure 116 presents a six-stage design thinking methodology, and associated individual design thinking practices, for undertaking a design thinking project. This model is an updated version of the one that I first presented in Chapter Six: Curriculum, and which was further updated in Chapter Eight: Action Research Cycle Two. Significant changes included restructuring to include, and help emphasise, a Reframe stage, and the merging of Evaluate and Ideate stages into a Develop stage. Associated practices were also updated to reflect the changes.

Figure 116. My design thinking methodology model

I contend that this methodology provides an appropriate structure for the undertaking of a design thinking project, and therefore provides an effective framework for the learning environment that uses project-based learning.

11.16.2 Design thinking practices

Table 73 presents an updated list of individual design thinking practices that I contend are appropriate for the model presented in Figure 116, and a novice level of design thinking. It is important to note that throughout the action research process, I made various adjustments to many practices including renaming some practices (such as the 3D prototyping practice), creating a number of new practices such as needs identification practice (which combined some practices), SCAMPER practice and Storytelling practice, and general improvements to the content and the steps of many others. These are described in each action research chapter.

Table 73. Individual design thinking practices

DESIGN THINKING METHODOLOGY						
Stages	**ORIENTATE**	**INVESTIGATE**	**REFRAME**	**CREATE**	**DEVELOP**	**COMMUNICATE**
Practices	Beginners Outlook	Knowledge Gathering	Persona Development	Brainstorming	Sketching	Storytelling
	Assumption Mapping	Interviewing	Needs Identification	Lotus Blossom	3D Prototyping	Video
		Roleplaying	Insight Development	SCAMPER	Concept Matrix	
		Observation	Opportunity Identification	Idea Harvesting	Scenario Building	
		Empathy Mapping				
	Collaborative Practice					
	Reflective Practice					

Weighting, timing and pace

The six-stage design thinking methodology aligns closely with a 12-session university level course, or part of a course, that is substantially underpinned by a design thinking project. For example, it aligns well with a one session per week, 12 week (one semester), or two-session per week, six week (half semester) university course.

I noted in the findings of my research that there was a tendency for some students to perceive a greater emphasis on the first half of the methodology during curriculum enactment. This appeared to be the result of a greater number of practices in the first half, teachers emphasising the first half, and students losing some momentum through the mid-stages of curriculum enactment. During the action research cycles, I adjusted the weighting and content of the stages, and associated practices, to provide a better balance. In addition, I recommend that:

- Each stage of the methodology approximates four sessions, and the students' engagement with four individual design thinking practices. The exceptions to this are the Investigate stage, which includes five practices, and the Orientate and Communicate stages, which have two practices each.
- Given the large number of practices across the methodology, the *managing* of the timing, such as *enacting* workshops and *facilitating* self-directed learning, needs to be tightly managed by teachers. While this approach provides momentum for the students' engagement, teachers need to be aware of the variation in students' ability to cope with the high level of pace, and have strategies to manage this if there are problems.
- Teachers should be *encouraging* and *facilitating* students through the mid-stages of the project*,* and *emphasising* the second half to students.

Learning approach and activities

In this section I explore recommended learning approaches, based on constructivist and experiential learning.

Constructivist/constructionist learning

I contend that constructivist/constructionist learning theory and principles generally provide an appropriate overall epistemological orientation, and a set of guiding principles for the learning and teaching of design thinking.

The constructivist/constructionist learning approach aligns closely with an experiential learning approach, such as learning through the undertaking of a design thinking project, and approaches used in the teaching of design. It is therefore a very familiar learning approach for product design students, but it is generally a very different approach for business students. It is therefore important to understand and respond to the contextual differences of students who have had different previous learning experiences. Recommended teaching mechanisms include:

- *inspiring* students about the potential of design thinking and their opportunity for learning design thinking.

- *negotiating* aspects of learning that are flexible, such as when and where to meet groups.
- *facilitating* dynamic and interactive discussions.
- *encouraging* self-reflection, and *supporting* collaboration.

It is important to note that while students are encouraged to take control over their learning, given that they are at the novice level, they need relatively tight structure, which leaves a limited opportunity for students selecting individual practices, and varying from the methodological model provided.

Experiential learning

Aligning with a constructivist learning approach described above, I contend that design thinking expertise is most effectively developed using experiential learning (Kolb, 1984). The approach prioritises learning through ‘doing’ and ‘experiencing’, which in this case is the undertaking of a design thinking project/s. Given the novice-level of expertise, I recommend that students should be led through the experiential learning process in a structured, ‘step by step’ manner.

As part of my approach to experiential learning outlined in this thesis, I contend that there is a strong alignment between engaging students with a design thinking practice, an experiential learning cycle, and a critical realist conceptualisation of learning. For example, utilising the Kolb (1984) cyclic model, an experiential learning cycle can consist of *abstract conceptualisation,* which in this case is an introduction to, and thinking about, the concepts, principles and theory and of design thinking, and *active experimentation*, which in this case is the active engagement with a design thinking practice and the exercising of various design thinking mechanisms. This leads to *concrete experience*, which can then be reflected on (*reflective observation*), and transformed into learning, which in this case is the development of learning outcomes such as the development of design thinking attributes, i.e. design thinking mindsets, knowledge and sensorimotor skills. This cycle is presented in Figure 117.

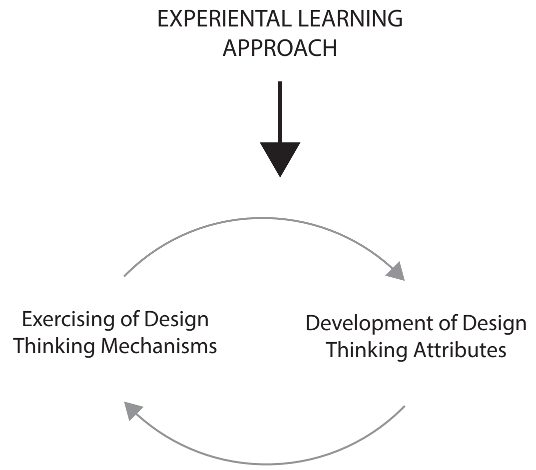


Figure 117. Experiential learning and the reciprocal relationship between the exercising of learning mechanisms and the development of design thinking attributes

A student's 'step by step' engagement with each of the individual design thinking practices can therefore be aligned with an experiential learning cycle. I recommend that each cycle consist of:

1. A tightly structured, experiential workshop, which introduces students to the individual design thinking practice within a studio/classroom /classroom-learning environment. This includes *abstract conceptualisation* through brief introductory presentations and discussions, followed by *active experimentation* through practical and applied exercises. This leads to *concrete experience.*
2. The student's relatively independent, self-directed engagement and application of the design thinking practice, in a 'real-world' context such as in the field, i.e. further *active experimentation* in a 'real-world' context such as in the field, leading to further *concrete experience*. Students may refer to learning resources to support this process (further *abstract conceptualisation)*.
3. Formal and informal *reflective observation* on engagement with the practice, and more discussion and reading leading to further *abstract conceptualisation.*
4. A repeat of the cycle, or a new practice.

The alignment of students' engagement with a design thinking practice and an experiential learning cycle is illustrated in Figure 118.

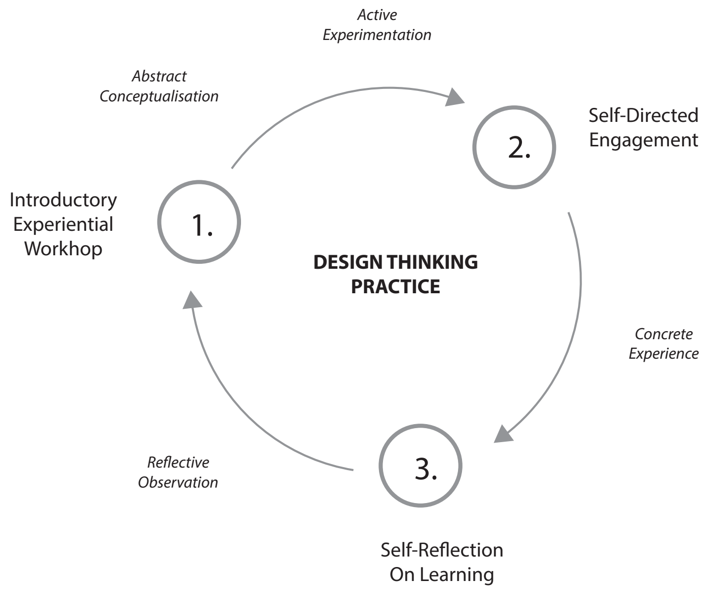


Figure 118. An experiential learning cycle for design thinking

As illustrated in Figure 119, each of these engagements and cycles can be linked together, aligning with a design thinking methodology and project.

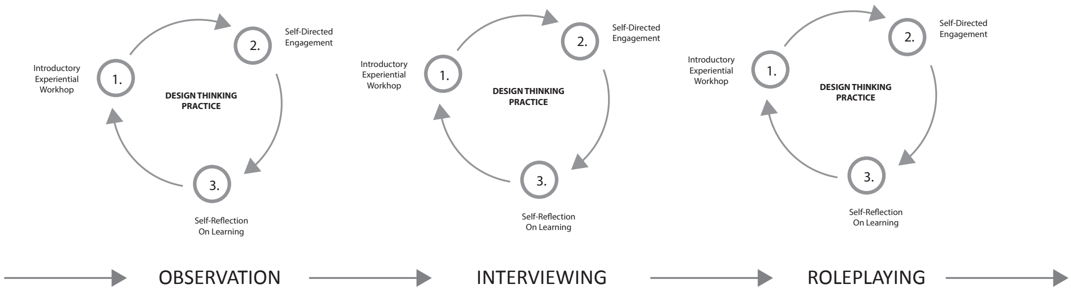


Figure 119. A series of experiential learning cycles within a design thinking process

Key activities associated with the engagement with each practice, and experiential learning cycle, generally comprise an experiential workshop, self-directed learning, and self-reflection. These are described in the following sections. My recommendations for engaging students with individual practices are described later in this appendix.

Experiential workshop learning

An introductory experiential workshop is a short (ideally 45 minutes to one hour), tightly structured, facilitated and directed experiential learning session. I recommend the following teaching strategies and associated mechanisms.

- Carefully *managing* the timing and pace of the workshop, and actively *inspiring* and *encouraging* participants to experientially engage and participate.
- In addition, it may include *modelling*, and/or *demonstrating* practices.
- An experiential workshop should be augmented with more traditional learning activities such as *presenting* introductory mini-lectures, providing explanatory videos, and facilitating class or group discussions. See Appendix III, Figure 111 for an example of an individual teaching plan, which includes detailed recommendations of content, timing and structure of an experiential workshop.

Self-directed learning

Following a workshop, students undertake self-directed activities, building on the experience and learning from the experiential workshops, often involving field work away from the classroom. I noted from the research that students' engagement with individual practices varied, especially those that involved empathic and imaginative practices such as roleplaying. I recommend the following teaching strategies and associated mechanisms including:

- *Directing*, *encouraging* students to engage with the self-directed activity. Specific recommendations for engaging students with individual design thinking practices are described later in this section.

Reflective learning

I recommend that students should undertake formal self-reflection on each stage of the design thinking methodology. My specific recommendations for engaging students with reflective practices are described later in this section.

Portfolio documentation

As part of this process, I recommend that students document the work outcomes of each engagement with a design thinking practice. This process needs careful teacher support and facilitation, including:

- *providing* a simple Microsoft Word template for portfolios.
- *providing* benchmarked examples of previous students' work.
- *facilitating* portfolio review and *critiquing* opportunities at a mid-point in the project.

Pre-project learning and teaching goals and activities

During the period before students begin the design thinking project, the teaching goals include briefing students on the course or project, providing an overview of learning outcomes and assessment, and presenting a general introduction to design thinking principles, methodology, and practices. This phase also provides teachers with the opportunity to assist students from backgrounds other than design (i.e., those with experiences of other signature pedagogies), to adjust to a constructivist, experiential learning approach.

Specific teaching strategies and associated mechanisms that are recommended for this phase include:

- *presenting* and *discussing* differences in signature pedagogies, and *presenting* more theoretical content to help bridge the design thinking environment with, for example, a traditional business learning environment. *Encouraging* students to reflect on their own experiences of learning in relation to what they will experience.
- in relation to the above*, presenting* and *discussing* differences in existing expertise levels. This may including *directing* students to map and assess their own existing attributes in relation to design thinking.
- *providing* extra support to students not familiar with portfolio documentation processes.
- *discussing* the journey that students will go on through the project, and potential highs, lows and other issues.
- *facilitating* personal visioning and goal setting around learning.
- *facilitating* a quick (i.e., two-hour) design thinking project to experientially introduce design thinking. This can be followed by an informal reflection and discussion session.

I also believe that there is an opportunity to further highlight and more deeply integrate anemancipatory agenda into all aspects of students' learning. I recommend that teachers be very explicit when *communicating* and *inspiring* students about the emancipatory agenda of design thinking, its potential and advantages in relation to other frameworks for enhancing people's lives through innovation, and the deep, values-based reasons for engaging with and learning design thinking. In relation to this, the project briefs could be better contextualised, developed and communicated within a broader emancipatory agenda or narrative.

Engaging students with individual design thinking practices

In this section I present a brief summary of research findings, in relation to some general recommendations for engaging students with each stage of the design thinking methodology and an associated project.

Orientate stage

The goal of the Orientate stage is to assist students to adjust and prepare themselves to actively engage with the design thinking projects through a number of orientation practices. Some general recommended teaching strategies and associated mechanisms for the Orientate stage include:

- *Unpacking* students' emotional experiences from their reflections during the Orientate stage.
- *Closely watching, identifying and supporting* students who are experiencing difficulties in adjusting to the experiential learning process.

Investigate stage

The Investigate stage utilises empathic and human-centred research practices to help design thinkers to develop a deep understanding of, in this case, a relatively ill-defined, 'real-world' problem, which can then be reframed into a more manageable problem.

As noted in Chapter Ten a number of tendencies were identified relating to this stage. For example, this included students feeling very challenged when undertaking the interview practice and observation practice, a lack of general engagement with the roleplaying practice, and an over-engagement with the personas development practice. Some students reported that they should have been pushed harder, or repeated these practices through cycles. I identified that these tendencies were associated with the existing attributes of many students, such as a relatively young age, a general lack of maturity or lack of knowledge about the value of empathy, and empathic research practices, in design thinking. Gender may have also played a role, with males less inclined to engage with empathic research practices. Other key tendencies are outlined in Chapter Ten: Comparative Case Studies. I recommend the following teaching strategies and associated mechanisms for counteracting tendencies noted in my research, and engaging students with empathic research practices.

- *Modelling* or *demonstrating* empathic and other related mindsets in the learning environment.

- *Facilitating* student discussions around the importance of empathy, human-centredness in design thinking, and/or students' potential lack of confidence, shyness or trepidation about empathic research.
- *Facilitating* introductory exercises specifically aimed at helping students to more effectively empathise and develop other mindsets.
- *Presenting* to students a framework of general research questions to help guide all empathic research practices.
- *Closely supporting* students' engagement with all empathic research practices. This also includes *highlighting* the importance of the roleplaying practice, and specifically *encouraging* and supporting students to undertake the practice.
- *Encouraging* students to (re)cycle through selected empathic research practices again to develop confidence and deeper understanding through repeated experience.
- *Facilitating* reflection on personal development of empathy, human-centredness, and other attitudinal mindsets, before, during and after this stage.

Reframe stage

The Reframe stage utilises various practices to help design thinkers to develop mapping, analysing, synthesising and developing insights to reframe, in this case, a relatively ill-defined problem in to a more manageable one that can be creatively explored in the next stage.

As noted in Chapter Ten: Comparative Case Studies, students in the first two cohorts had difficulty unpacking the findings of their research, especially identifying human 'needs'. This tendency was associated with the students' existing attributes such as lack of maturity, lack of cognitive ability to synthesise due to young age and inexperience, and a lack of ability to deeply emphasise beyond a relatively surface level description of the needs of others. It was also associated with a lack of conceptual knowledge of what a human need is, and how human needs can be categorised at various levels. I recommend the following teaching strategies and associated mechanisms for counteracting tendencies noted in my research, and engaging students with reframing research practices.

- *Managing* students' often over-enthusiastic engagement with the persona development practice, and *encouraging* students to use the process sensitively to synthesise research findings, and to drive further empathic research.
- *Modelling* the identification of human needs from research findings.
- *Closely monitoring* student engagement and enthusiasm through this stage, especially identifying needs, and insight development practices.

- *Discussing* with students how they are coping, and providing support strategies for improving enthusiasm and engagement if needed.
- *Modelling* the writing of opportunity statements.

Create stage

The Create stage utilises creative practices to help design thinkers to generate, explore, critique and select ideas and concepts that respond to the reframed design problem.

As noted in Chapter Ten: Comparative Case Studies, the initial ideas produced by the business students were very weak, but they responded when provided with a framework to map their ideas, and to push them further. Many students appeared to lack an optimistic and experimental mindset, and appeared to lack ability to think beyond relatively obvious and superficial ideas and concepts. I recommend the following teaching strategies and associated mechanisms for counteracting tendencies noted in my research, and engaging students with reframing practices.

- *Facilitating* students' reflection on initial ideas and concepts, and *encouraging* students to push/extend/rethink them through re-engaging with the creative practices.
- *Facilitating* reflection on personal development of creative capabilities, and other attitudes and mindsets, such as an experimental and risk-taking mindset.

Develop stage

The Develop stage uses iterative development practices to help design thinkers to selectively develop, refine and test selected ideas using sketching/drawing and 3D prototyping.

The utilisation of sketching and drawing practices was weak across most cohorts, although unsurprisingly better from the product design students, who came in with a higher level of drawing expertise. Many students appeared to lack confidence, and many were apprehensive about using drawing. In contrast, the first cohort of business students tended to be very enthusiastic about the *3D Prototyping* practice, but in spite of the initial enthusiasm and effort that they put in, were reluctant to actively modify and change their prototypes as part of an iterative process. I recommend the following teaching strategies and associated mechanisms for the Develop stage.

- *Discussing* apprehension and fear of drawing.

- *Facilitating* drawing workshops, as with 3D prototyping. This may not be appropriate for design students.
- *Modelling* a process of simple and effective sketching as part of workshops, and *providing* examples of an appropriate level of sketching.
- *Facilitating* 3D prototyping, especially encouraging students to not be 'precious' but to actively modify and evolve the prototypes.

Collaborative practice

As noted in Chapter Ten: Comparative Case Studies, there was a tendency for some business students to have strong negative preconceptions about collaboration before they experienced it, and while many students of all cohorts were challenged by collaboration in the first few weeks, most students enjoyed collaborating with other students. A number of tendencies were noted, including students having a negative experience due to cultural differences, lack of strong group leadership and a lack of motivation of other students. Other key tendencies are outlined in Chapter Ten: Comparative Case Studies. I recommend the following teaching strategies and associated mechanisms for counteracting tendencies noted in my research, and engaging students with collaborative practices.

- *Selecting* and *organising* groups no bigger than five team members.
- *Discussing* cultural and other differences between members, and the impact that this may have on the success of collaborative processes.
- *Facilitating* additional orientation activities, i.e., social icebreaking, group-bonding activities.
- *Providing* strategies for groups to set goals and self-monitor and manage their collaborative process.
- *Actively supporting* student groups throughout the collaborative process, including *meeting* regularly with teams throughout the project, and *watching* and *actively intervening* when groups appear to be struggling to collaborate.
- *Encouraging* and *supporting* leadership within a team.

Reflective practice

As noted in Chapter Ten: Comparative Case Studies, students' engagement with reflective practices was generally very mixed, with the self-reflection process very unclear for some, and many students not grasping the fundamental concept, rationale, and importance of reflective practices during the learning process. This was in spite of adjusting the reflection model and process. I recommend the following teaching strategies and associated mechanisms for counteracting tendencies noted in my research, and engaging students with reflective practices.

- *Providing* an effective model for self-reflection on learning.
- *Providing* a set of simple, self-reflection questions that students can draw upon as needed. These should be focused on students' reflections on learning and design thinking.
- *Modelling* reflective practices in workshops and other activities.
- *Providing* opportunities for informal reflection during workshops, and formal (assessed) reflection after each stage in the project.

Assessment

I recommend that assessment be structured around:

1. Individual written work that demonstrates achievement in conceptual knowledge of design thinking, i.e., the key principles and purposes of design thinking, and the key attributes of a design thinker, including fundamental attitudes and mindsets, knowledge and capabilities.
2. A collaborative portfolio that groups develop to document their undertaking of each stage of the design thinking methodology, and associated design thinking practices. I recommend that the portfolio is assessed in terms of achievement across the design thinking practices, as a collaborative grade, i.e. describe, select, sequence, and apply specific design thinking practices, and apply fundamental cognitive and reasoning processes required to undertake specific design thinking practices.
3. Individual reflections on learning.

APPENDIX VI: SELECTED EXAMPLE FROM DESIGN THINKING PRACTICES LEARNING RESOURCE

The following is an example of an individual practice selected from a comprehensive Design Thinking Practices resource that I developed and was made available as a set of interactive Adobe PDFs to students during curriculum enactment. The resource contains all practices that were introduced to students, with many additional resources included. The resource was updated through the action research cycles to reflect changes made in the curriculum.

The full resource is available on request.

DESIGN THINKING PRACTICES

2. Investigate

ROLEPLAYING

What is it? Roleplaying puts you in the shoes of the person you are trying to understand and empathise with.

Why? One of the reasons Halloween is so popular is that it gives people a chance to imagine they are some one else- if only for a few hours. From a design thinking perspective, getting into character and walking in someone else's shoes can provide real empathy and insight into the unique problems and needs they might face.

Methods Roleplaying works best when you are trying to understand the problems and needs of people unlike yourself. For this reason, it may be useful to conduct some interviews (see Interviewing) with specific users before starting.

(+) (-) Roleplaying facilitates empathy in a way which other methods cannot because it puts you directly in the situations that your potential users face. Some people may find Role Playing difficult as it can take them out of their comfort zone.

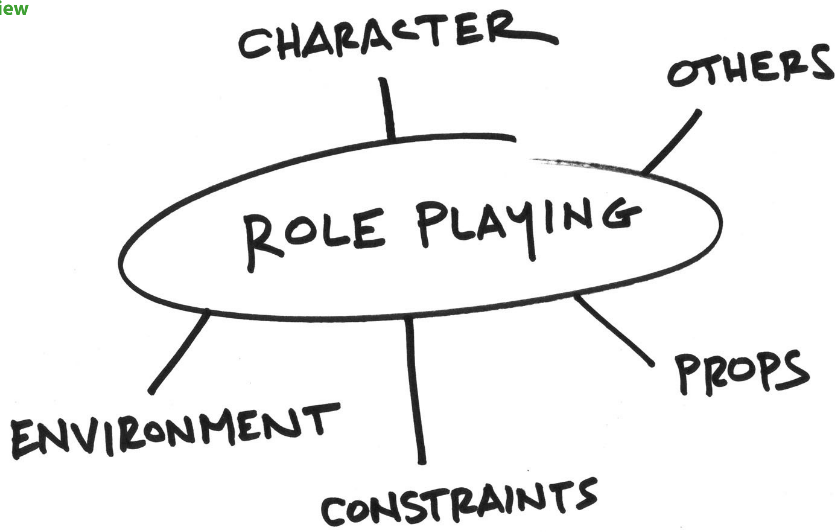
Tips When Roleplaying, get into character. Don't just go through the motions. Think like an actor, and see what they see. Do what they do. Think like they think. Feel what they feel.

"I imagined what it would be like to be a wizard, and then I pretended and acted in that way on the day."
- Sir Ian McKellen, Actor

AUT UNIVERSITY Design Thinking Practices

Figure 120. Example page from Roleplaying practice

Overview



Types

Character
The purpose of Roleplaying is to gain understanding and empathy. Who is the person you are trying to understand and empathise with? Refer to Personas to define the characteristics/traits of the role you will play.

Others
Other group members may also play roles along with you. This all depends on the nature of the role you are playing and the understanding and empathy you are trying to gain.

Props and Constraints
Sometimes your role will require props and/or constraints which facilitate your understanding and empathy. For example, if you are trying to empathise with someone who suffers from hearing loss, you can wear earplugs. Diminished eyesight - you can wear glasses with spots painted on them to obscure your vision. Arthritis - try wearing gloves while going about your daily routine.

Environment
Depending on the role, you may need to go to a specific environment or create one in order to gain the desired

Links

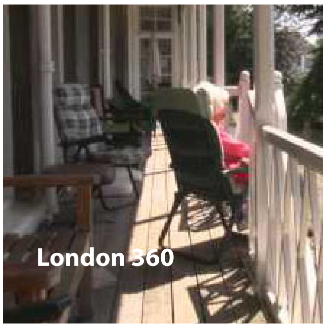
Science Education Resource Centre: http://serc.carleton.edu/introgeo/roleplaying/
Compilation on Roleplaying

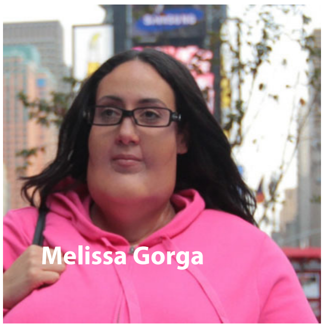
Paper by Kristian Simsarian titled "Take it to the Next Stage: The Roles of Roleplaying in the Design Process"

Personal website of Adam Blatner: http://www.blatner.com/adam/pdntbk/rlplayedu.htm
Article on "Roleplaying in Education" by Adam Blatner

AUT UNIVERSITY Design Thinking Practices

Figure 121. Example page from Roleplaying practice





Get into character. The video clips above (from upper left to lower right) illustrate 1. how going "undercover" can facilitate empathy and understanding between owners of companies and the persons who work for them, 2. how doing someone's job in a third world country can facilitate empathy and understanding among young Britons, 3. how props and constraints can enable young Britons to understand and empathise with persons who aged, 4. how a sophisticated constraint allows a young woman to step into the shoes of those who suffer from obesity.

AUT UNIVERSITY Design Thinking Practices

Figure 122. Another example page from Roleplaying practice

APPENDIX VII: STUDENT INFORMATION SHEET AND CONSENT FORM

The Participant Information Sheet and Consent Form, approved by the AUT Ethics Committee, and which were given to students during the participant recruitment process are presented in this appendix below.

Partcipant Information Sheet

Date Information Sheet Produced: 16 September 2012

Project Title: Developing Design Thinking Expertise in Higher Education

Researcher: Andrew Withell, PhD candidate (AUT University).

Research Supervisors: Dr Neil Haigh and Dr Stanley Frielick

An Invitation

You are invited to participate in a research project that seeks to explore and better understand how Design Thinking expertise can be taught (introduced, developed, and nurtured) within university programmes. Your participation in the research is entirely voluntary and you may withdraw at any time prior to the completion of the data collection in which event your participation in the research will immediately cease and any information obtained from you will not be used. It is important to note that your academic work is not under scrutiny in this research, and the researcher will not participate in any associated marking, moderation or grade approval processes. Choosing to participate or not will not advantage or disadvantage you, and your confidentiality will be maintained at all times. An independent third person (not the researcher) will conduct the data collection.

How was I chosen for this invitation?

You are invited to participate in this research because you are enrolled in a paper that includes an Introduction to Design Thinking as part of the curriculum.

What will happen in this research?

Your involvement will consist of:

1) Two surveys (questionnaires) 'pre' and 'post' your learning from the Design Thinking project.

- The surveys are completely anonymous. Questions will be related to your understanding and experiences of the Design Thinking project and your perceptions of the impact of the project on the development of your Design Thinking expertise (attitudes, knowledge, thinking and practice. The survey will take no more than 10 – 20 minutes to complete.

2) Developing an electronic portfolio of Design Thinking project work that includes a journal of reflective thinking (students will be briefed in detail Monday of next week).

- The electronic portfolio will be completed as part of the project coursework, and is not an additional requirement for the research. You will be asked to record your Design Thinking processes, including research, creativity and final communication. In addition you will write a reflective journal throughout the process.

- The electronic portfolios will be reviewed by the researcher only after all work for the paper has been marked, approved by the appropriate exam board and all identifying characteristics of students has been removed by an independent third person.

3) Face to face interview

- You will invited to take participate in a face-to-face interview at a later date. The interview, which is expected to take no longer than one hour, will be undertaken by an independent third person (not the researcher) a time and location convenient for you.

- Interview questions will explore in more depth your understanding and experiences of the Design Thinking project, your perceptions of the impact of the curriculum on the development of Design Thinking expertise (attributes and capabilities) and identifying the factors that may influence this development.

- Your permission will be sought for the interview to be audio-taped for transcribing at a later date. To maintain confidentiality, all identifying characteristics of students will be removed before transcripts are passed on to the researcher

4) Co – Design session

- In addition you will also be invited to take part in a co-design session that will look at the findings of the research, and to use creative methods to find ways of improving the Design Thinking project. Ideas and concepts generated in the session may be incorporated in the future development of the project.

What are the benefits?

The findings of the research will primarily be used to improve the development of the learning and teaching of Design Thinking at AUT University. Findings may be also relevant for other programmes and for professional contexts. Dissemination of the research findings may include journal publications and conference presentations. In addition the findings will be presented as part of the researcher's PhD thesis.

Potential Risks?

It is unlikely that there will be any risk to you as a participant. In the event that you find a question embarrassing then you can decline to answer the question and to complete the questionnaire or may terminate the interview.

How will my privacy be protected?

Your confidentially will be ensured at all times and no identifying characteristics of students will be reported as part of the research. The questionnaires will be anonymous, and interview participants will remain anonymous to the interview transcriber and the researcher. Consent forms will be collected and stored by a research administrator to ensure your identity is protected. The data produced from the questionnaires and interview transcripts will be combined with similar data from other participants. Reports or publication of the findings will not contain any identifying material. The confidentiality and identity of all participants and placement organisation will be protected at all times.

What are the costs of participating in this research?

The only cost to you as a participant is time. Each questionnaire will take approximately 20 minutes to complete. The interview will take approximately 40 minutes. The interview will be conducted at a location convenient for you. In addition the co-design session take approximately 60 minutes.

Will I receive feedback on the results of this research?

A summary of the findings will be available to you if you are an interview participant at the completion of the project on request. Please indicate this on the consent form and a research administrator will send a copy to you.

What do I do if I have concerns about this research?

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor, Dr Neil Haigh (neil.haigh@aut.ac.nz).
Concerns regarding the conduct of the research should be notified to the Executive Secretary, AUT Ethics Committee, Rosemary Godbold, rgodbold@aut.ac.nz, 921 9999 ext 7772.
Whom do I contact for further information about this research?

If you would like to participate in this project, or would like further information about this project, please contact the researchers listed below.

Research Supervisors Contact Details:

Dr Neil Haigh email: neil.haigh@aut.ac.nz

Dr Stanley Frielick email stanley.frielick@aut.ac.nz

Researcher Contact Details:

Andrew Withell email: andrew.withell@aut.ac.nz

Approved by the Auckland University of Technology Ethics Committee on 14 September, 2012
AUTEC Reference number 12/140

Consent Form

For use when interviews are involved.

Project Title: Developing Design Thinking Expertise in Higher Education

Project Supervisor: Dr Neil Haigh

Researcher: Andrew Withell

I have read and understood the information provided about this research project in the Information Sheet dated 13 09 2012.

○ I have had an opportunity to ask questions and to have them answered.

○ I understand that notes will be taken during the interviews and that they will also be audio-taped and transcribed.

○ I understand that my research journal and project portfolio will be collected and used as part of the research. This will happen only after all my work has been assessed and the grades approved by the Bachelor of Design, Exam Board.

○ I understand that I may withdraw myself or any information that I have provided for this project at any time prior to completion of data collection, without being disadvantaged in any way.

○ If I withdraw, I understand that all relevant information including tapes and transcripts, or parts thereof, will be destroyed.

○ I agree to take part in this research.

○ I wish to receive a copy of the report from the research (please tick one): Yes/No

Participant's signature: ....……………………………………………………

Participant's name: ....……………………………………………………

Participant's Contact Details (if appropriate):

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Date:

Approved by the Auckland University of Technology Ethics Committee on 14 September, 2012 AUTEC Reference number AUTEC 12/140

Note: The Participant should retain a copy of this form.

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