Using complexity thinking and MOOCs to disrupt current debates on educational futures.

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Abstract

Major changes in the world have led to what some scholars are calling 'post-normal times', an age characterised by uncertainty, unpredictability, rapid change, complexity, chaos and contradiction. Some have argued that, as a result of these developments, major reform is required in education. The reforms argued for are widely known as 'future-focused' education. In the past, education reform efforts have often encountered unanticipated complexity which has derailed or diluted their implementation. This thesis argues that past reform efforts have been limited by their assumption of a reductionist paradigm. It describes a study designed to test the usefulness of complexity thinking for understanding and implementing the kinds of changes needed in 'post-normal' education. The project involved designing a 'safe-to-fail experiment', in the form of a MOOC, to investigate whether the system could be 'nudged' to produce conditions under which future-focused change can emerge. The effects of this experiment were investigated via a complexity-informed case study of some of the MOOC participants. The study found that the system was influenced by this 'safe-to-fail experiment'. However, deeper analysis revealed a more nuanced system of negative feedback loops acting to constrain the possibilities for system-wide, future-focused change. This study concludes by suggesting that complexity-oriented research approaches are probably most useful, at this point in time, for identifying and exploring the nature of the system's homeostasis-maintaining feedback loops. Such attempts to 'see the system' are likely to suggest fruitful sites for further experimentation.

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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

AUT ethics approval number 16/56.

See Appendix A for more detail.

1 Introduction

1.1 Context

Self-driving cars, virtual and augmented reality, synthetic laboratory-grown meat, genetic profiling, and autonomous drones are no longer the stuff of science fiction. As well as technological advancements such as these, the world is now more connected than ever; globalisation and the internet have seen to this. However, this narrative of innovation, knowledge economies, and technological advancement plays out against the rise of the Anthropocene; the geological epoch characterised by human activity as the dominant geological force on our planet (Crutzen, 2006; Smith & Zeder, 2013). Coral reefs are disappearing, glaciers are melting, and climate change is already impacting communities around the world through extreme weather events (Kolbert, 2014; Stokes, Wike, & Carle, 2015). These major changes in the world have produced what some are calling post-normal times. For Sardar, this is: "the in-between period where old orthodoxies are dying, new ones have not yet emerged, and nothing really makes sense" (Sardar, 2010, p. 435). For him, post-normal times are characterised by uncertainty, unpredictability, rapid change, complexity, chaos and contradiction.

Yet, despite these unprecedented levels of complexity, unpredictability and volatility, our schools have stayed largely the same, ignoring these fundamental shifts. Or at least, this is the position of some scholars and reformers (Berry, 2011; Claxton, 2013; Facer, 2011; Gilbert, 2005; Lichtman, 2014; Wagner & Compton, 2012), who argue that the need for change is now urgent if we are to maintain a relevant public education system that is capable of realising the democratic and egalitarian ideals on which it was founded (Facer, 2011, 2016; Gilbert, 2018).

The future-focused education discourse developed in response to these emerging knowledge economies, technological advancement and globalisation. For many schools and teachers, future-focused education seems like a solution to the apparent mismatch between the rapid and accelerating change outside of education, and the seemingly static nature of our public education systems. Rather than emphasising the acquisition of knowledge organised according to the traditional academic disciplines, this discourse advocates lifelong learning, creativity, problem solving, critical thinking and collaboration. For many reformers, this shift in education is urgent if we are to save the world from the apocalyptic possibilities driven by radical inequality and climate change (Facer, 2011, 2016; Sardar, 2010; Slaughter, 2015).

However, history has shown us that reform efforts in public education are fraught with problems. New initiatives and policies, despite their good intentions, appear to face a constant struggle with unanticipated complexity. Thus, the future-focused reform effort, much like past reform efforts in public education, is encountering unanticipated complexity that has produced conflict and compromise. However, in the face of accelerating change and impending existential threats, the problem of education reform then becomes increasingly urgent and important. How do we reform public education to create more hopeful possibilities for our futures when past efforts have been fraught with such complexity and conflict?

My interest lies in the radical transformation of the public education system. As a teacher, I have witnessed students from diverse socio-economic and geographic contexts become disengaged from the curriculum, struggling to find relevance in what they were learning. My concerns were amplified through working with #edchatNZ, a national professional learning community of teachers based mainly on Twitter. Involvement in this community revealed that across New Zealand (and the world), other educators are noticing the same sense of disengagement among students. This project came about in response to the needs of this community.

1.2 Research intent

This thesis takes the position that new ways of thinking are required if we are to steer towards more hopeful possibilities in our futures. In particular, the case is made that currently, at least part of the problem in successfully reforming public education is that our thoughts are colonised by a dominant reductionist paradigm. As a result, education practice, research and theory are filtered through reductionist ideals of linear cause and effect, objectivity and a desire for laws, formulas and algorithms. While these reductionist values are useful and even powerful in some contexts, this research makes the case that they have significant limitations when thinking about public education and reform in post-normal times.

In response to the limitations of reductionism, some scholars have begun to consider elements from the developing field of complexity theory as an alternative. This research aims to test whether the emerging ideas, theories and concepts from complexity could be a useful framework to use when thinking about future-focused reform in education. In effect, this study is intended as a pilot for adopting a complexity framework in research about education futures and reform efforts.

One way in which complexity offers a different approach to research is through an alternative positionality for researchers. Rather than acting as an objective observer, complexity thinking suggests a ‘sense-and-respond’ approach where researchers can actively participate and influence their object of study. Thus, this research project used ideas from complexity theory in a deliberate attempt to disrupt the status quo in education. This took the form of developing a ‘safe-to-fail experiment’ designed to deliberately ‘nudge’ the education system towards more future-focused possibilities. The experiment was designed as a Massive Open Online Course (MOOC) that sought to disrupt interactions about education futures, both in and beyond the experiment.

While the MOOC served as a complexity informed disruption, research methods that were capable of making sense of and conceptualising the complex nature of this project were required. Therefore, a complexity informed case study was designed to make sense of the interactions connected with the MOOC. The study collected data about the number and depth of

interactions in and about the future-focused ideas presented in the MOOC and considered whether these led to change. Interviews, surveys, social media, and course reflections, as well as software analytics from the learning management system used to host the MOOC, were all used as sources of data.

Analysis of the data adopted case study methods, although these were modified based on complexity ideas. Analysis of data occurred at two levels. The first analysed data that were relevant to the research questions. This involved conventional methods - such as basic statistical analysis of quantitative data, and an inductive approach for the analysis of qualitative data. A second level of analysis, informed by complexity's ideas of holism and irreducibility, was also done. This analysis sought emerging trends from all data collectively and across all three of the research questions, rather than viewing each one in isolation.

The findings from this research indicate that MOOC participants were likely to increase the number and depth of interactions they were having about education futures. Some participants also indicated a change in their thinking as a result of being involved in this project. However, secondary findings revealed a more nuanced view of the education reform landscape. Three key ideas that emerged are as follows: the potential presence of echo chambers in education; conflicts about who is responsible for reform; and the impact of time constraints. Taken together, these ideas suggest that the system has a number of negative feedback loops that are acting to restrict urgent and critical reform efforts. The findings from this research point to significant challenges for those supporting the ideal of a democratic, egalitarian, public education system in the future.

1.3 Overview

This thesis begins by making the case that unanticipated complexity characterises reform efforts in the past and present. An argument is then made that, at least in part, past and present reform efforts have been limited by the dominant reductionist paradigm that has colonised our thinking about education. Complexity thinking is proposed as an alternative theoretical framework for thinking about education reform. Following this, the methodology and methods of this research project are described. Chapter Four begins by discussing the MOOC, looking at how complexity thinking and other literature influenced its design. Chapters Four and Five outline the research design and describe the methodology and methods. The findings are summarised in Chapter Six. Chapter Seven discusses the significance of the results. The final chapter discusses the implications of this research.

2 The problem of change

Introduction

This chapter outlines some past examples and current initiatives for educational change in New Zealand in order to show how reform efforts are often fraught with conflict, complexity and compromise. It argues that at least some of this complexity is the result of the incompatible ideologies that underpin debates in education. The chapter then looks specifically at the future-focused reform efforts (also known as '21st century learning'). A brief history of this movement is given, and some of the critiques of it are outlined. The chapter ends with an account of some of the limitations of the future-focused education discourse.

2.1 Education past and present

In the past 150 years, New Zealand education has seen a multitude of changes, including the development of state schooling in the 1870s, followed a century later with the Tomorrow's Schools reform in 1989 (Gordon, 1992; Novlan, 1998). In 2002 a new qualification system for students from years eleven to thirteen was implemented (New Zealand Qualifications Authority, n.d.), and in 2007 a completely new curriculum was introduced (Schagen, 2011). National Standards were introduced in 2010, requiring schools to report on the literacy and numeracy levels of students from years 1 to 8 to the Ministry of Education and to parents, (Ministry of Education, 2010; The New Zealand Assessment Academy, 2009). Most recently, the Investing in Educational Success (IES) policy was introduced. These are just a few of the large number of reforms the New Zealand public education system has experienced over the century and a half of its existence. The next section looks at three of these reform attempts, arguing that, as it has been implemented, each one has encountered unanticipated complexity. These three examples are designed to illustrate how change in education is usually characterised by conflict, compromise and complexity.

2.1.1 1877 Education Act

The 1877 Education Act legislated for universal national primary school education in New Zealand. Before this, the responsibility for education fell to the provinces (Stephenson, 2009). While some provinces had established sound financial and administrative systems, this was not the case for all (Stephenson, 2009). Additionally, there were major inequalities. Education was primarily accessed by the wealthy or the socially advantaged, and for them it was the route to a professional career. For the socially disadvantaged, education was a way to manage the threat of social instability by instilling conformity and industriousness (Stephenson, 2009).

The 1877 Education Act saw a shift in the responsibility for educating children from the provinces to the newly formed government (Macpherson, 1989; Stephenson, 2009). At the time,

it was argued that the provincial system in operation was leading to inequality, and that this act might serve as the "foundations on which could be built a just and egalitarian education system" (Stephenson, 2009, p. 9). While admirable in its intent, this legislation was controversial (Cumming & Cumming, 1978; Stephenson, 2009). Inevitably compromises were reached, such as the decision that public education should be secular to allow freedom from and of religion (Stephenson, 2009).

After the Education Act had been passed into law, there was heated debate, specifically around fear of religious instruction, economic impacts and the enforcement of compulsory attendance (Cumming & Cumming, 1978). Hence, while the intent was equal opportunity, other variables meant that this legislation was not always well received. For example, the great depression of the 1880s occurred shortly after the implementation of this legislation. Wage-earning families were particularly affected as they were no longer able to withdraw their children from school to support family finances (Cumming & Cumming, 1978).

2.1.2 Tomorrow's Schools

The hundred-year period after the 1877 Education Act saw several other major reforms to New Zealand's public education system, many of which were focused on developing an equitable secondary education system. In the late 1980s there was a major shift in thinking about the administration of education. The significant political and economic upheaval of the time precipitated vociferous debate about whether education is a 'public good' or a private (individual) good', and whether the state should be the primary 'provider' of education 'services'. A review of the whole education system was commissioned and published as the 1988 report, *Administering for Excellence.* This report, known as the Picot report, served as the basis of the 'Tomorrow's Schools' policy implemented in 1988 by the Labour Government of the time (Macpherson, 1989; Ray, 2009). There was massive restructuring of the education system, aimed at producing "greater effectiveness, efficiency and equity" (Macpherson, 1989, p. 31), greater community involvement, and more power and control for parents (Ray, 2009).

The Tomorrow's Schools reforms were highly significant in forming the current New Zealand education landscape. The economic reforms that accompanied them have been characterised as "one of the most notable episodes of liberalisation that history has to offer" (Evans, Grimes, Wilkinson, & Teece, 1996, p. 1856). Tomorrow's Schools introduced free market ideals into the education sector (Philips, 2000). The many flow-on effects include the Boards of Trustees governance model, competition between schools, fee-paying students in schools and tertiary education, and operational funding being managed by schools. The Tomorrow's Schools Act is responsible for the autonomy with which New Zealand schools function today (Gordon, 2006).

The Tomorrow's Schools reforms, like the 1877 Education Reforms, were controversial. Critics argued that the changes were not about educational improvement, but about economic policy.

In the years following the introduction of Tomorrow's Schools, New Zealand saw a significant increase in the difference between the top and bottom wage earners, and general increases in inequality (Glennerster, Hills, Piachaud, & Webb, 2004; Wylie, 1991).

2.1.3 Communities of Learning

In January 2014, the government announced a policy called Investing in Educational Success (IES). One of the initiatives of IES was to establish entities called Communities of Learning, later renamed to Kāhui Ako. These are groups of schools that are provided with additional resourcing to allow collaboration between schools and their teachers. In justification of this initiative, the Ministry of Education argued that collaborative professional problem solving can lead to "significant and sustained" improvement in educational outcomes (Ministry of Education, 2016a, p. 2). A second initiative under the IES legislation was the establishment of the Teacher Led Innovation Fund (TLIF). This funding is intended to support the development of innovative practices, specifically where these might improve learning outcomes for 'priority learners'.[1] The intent of both the Teacher Led Innovation Fund and Communities of Learning, was to accelerate the spread of effective teaching and leadership across the New Zealand education system (Ministry of Education, 2014, 2016). These initiatives and their associated resourcing were specifically targeted at 'priority learners'.

The announcement of IES was met with debate, even leading to protests (Moir, Wilson, & McLeod, 2014). The final policy saw a compromise between the primary and secondary teachers' unions (NZEI and PPTA), and the government (Ministry of Education, 2014; New Zealand Post Primary Teachers' Association, 2017). However, the Post Primary Teachers' Association stated in their 2017 report to the incoming minister that the roll-out of this policy was "disappointing", citing the narrow range of approved achievement challenges as one of their concerns (New Zealand Post Primary Teachers' Association, 2017). A report from the New Zealand Council of Educational Research published in 2016 also indicated that the implementation of Communities of Learning was more complex than anticipated, with many of the roles promised by 2017 still not in place (Wylie, 2016). Additionally, it is worth noting that under the Tomorrow's Schools reform, schools were set up to compete, in line with market liberalisation. In direct contrast to this, IES calls for collaboration between schools. Yet, none of the legislation from the Tomorrow's Schools reform has been amended to reflect this shift from competition to collaboration.

In conclusion, New Zealand education has been subjected to many reforms. These reforms are usually politically driven, top-down and with admirable intentions. Yet they rarely appear to have the desired effects, frequently encountering unanticipated conflict and complexity in their

[1] The term 'priority learners' is used in New Zealand education policy to refer to various groups traditionally under-served by the schooling system. It includes Māori, Pasifika, students from low socio-economic families, and students with special education needs.

implementation. Additionally, each reform has faced opposition, which has resulted in some measure of compromise to reach consensus.

2.2 Education's conflicting purposes

As discussed above, the development of education policy is often complex because unanticipated consequences emerge. Despite good intentions, new policies are met with intense debate. Upon implementation, these policies rarely live up to their promise. Many scholars of education have attempted to explain this phenomenon, for example, Egan (2001) and Biesta (2009). Egan (2001) argues that education is so "difficult and contentious" because it has three quite different (and philosophically incompatible) purposes. Evaluating the 'success' of education initiatives is fraught with difficulty because different parties prioritise different purposes, and consensus is difficult. Table One below draws on Biesta (2009) and Egan, 2001) to summarise these three conflicting purposes.

Table 1: Purposes of education

Purpose	Description
Knowledge and/or qualification development	The knowledge development purpose of education as upheld by Plato maintains that the 'best' accumulated knowledge is learnt and that it transforms the mind of the student to become increasingly rational (Egan, 2001). In application, this is the provision of particular knowledge and skills for set purposes. These include preparation for the workforce, and contribution to economic development and growth (Biesta, 2009).
Subjectification or individual development	Subjectification, initially described by Jean-Jacques Rousseau, maintains that the purpose of education is to develop the individual to become more autonomous and independent in their thinking. Rousseau's ideas about a developmental curriculum are significant because they formed the foundation upon which Piaget and Vygotsky's theories were built (Egan, 2001). Many of today's debates around personalisation in education draw on Rousseau's work.
Socialisation	Finally, the socialisation purpose of education seeks to impart the norms and values of a particular society (Biesta, 2009; Egan, 2001). For Dewey (2012) education is the process by which a social group moulds or shapes immature members into its social forms. Additionally, the socialisation purpose also seeks to inculcate ways of being, or cultures of inquiry within an academic domain as mathematician, scientist, sociologist and so forth (Biesta, 2009; Kuhn, 2008). This means that a third purpose of education is that it helps young people learn to navigate the social codes of their society successfully (Dewey, 2012).

2.2.1 The purpose of education in application

The dissonance brought about by these conflicting philosophies is evident in the debates that surround each reform. For example, in relation to the 1877 Education Act, Charles Bowen (a Member of Parliament at the time) declared that through education, the masses would learn self-control, and to be moral and disciplined citizens (Stephenson, 2009). The socialisation purpose is evident in Bowen's view, as it highlights the policy's intention to inculcate the democratic norms and values of the newly formed New Zealand government. However, through the emphasis on the needs of the state, this policy devalues the needs of the individual or family, such as the need during the great depression for children to contribute to family finances.

In contrast, the Tomorrow's Schools reform is recognised for its neoliberal, free-market idealism. This saw a shift from the view of education as a public good, to education as an individual good, while at the same time supposedly allowing parents and community greater involvement (Ray, 2009). Ray (2009) explains that while these education policies aimed to develop moral and social democratic citizenship, the rhetoric remained on the contribution of individuals to national development and its economic needs. Thus, this reform too saw a conflict of interest between the socialisation purpose of education that aimed to inculcate democratic citizens and the qualification purpose that saw preparation for the workforce and economic contribution.

The Investing in Educational Success policy also sees these fundamentally irresolvable purposes of education come to a head. The increased collaboration, resourcing and new leadership roles have all been cited as positives for teachers and school leaders. However, there are those who suggest that these policies are merely a response to New Zealand's slipping performance in international measures (Bendikson, 2015). The focus of Communities of Learning (Kāhui Ako on raising achievement (Ministry of Education, 2016a) prioritises academic achievement, and thus the qualification purpose of education. And there are concerns that the achievement challenges that Communities of Learning must establish is too narrow, as many schools would prefer to target competencies instead (Ministry of Education, 2014; New Zealand Post Primary Teachers' Association, 2017). Again, this presents a tension between the qualification purpose of education, and the preference to instead focus on the development of the individual under the subjectification purpose.

2.2.2 Conclusions

The examples above illustrate that a variety of implicit ideologies are in play in reform debates. As a result, reform attempts are likely to be met with opposition as different stakeholders in

education prioritise these competing commitments differently. This establishes a significant problem in education reform, as the opposition may serve as a barrier towards the successful implementation of necessary reform attempts.

2.3 Future-focused Education

Towards the end of the twentieth century, a new reform movement in education started to emerge. The next section describes this movement. It looks at the global mega-trends that catalysed it and then at the literature advocating the need for education to change in response to these trends. The limitations and some of the critiques of this work are discussed.

2.3.1 History of the future; where did future-focused education come from?

Towards the end of the twentieth century, thinking about education began to shift in response to certain emerging mega-trends (Bolstad et al., 2012; Robertson, 2005; Wood & Sheehan, 2012). These mega-trends were seen as accelerating the pace at which society was experiencing change. The digital revolution saw rapid technological advances reminiscent of the Industrial Revolution of the 1800s (Brynjolfsson & McAfee, 2012). The Knowledge Economy saw knowledge, its production, and exploitation, come to be seen as central to wealth creation in the 'new times' (Gilbert, 2005; Houghton & Sheehan, 2000; Wood & Sheehan, 2012). Concerns were mounting about 'wicked problems', and the Anthropocene (Bolstad, 2011; Bolstad et al., 2012; Crutzen, 2006; Frame, 2008). All of these were occurring against a backdrop of globalisation (Delors et al., 1996; Houghton & Sheehan, 2000; Levitt, 1993; Wood & Sheehan, 2012). Together, this literature argues, these global mega-trends have produced unprecedented levels of complexity, rapid change and volatility (Bennett & Lemoine, 2014; Houghton & Sheehan, 2000). These trends are briefly described below.

2.3.1.1 Globalisation

Globalisation can be understood as the escalated interconnectedness of the world's economic activities. This heightened level of interconnectivity was catalysed by deregulation of the financial sector and easing of competition laws in the 1980s (Houghton & Sheehan, 2000; Levitt, 1993), the impact of which, was accelerated by the increasing presence of information communication technology (Hatzichronglou, 1996). While deregulation freed capital movements, the easing of competition laws meant that domestic markets were no longer protected from international competition. The combination of these events saw the emergence of a new global competitiveness (Houghton & Sheehan, 2000; Levitt, 1993). This increased movement of capital and production across an international rather than domestic market, saw a considerable increase in interconnectivity. As a result, we have seen a huge increase in

complexity as new global power relations, affiliations and connections emerged (Murdoch & Miele, 1999).

2.3.1.2 Knowledge Economy

The beginning of the 21st century saw knowledge take on a new role with the rise of the knowledge economy. This involved a shift from the mass production of goods to the intensified production, manipulation, and exploitation of knowledge (Florida & Kenney, 1993, p. 637). This shift was amplified by the digital revolution, which meant that the cost of manipulating, transmitting and storing of information had become increasingly insignificant (Houghton & Sheehan, 2000). Florida and Kenney (1993, p. 638) illustrate this shift from the production of goods to the production of knowledge, saying that "before, when we came to work in the morning, we used to check our minds at the factory gate, now we are the source of innovation."

2.3.1.3 The Digital Revolution

G. E. Moore (1965), wrote that the number of transistors in integrated circuits have been doubling every 18 months. This prediction became known as Moore's law and has held true with remarkable accuracy since Moore's initial prediction in 1965 (Guarnieri, 2016; Hull, 1997). This exponential trend has meant the rapid advancement of digital technologies which, in turn, have redefined economies, knowledge and relationships (Brynjolfsson & McAfee, 2012; Gardner & Davis, 2014; Gilbert, 2007; Hull, 1997; Weinberger, 2011). Additionally, we are also now seeing the synergistic combination of technology, such as nanotechnology and biotechnology (Bainbridge, 2013). This converging of technologies further contributes to the already exponential pace at which the digital revolution is advancing. Some commentators are referring to this convergence as the 'Singularity' (Kurzweil, 2005).

There is increasing concern about the risks to employment posed by automation and increasing computing power (Arntz, Gregory, & Zierahn, 2016; Brynjolfsson & McAfee, 2012; Frank, Sun, Cebrian, Youn, & Rahwan, 2017; Frey & Osborne, 2013). As technology substitutes for labour, workers are required to acquire new skills. This is becoming increasingly challenging as computing power advances exponentially, meaning that computers are entering increasingly cognitive domains (Brynjolfsson & McAfee, 2012; Frey & Osborne, 2013).

2.3.1.4 The Anthropocene and wicked problems

The global scale of environmental degradation has reached a point where human activity is influencing the earth's natural processes (Crutzen, 2006). These activities have not only continued but have escalated as the population has increased (Emmott, 2013). The term "Anthropocene" has come to represent this geological epoch, characterised by the extent that

human activity has modified the global environment (Smith & Zeder, 2013). These activities have resulted in various 'wicked problems' that need urgent attention (see Head and Alford (2015) for an explanation of the term 'wicked problem'). Climate change is one such wicked problem as it poses significant risks for humanity. These include rising sea levels affecting coastal communities and infrastructure, drastic differences in climate impacting global food production through changing weather patterns, as well as an increased risk of natural disasters (Kolbert, 2014; Stokes et al., 2015). Other wicked problems include radical inequality, water shortages and political instability.

2.3.2 Impact on education

Globalisation, the digital revolution, the knowledge economy and the rise of wicked problems contribute to a new "spirit of our age ... characterised by uncertainty, rapid change, realignment of power, upheaval and chaotic behaviour" (Sardar, 2010, p. 435). Sardar terms this "post-normal times", in reference to the idea that there is no longer a normal, as the world has reached a new state of constant flux and complexity. It is in response to these post-normal times that the future-focused education discourse emerged.

The 1990s saw the publication of a number of influential reports on the future of education, sponsored by major international organisations like the OECD (Organisation for Economic Co-operation and Development, UNESCO (United Nations Educational, Scientific and Cultural Organization), and the World Bank (Bolstad et al., 2012; Robertson, 2005). A 1991 UNESCO report that came to be known as the Delors report made a series of recommendations for education in the 21st century (Delors et al., 1996). Later, in the DeSeCO project, the OECD made the case for certain key 'competencies' needed by individuals to thrive in a changing world and to contribute to a well-functioning society (Organisation for Economic Co-operation and Development, 2005). This approach was influential, heralding what was later seen as a (contested) shift away from acquiring knowledge and 'knowing', to a focus on ways of 'being' (Priestley & Sinnema, 2014).

These events were the catalysts for the development of the 'future-focused education' discourse (Wood & Sheehan, 2012). This discourse is not easily defined, but is a better seen as a cluster of emerging ideas, theories and practices that have developed in response to the mega-trends identified above, and to new understandings about learning and knowledge (Bolstad, 2012). Many of these ideas, theories and practices are as ideologically conflicted as those underpinning past reforms. Bolstad (2012) suggests that there are three main ways of understanding the term 'future-focused education': thinking about what students need for their future lives; about how schooling might need to change; and about how best to prepare young people to think in future-focused ways.

The Delors report and the DeSeCo project initiated the discourse now known as 'future-focused education': however, there have been many developments since then. Educationists have continued to develop arguments in support of radical change in schools, both internationally and in New Zealand (Berry, 2011; Bolstad et al., 2012; Claxton, 2013; Facer, 2011; Gilbert, 2005; Robinson, 2011; Wagner & Compton, 2012). A common theme has been the need to shift away from an industrial-age model of education. However, what this shift entails has seen many different interpretations, some of which are summarised below.

Lifelong-learning and the learnification of school

The Delors report argued that given the rapid evolution of science, technology, economy and social activity, education would need to become a lifelong endeavour to develop the adaptability required to thrive in a world of rapid and constant change (Delors et al., 1996). Additionally, as autonomous machines replace increasingly complicated jobs, one might argue that retraining and further education becomes increasingly important in transitioning to new roles. Kennedy (2008, p. 17) suggests that as a result, this concept of lifelong learning has become "*almost a mantra",* as both teachers and students are called on to become lifelong learners (Bolstad, 2012).

This idea of lifelong learning has been built on by several academics, including Claxton (2013, 2017), who suggests an approach to schooling that involves 'building learning power'. The work of Dweck (2012) on 'growth mindsets' has also been drawn on extensively, as schools have worked to make sense of what being a lifelong learner means in practice.

Creativity, critical thinking and problem solving

Gilbert (2005) suggests that in the industrial age model, schooling's focus was on students acquiring knowledge in preparation for their future life. In contrast, the future-focused education literature suggests that it is the '*how'* of knowledge rather than the '*what'* that is now important. In other words, the focus has shifted from learning content, to being able to use knowledge critically and creatively to problem solve (Berry, 2011; Gilbert, 2005; Robinson, 2011; Wagner & Compton, 2012). This emphasis on creative problem solving stems from the belief that the long-term success of economies relies on the creation of new ideas, products and services to create wealth (Wagner & Compton, 2012).

Much has been written about creativity and problem solving as a response to the shift from acquiring knowledge to applying knowledge. For example, educationist Ken Robinson argues for a move away from the industrial model of education towards increased creativity. The increased focus on creativity has seen the rise of approaches such as design thinking and 'maker' education (Halverson & Sheridan, 2014; Wagner & Compton, 2012). Project based learning and inquiry learning have also been adopted in response to the focus on the application of knowledge rather than acquisition alone (Bell, 2010; Wagner & Compton, 2012).

Diversity and collaboration

A further essential element of future-focused education is the focus on diversity as a resource to be actively fostered (Bolstad, 2012; Facer, 2011). This is a significant shift from the industrial model that requires students to conform in order to fit within the system. Instead, this discourse recognises that diversity is a requirement for creativity and innovation and should be fostered. And further, we require a workforce that can draw on the expertise and perspectives of others effectively, who can synthesise and use this diversity for collaborative problem solving.

While collaboration is not new to the education discourse, the justification for using it as a pedagogical strategy now stretches beyond the positive impact it can have on student achievement. As Bolstad (2011) and Facer (2011) remind us, a key part of future-focused education is preparing students to address the wicked problems that threaten society. The nature of wicked problems means that they stretch disciplinary boundaries (Frame, 2008; Hipkins, Bolstad, Boyd, & McDowall, 2014). Thus, in order to address these (and other complex problems that are increasingly dominating everyday life), collaboration with many diverse disciplines and perspectives is required.

This shift has seen an increased focus on student-centred learning, including personalisation, to foster rather than suppress diversity (Bolstad, 2012; Dumont, Instance, & Benavides, 2010). Again, project based learning can be identified as a key practice, as it creates the conditions for complex problem solving across interdisciplinary and social boundaries (Bell, 2010; Wagner & Compton, 2012).

2.3.3 Critiques of the future-focused education discourse

The future-focused education literature has its critics. One key theme is what some consider the "hollowing out" of knowledge (e.g. Rata 2012), while another is concerned with social justice issues (Butt, 2017; M. Young, 2007). Young (2007) argues that future-focused education can deny students access to 'powerful knowledge', and in doing so actively reproduce social inequalities (M. Young, 2007, 2010). Rata and Barrett (2014) support Young's claims, arguing for a curriculum built on knowledge. They claim that a focus on personalisation and student centeredness limits students to their own experiences, rather than providing access to conceptual and intellectual tools that might provide the means for conceptualising a future beyond the lived reality (McPhail, 2016; Rata, 2012; Rata & Barrett, 2014; M. Young, 2007) (McPhail, 2016; Rata, 2012; Rata & Barrett, 2014; M. Young, 2007).
The competency-based (as opposed to knowledge-based) curriculum has also been condemned as 'indoctrination' (Priestley & Sinnema, 2014). It is argued that the new approaches are "setting out not what children are expected to know, but how they should *be"* (Watson, 2010, p. 88). Other scholars have argued that the competency based discourse was

developed in response to economic rather than humanitarian demands (Facer, 2011; Robertson, 2005; Singh, 2015), and that it is likely to amplify existing inequalities (Facer, 2011; Rata, 2012).

In summary, concerns about the future-focused education discourse centre largely on students in their future lives and how schooling might need to change. However, with the exception of Facer (2011), these critiques in general do not focus on the third understanding of future-focused education - the need to prepare young people to deal with future-focused issues.

2.3.3.1 Limitations

While references to 'future-focused education' have been everywhere for the past two decades or more, the uptake of this discourse has been limited (Gilbert, 2013; Voogt, Erstad, Dede, & Mishra, 2013). Change rarely moves beyond adoption and implementation to institutionalisation (Fullan, 2000). For example, the Investing in Educational success policy (discussed earlier) is a response to the future-focused advocacy of collaboration and the call for innovation. However, its roll-out has been called "disappointing" (New Zealand Post Primary Teachers' Association, 2017, p. 9) and "more complex to bring to life than the initial political expectation" (Wylie, 2016, p. 19), just as the politically driven 1877 Education Act and the economically driven Tomorrow's Schools reforms were. And like the earlier reforms, the future-focused education discourse has also found itself in the crosshairs of debates about education's purpose. While some focus on the economically driven objectives, others have focused on the democratic and egalitarian.

One possible reason for the limited uptake of these ideas is that they require substantial change in practice from teachers and school leaders (Benade, 2017; Bolstad et al., 2012; McLaren, 2013). While the field of research on teacher education and teacher professional learning is huge, there is little research investigating the impact of teacher professional learning on student outcomes (Wiseman, 2012; Yoon, Duncan, Lee, Scarloss, & Shapley, 2007). And, while there is much discussion of the need to prepare students differently for the world of the future, there is very little work focusing on how to support *teachers* to work differently (Dole, Bloom, & Kowalske, 2015; Gilbert, 2013).

Gilbert (2013, p. 105) argues that in order for teachers to design future-focused learning programmes, they need to change how they "think, know, and learn". This change requires not just 'informational learning' (adding more to what they already know), but 'transformational' learning (thinking about what they know differently) (Drago-Severson & Blum-DeStefano, 2014; Gilbert, 2013). However, there has been little support for this kind of change, with the result that ideas from the future-focused education discourse are now largely slogans or buzzwords, assimilated into existing understandings (hence the need for the Education Review Office to publish a glossary of '21st century education' terms). Most people understand future-focused education to mean the adoption of digital technologies or the new 'modern learning

environments'. The substantial mind-shift it requires is not widely acknowledged or supported (Gilbert, Bull, Giroux, & Stevens, 2015).

While teachers and school leaders are at the forefront of educational change, they are not the only players. Successful and sustainable school reform requires conditions and infrastructure outside schools to support those on the inside (Fullan, 2000). For example, educators and school leaders making shifts towards new schooling models can attest to the challenges this presents to their communities (see for example the perspectives from Redmond (2017) and J. Carroll (2015) in regards to future-focused schools in New Zealand). As yet, there appears to be little research on the role parents and community members are playing in the transition to future-focused education, despite the large involvement that the New Zealand school governance model demands from parents and community.

2.4 Conclusions

There is much contemporary rhetoric about future-focused change in education. However as has happened in the past, reforms have been met with complexity, conflict and compromise. Alarmingly, the world is now categorised by even more complexity through the rise of globalisation, information and communications technologies and the interrelatedness of environmental issues. Complexity plays a fundamental role in understanding current mega-trends and future-focused education reform. Yet, despite the pervasiveness of our heightened interconnectivity, complexity theory is only just beginning to be used in the future-focused education literature.

The starting point of this thesis is that the need for change is now urgent, if we want a viable public education that can foster democratic and humanitarian ideals in the future. The purpose of the thesis is to argue for a new approach to thinking about future-focused education reform. The next chapter makes the case for applying a complexity-influenced framework to future-focused education reform.

3 From reductionism to complexity

3.1 Introduction

Chapter Two outlined the conflict, complexity and compromise which besets education reform efforts past and present. It then considered future-focused reform efforts, highlighting the increasing complexity of post-normal times. This chapter argues that if we are to continue having a viable public education system, a new theoretical framework is needed. It argues that educational discourse has been limited by reductionism, and proposes complexity thinking as a theoretical framework that can accommodate the complexity of future-focused education reform. The strengths and limitations of complexity approaches are discussed, and the 'safe-to-fail experiment' concept is introduced.

3.2 Reductionism

3.2.1 An introduction to reductionism

Reductionism makes the assumption that all aspects of complex phenomena can be understood by reducing them to their parts (Capra & Luisi, 2014). Or, as Brown and Smith explain, "reductionism … does not aim at analysing how wholes are put together from parts, but rather at explaining wholes away" (2003, p. 29). For example, reductionism maintains that biology is reducible to the laws of physics and chemistry (Capra & Luisi, 2014; Waldrop, 1993).

This approach originates in the work of Descartes and Galileo, who conceptualised the world as a machine operating by precise mathematical laws (Capra & Luisi, 2014). Their conceptual framework was later built on by Newtonian mechanics, as Newton was able to show the mechanical laws governing celestial bodies and other phenomena (Biesta, 2010; Capra & Luisi, 2014). The rise of reductionism was supported by Bacon's work on empiricism and the scientific method, and again during the discovery of cell theory and biochemistry (Capra & Luisi, 2014). This combination of empiricism and reductionism led to the belief that only observable, measurable primary qualities of phenomena could produce genuine knowledge (Loughborough, 1991).

Reductionism came to represent a mechanistic view, characterised by linear causality, objectivity and predictability (Capra & Luisi, 2014; Davis & Sumara, 2014; Kuhn, 2008; Snyder, 2013). This mechanistic view has since developed into three distinct types, methodological, epistemological and ontological reductionism (Beresford, 2010; Loughborough, 1991). As a result, reductionism has been applied extensively in the sciences and sociology. Many other fields have also adopted this theoretical framework, for example, John Maynard Keynes applied reductionism to economics where he sought to reduce the complex economic landscape to its *parts,* in order to command and control economics at a government level (Capra & Luisi, 2014).

3.2.2 Reductionism in education

The reductionist paradigm has influenced education extensively (Loughborough, 1991; Miller, 1990; Reich, Garrison, & Neubert, 2016). This influence is evident in education research, policy and practice (Mason, 2009; Reich et al., 2016). For example, Reich et al. (2016, p. 1009) argue that "the habits of reductionist compartmentalisation influence our research and outlook on education." An example of this is the widespread use of the linear causality model in education research. In this kind of research, researchers look at whether a change in input A 'causes' a change in output B. In education this usually takes the form of investigating the effects of an intervention on, for example, student achievement in literacy.

Education policy also utilises reductionism. Policies are frequently implemented with implicit assumptions about linear causality, where cause (policy) and effect (improved educational outcomes) is assumed (Capra & Luisi, 2014; Mason, 2009). An example of this in New Zealand is the introduction of National Standards as a means to clarify expectations for progress and achievement in literacy and numeracy (Ministry of Education, 2010). The influence of reductionism is evident here, both in terms of the cause and effect assumptions, but also in the way that this policy seeks to address literacy and numeracy by reducing them to objective, standardised, measurable variables.

Reductionism has impacted curriculum as well. For example, complex academic fields such as mathematics, science, and history have been reduced to impersonal, standardised learning and achievement objectives, allowing them to be measured and compared objectively (Loughborough, 1991; Reich et al., 2016). We can see this tendency in education towards the quantifiable, objective and impersonal in the global preoccupation with PISA scores too (Reich et al., 2016; Thruppe, 2017).

3.2.3 Critiques of reductionism

While the reductionist theoretical framework predominates in education, it has many critics. Some scholars argue that not everything can be understood via a reductionist theoretical framework. Some properties cannot be found in the parts, but instead only emerge at a higher level through the interaction of the parts (Beresford, 2010; Capra & Luisi, 2014; Loughborough, 1991; Miller, 1990; Reich et al., 2016). For example, school culture only emerges at the higher level; it does not emerge at the individual level. A second criticism is the tendency to favour research that follows the reductionist demands of objectivity, quantification, and linear causality, over holistic approaches (Capra & Luisi, 2014). This, as Loughborough (1991) argues, presupposes that all knowledge is generated via the methods used in science. Loughborough is critical of the way the social sciences have emulated science with attempts to formulate general

laws that can make predictions. Loughborough points out that this search for generalisable patterns dismisses the individual as well as the outliers. Reich et al. (2016) claim that this objectivity and standardisation in education can be especially harmful, as this impacts student-teacher relationships, and dismisses cultural constraints.

Other criticisms of reductionism suggest that the demand for quantifiable, measurable variables risks oversimplification of complex phenomena. (Beresford, 2010; Johnson, 2008). Additionally, this requirement to identify quantifiable variables means that reductionism is unable to conceptualise the complexities of social realities (Kuhn, 2008). For the education futures literature, this limitation is particularly relevant as this discourse is in response to a world characterised by increased complexity, volatility, uncertainty and unpredictability (Bennett & Lemoine, 2014; Dator, 2011; Facer, 2011, 2016; Sardar, 2010; Slaughter, 2015).

3.2.4 Reductionism and education reform

Reductionism prevails in policy contexts as well as in research (Duit, Galaz, Eckerberg, & Ebbesson, 2010; Johnson, 2008; Snyder, 2013). Reform efforts are predicated on linear causality models, and the assumption that variables in the system can be isolated (Johnson, 2008; Snyder, 2013). However, critics argue that these assumptions oversimplify the education system, resulting in unsustainable or overly narrow policies, and system paralysis (Snyder, 2013). Further, Johnson (2008) and Reilly (1999) contend that assumptions of linear causality often lead to public perceptions of failure when spending on the reforms does not produce the anticipated benefits.

Education reform efforts over the last 150 years or so have largely assumed the reductionist paradigm. The resultant failure to deal with the complexity that is a feature of all education systems has limited the success of these reforms. And further, the limitations of this paradigm become even more apparent as we move into the complexities of ‘post-normal’ times.

3.2.5 Future-focused education reform and reductionism

The future-focused education discourse developed in response to increased complexity in our social, political, economic and environmental landscapes. In a number of ways, it is not a good fit with a paradigm based on assumptions about predictability and linear causation. For example, its emphasis on competencies does not mesh easily with approaches to learning and assessment that reduce these to measurable achievement objectives. The development of creativity, complex problem solving or collaborative ability cannot sensibly be measured via the methods currently used to assess progress in reading, writing and arithmetic (Silva, 2009). Attempting to do this will result in the simplification of these competencies, which is likely to have the same deleterious effects as the oversimplification of the disciplines. As Rata and

Taylor (2015) argue, the compartmentalisation of knowledge that has resulted from current assessment methods has produced a loss of epistemic coherence and conceptual progression in the disciplines.

Future-focused education reforms demand change at multiple levels of the system. They require a shift in teacher practice, in assessment, in the use of technology, and even in school governance (Berry, 2011; Bolstad et al., 2012; Facer, 2011; Gilbert, 2013; Gilbert et al., 2015; Silva, 2009; Wagner & Compton, 2012). Top-down policy approaches to this kind of complex shift are likely to be too narrow.

In conclusion, the reductionist assumptions that have underpinned education reform efforts, are not likely to be capable of supporting and sustaining future-focused change. Accordingly, scholars are increasingly arguing for a shift away from reductionist approaches to policy, to complexity-oriented frameworks (Duit et al., 2010; Johnson, 2008; Reilly, 1999; Snyder, 2013). The next section of this chapter explores what a complexity-oriented approach to education reform might look like.

3.3 Complexity

The previous section made the case that the reductionist paradigm, while it has dominated educational thinking, has significant limitations. These limitations appear to have affected past attempts at reform, and the argument has been put forward that the same is likely to happen for future-focused education reforms. However, these limitations are more significant in relation to future-focused reforms because these reforms are a response to the Age of Complexity (Jorg, 2017). The following section summarises work by a range of scholars who advocate adopting complexity-oriented approaches to reform (Duit et al., 2010; Gilbert, 2018; Hetherington, 2013; Johnson, 2008; Snyder, 2013; White & Levin, 2016). It looks at the meanings, origins, applications and limitations of complexity-oriented thinking.

3.3.1 Origins of complexity thinking

Complexity theory has its origins in the sciences, specifically cybernetics, neural networks, and cellular automata (Capra & Luisi, 2014; Manson, 2001; Mason, 2009). While some scholars consider complexity to be an offshoot of general systems theory, for others it was built on chaos theory and catastrophe theory (Manson, 2001; Mason, 2009). According to Mason (2009), complexity was first introduced to the social sciences in economics, and later to education. Complexity's adoption in education, and particularly education reform is more recent (Jorg, 2017).

Complexity thinking is a newcomer to the social sciences, and, in this context it is regarded by most as not yet being a fully-fledged theory (Kuhn, 2008; Richardson, Cilliers, & Lissack, 2001). The term 'complexity thinking' (as opposed to complexity theory) is widely used in the social sciences to refer to a cluster of emerging ideas, research and theory about complex adaptive systems. Some use the term complexity thinking to refer to the 'space between' reductionist complexity science, and 'soft 'complexity, based on language and the metaphorical (Hetherington, 2013; Richardson & Cilliers, 2001). This project's epistemological position draws on these understandings of complexity thinking.

3.3.2 Complex systems

Waldrop (1993, p. 1) describes complexity as the "ordered state on the edge of chaos". This state is characterised by a very large number of interactions, which enable self-organising, open-ended systems (Capra & Luisi, 2014; Davis & Sumara, 2014; Kuhn, 2008; Snyder, 2013). Through the non-linear interactions of these highly dynamic systems, new properties emerge (Capra & Luisi, 2014; Davis & Sumara, 2014; Kuhn, 2008; Snyder, 2013). Complexity thinking's ontology emphasises interconnectedness, holism and unpredictability. The properties described here are in direct contrast with reductionism that assumes atomistic closed systems and predictability (Capra & Luisi, 2014; Gilbert, 2018; Loughborough, 1991).

Table 2 compares ideas from the complexity paradigm with those from the traditional reductionist paradigm, drawing on the work of the following scholars: (Capra & Luisi, 2014; Davis & Sumara, 2014; Hetherington, 2013; Koopmans, 2017; Kuhn, 2008; Loughborough, 1991; Mason, 2009; Miller, 1990; Morrison, 2009; Reich et al., 2016; Richardson & Cilliers, 2001; Snyder, 2013; White & Levin, 2016).

Table 2: Complexity thinking compared to reductionist thinking.

Reductionist thinking	Complexity thinking
Small changes have small effects	Small changes may have radical effects
Objective	Epistemic
Structure	Process
Measuring	Mapping
Building blocks	System of organisation
Hierarchical	Self-organising
Linear causality	Non-linear causality
Predictable	Dynamic and emergent
Parts of a whole	Irreducible

Reductionist thinking	Complexity thinking
Analysis	Sensemaking
Concise	Redundancy
Certainty	Approximate knowledge
Parts	Relationships
Fragmentation	Holism
Independent variables	System memory and history
Functions	Properties
Sum of the parts	Greater than the sum of the parts
Standardised	Diversity
Efficiency	Redundancy

In summary, we can think of complexity as a 'state of being', a system that has patterns, trends and properties that emerge out of a very large number of interactions between the system's elements. The way these patterns, trends and properties emerge is not predictable in advance, because they are not the result of simple input versus output, cause and effect relationships. Instead, complex systems self-organise, diminishing or amplifying the effect of a stimulus. In complexity new events do not necessarily follow past patterns but are novel: thus following 'best practice' has only limited impact (Snyder, 2013).

While complexity in the social sciences is an emerging theory, there are some defining properties of complex systems that are generally agreed upon by scholars. These include: interactions, irreducibility, feedback loops, diversity and redundancy (Capra & Luisi, 2014; Davis & Sumara, 2014; Morrison, 2009; Richardson et al., 2001). Non-linear causality, self-organisation, emergence, and unpredictability have been discussed extensively in the complexity literature (Kim, 1999; Osberg & Biesta, 2007; Richardson et al., 2001; Van Beurden, Kia, Zask, Dietrich, & Rose, 2013; C. Young, 2016). Others, discussed less frequently, include system memory and path dependence (Capra & Luisi, 2014; Cilliers, 1998; Kuhn, 2008; Mason, 2009). The term 'system memory' refers to the idea that in complex systems, "*their past is co-responsible for their present"* (Cilliers, 1998, p. 4). Path dependence, also called lock-in, refers to the tendency of complex systems to maintain their momentum along a particular path until sufficiently disrupted by a competing phenomenon (Mason, 2009).

3.3.3 An epistemological conundrum

Complexity thinking has been taken up in the social sciences largely because it offers what reductionism cannot. Where reductionism seeks objectivity from researchers, in complexity

thinking this is not possible. While reductionism seeks to make predictions, complexity offers endless, unpredictable novelty. Reductionism attempts to find linear causality, whereas complexivists assume this to be highly unlikely. Thus complexity thinking is a complete paradigm shift from reductionism (Koopmans, 2017). However, because research is usually thought of in reductionist terms, using complexity in research contexts presents some major challenges. Some of these challenges are outlined below.

3.3.4 Methods of complexity informed research

A major challenge in using a complexity informed methodology for research in the social sciences is that there are few established methods. As a result, researchers attempting to adopt this 'paradigm shift' encounter a number of challenges.

3.3.4.1 No tried and true research methods

As identified earlier, complexity is not fully established as a theory in educational contexts (Gilbert, 2018; Koopmans, 2017; Kuhn, 2008), and researchers are only just beginning to conceptualise ways of studying complex systems. This is extremely challenging, given the extent to which our thinking is colonised by reductionist thinking (Gilbert, 2018; Waldrop, 1993). In addition, the endless novelty of complex systems means that 'tried and true' or 'recipe' approaches to research are not possible in complexity, as each context is unique (Kuhn, 2008; White & Levin, 2016). In response, Kuhn (2008) calls for researchers to develop their own complexity-inspired research approaches, and some have done this (e.g. Hetherington (2013); White and Levin (2016).

3.3.4.2 Irreducibility

For some, complexity is too complex to deal with, at least in conventional research terms (e.g. Nowotny as cited in Jorg, 2017). A major challenge is deciding where to begin, and what to actually do (Gilbert, 2018). If irreducibility and non-linear causality are being assumed, it becomes difficult to establish parameters, boundaries, or objects of study. It becomes difficult see how to 'find' anything, or even to see what the 'point' of the research would be, without being drawn back into reductionist assumptions.

3.3.4.3 Methodological borrowing

The lack of established methods in complexity has seen many researchers engage in what Gough calls "methodological borrowing" (Gough, 2012, p. 41). However, as Gough (2012), cautions, concepts such as validity, triangulation and so on, borrowed from other

methodologies, may be inappropriate in complexity contexts. This raises some hard questions about how we might define 'quality' in complexity informed research (Gilbert, 2018).

3.3.4.4 Objectivity and positionality

A further difficulty in complexity informed research is that the positionality of the researcher requires a rethink. Since complexity acknowledges the impact that small changes in a system may have (Capra & Luisi, 2014), it stands to reason that researchers will impact the (social) system that they are studying. This is a shift from the well-established reductionist paradigm that requires objectivity from the researcher, seeking to distance them from the research altogether to remove bias. Complexity, in comparison, acknowledges that the researcher is, inevitably, 'in the system'.

3.3.5 Application of complexity informed research

Another issue is the problem of generalisability: all complexity informed research is highly contextual, having few applications beyond the immediate context. This raises the question of what its use or purpose is.

3.3.5.1 Goals of education

Scholars agree that complex systems operate without a greater goal or ethical commitment (Kuhn, 2008; Mason, 2009). This contrasts with education, which is goal-oriented and normative (Kuhn, 2008). This raises questions about what the purpose of complexity informed education research might be (Gilbert, 2018).

3.3.5.2 Application of complexity informed research

Understanding what complexity might contribute to education poses some difficult questions for researchers. Due to the high degree of localised, non-linear interactions that result in unpredictability and constant novelty, a complexity informed approach has limited ability to make predictions and generalisations. Additionally, Callaghan (2008) suggests that complexity informed research has limited evaluative capacity as this requires cause and effect predictability. Therefore, with limited generalisability, predictability and evaluative capacity, complexity informed research potentially has limited applications for public policy (Callaghan, 2008).

Many of these limitations have to do with the emergent status of complexity thinking. It may be that some of these questions are later resolved. However, in the meantime, it seems that

working in this area will have to take place in the 'spaces between', that it will have to involve pragmatism, experimentation, hybridity, and thoughtful borrowing.

3.3.6 Strengths of complexity

Despite these challenges, using complexity thinking in education research has some significant advantages. Facing these challenges is a necessary part of working in an emergent research space.

3.3.6.1 Complexity as a theoretical framework for education

Paradigm shift

Complexity offers a theoretical framework that enables ontologies that are not possible in the reductionist paradigm (Jorg, 2017; Koopmans, 2017). It is a paradigm shift that is the equivalent of employing a new operating system in a computer, rather than adding new files to an old filing cabinet. A new operating system enables new possibilities that are beyond the capacity of the old. Adopting a paradigm shift in our thinking about education reform is thus much the same as installing a new operating system, as it provides the capacity for new possibilities beyond the limitations of an old paradigm. Therefore, while complexity is still emerging as a theory and its applications in policy and practice are still evolving, this alternative theoretical framework could potentially generate novel and different ways of using research in policy altogether.

Agency of actors in the system

One way that complexity offers a novel approach to systemic education reform, is that it offers a view of change that is no longer necessarily imposed in a top-down way (Callaghan, 2008; Snyder, 2013; White & Levin, 2016). As Callaghan (2008), and White and Levin (2016) argue, complexity recognises the agency of actors in the system, and the possibility, indeed necessity that change could come from anywhere in the system.

Researcher positionality

As well as recognising the agency and influence of individuals within the system, complexity thinking also reconceptualises the positionality of the researcher (Hetherington, 2013; White & Levin, 2016). In reductionist thinking, the researcher should not be involved in or part of a study. Their observations must be objective, unbiased, and removed from the object of study. In contrast, complexivists see the researcher as unavoidably part of, and embedded in, the system (Loughborough, 1991). This embeddedness is seen positively, in that researchers are part of, and have insights into, the social realities they seek to investigate (Kuhn, 2008). They are able

to not just observe the system, but to act deliberately within it. This is obviously a critical difference between reductionist and complexity-influenced research paradigms (Loughborough, 1991). Rather than attempting to control or elide unpredictability, complexity thinking acknowledges it, creating a space for the researcher to "sense and respond" (Berger & Johnston, 2015; Snowden & Boone, 2007; White & Levin, 2016). This is novel in education research. The 'sensing and responding' concept is central to current complexity-oriented work. It is taken up here because, as argued below, it offers a way to make sense of and cope with the zeitgeist of post-normal times.

3.3.7 Complexity in education research

Acknowledging complexity brings with it the realisation of an endless supply of novel problems, and hence significant challenges to the dominant paradigms of education practice, leadership and research. For example, how does one even begin to approach education research in a context in which irreducibility and unpredictability are assumed? Traditional academic research involves the search for truth and the construction of knowledge. The tradition of known knowledge and knowable truth is in direct contrast with complexity's assumptions of unknowns and uncertainty. Additionally, complexity calls for a shift from thinking about individuals and/or entities, to thinking instead about the *space between* people or entities, about the interactions that take place in these spaces. In conventional research terms, these spaces are invisible, inaccessible, unthinkable, and certainly unmeasurable. How then might we approach complexity informed research in education?

3.4 Safe-to-fail

In the business leadership domain, the problem of complexity has already prompted new approaches. A widely used example is the Cynefin Framework developed by Snowden and his associates (Snowden and Boone, 2007; Kurtz and Snowden, 2003). This framework has four spaces, known as 'simple' (later 'obvious), 'complicated', 'complex' and 'chaos', which, because they have very different conditions, require very different kinds of decision-making. In the complex domain, there are no clear answers, hence, experimentation, prototyping, fast iteration and play become important tools in navigating uncertainty. Snowden et. al. argue that experimentation, prototyping and fast iteration are more useful in uncertain and volatile times, as a predetermined course of action cannot account for all the emergent possibilities (Kurtz & Snowden, 2003; Morris, 2015; Snowden & Boone, 2007).

Building on this, Snowden developed the 'safe-to-fail' experiment concept (also called 'safe-to-fail probe') as a tool for navigating complexity. 'Safe-to-fail' experiments are small-scale 'nudges' designed for gathering information about how the system is working, based on how it reacts to the nudge (Berger & Johnston, 2015; Cognitive Edge, 2017; Snowden, 2007). The

concept was designed to be used in complex business and/or leadership decision-making contexts where traditional methods, such as strategic goal setting or best practice, are inappropriate (Morris, 2015). It is now widely advocated and used in these contexts as a tool for making sense of and responding to complexity, not attempting to simplify or analyse it, which, in complexity, is not possible Berger & Johnston, 2015). Safe-to-fail experiments are put forward as an alternative to implementing endless initiatives or 'failsafe' plans. To be a 'safe-to-fail probe' the experiment must satisfy a number of criteria (Berger & Johnston, 2015; Cognitive Edge, 2017). These are outlined below.

3.4.1 Safe to fail, rather than failsafe

Interventions or initiatives in organisations (and schools) are usually designed not to fail, and as a result, measures such as backup plans and systems of accountability are put in place. This is usually because failure comes at a high cost, whether personal, financial or otherwise. By comparison, a safe-to-fail experiment is designed so that it does not matter if it fails. In fact, Snowden (2007) goes as far as to say that experiments should be designed with failure in mind, so that at least half of them fail, because we learn more from failure than success. Berger and Johnston (2015) suggest that if there is no failure, the experimenter will not learn very much. As such, Johnston, Coughlin, and Berger (2014) advocate designing contradictory probes. The safe-to-fail rather than failsafe nature of these experiments means that the success or failure of the experiment can act as a probe in the complex system. The success or failure presenting equal opportunity to make sense of the way the system is and has responded to the experiment.

3.4.2 Nudge, rather than control the system

In designing safe-to-fail experiments, the first step is to identify what we want to see *more* of and/or what we want to see *less* of in a system. Then an experiment is designed to amplify or dampen these properties (rather than designing an intervention with a fixed, predetermined outcome). There is a tendency within organisations, particularly in education, to try to predetermine outcomes. According to Snowden et al, in the complex domain, this is not possible. The system responds and reorganises itself in ways that mean our actions often have effects beyond what we intended. For example, a national focus on literacy and numeracy in education might produce a reduced focus on science education, and this in turn will have other unintended effects. The safe-to-fail experiment concept recognises that interventions can have undesired consequences. For this reason, experiments should be designed so that they are easily shut down, or, if the response is desirable, amplified.

3.4.3 Parallel experiments, rather than single interventions

Navigating complexity requires us to focus, not on cause and effect, but on the non-linear causality that is produced in situations where there are very large numbers of interactions. To this effect, when attempting to learn about a system by nudging it with a safe-to-fail experiment, it is recommended that several safe-to-fail probes be used at any one time. Running several safe-to-fail experiments in parallel allows one to monitor a system from multiple perspectives (Berger & Johnston, 2015). Additionally, the dynamic nature of a complex system means that if only one experiment was run, the system is likely to have shifted by the time a second experiment is designed, potentially rendering the learning from the first experiment out-dated (Berger & Johnston, 2015). Hence, multiple safe-to-fail probes allow for learning about multiple interactions simultaneously, rather than experimenting with a part of a system that is unlikely to translate to the behaviour of the system elsewhere.

In summary, the safe-to-fail probe is a new conceptual tool to make sense of the emergent properties of complex systems. To illustrate this, one might consider the examples below from Berger and Johnston (2015), to gain a sense of what a safe-to-fail experiment might involve:

> *Example 1*
>
> A company hoped to see more engagement between different departments. They proposed having shared food to bring people out of their offices to talk more with each other.

> *Example 2*
>
> In a company that had become too focused on developing software rather than on meeting customer demand, the company experimented with patching customers through to software engineers once a week to open channels of communication between the customer demand and the software engineers. At the same time, the company ran a simultaneous but contrasting experiment where it gave engineers time to work on a project of their own choice.

In both these cases, the experiment could easily be shut down or amplified, there was little risk involved, and there were opportunities to learn from how the system responded. One might consider a safe-to-fail experiment in the same way as nudging a foreign object with a stick; you are not sure how the foreign object will respond, so you create a small, safe experiment to test it out. Hence, safe-to-fail experiments enable learning about a complex system, through *nudging* it in a particular direction, and then *noticing* how it responds.

3.5 Conclusions

Education research that employs a reductionist paradigm has significant limitations for education reform. These limitations are largely because reductionism is unable to take account of the dynamic, unpredictable nature of social realities. In contrast, complexity thinking presents an alternate paradigm. Complexity as a theoretical framework allows the conceptualisation of complex social systems such as education without forcing them into frameworks that require linear causality, predictability and objectivity.

Complexity-oriented approaches to research in the social sciences have a number of challenges. In particular, there are no established methods for working in this area. As a result, a precondition for working in this area is that researchers must develop their own methods for making sense of and/or navigating their particular context.

The next chapter outlines how this issue was addressed in this project. It describes how a Massive Open Online Course was developed as a safe-to-fail experiment designed to ‘sense and respond’ to how the education system is taking account of the future-focused education discourse.

4 A MOOC for disruption

4.1 Introduction

Chapter Three discussed the limitations of reductionism and looked at how complexity thinking might offer an alternative theoretical framework for thinking about future-focused education reform. This chapter ahead describes how the 'safe-to-fail experiment' concept from complexity thinking was used in this research project. A MOOC (Massive Open Online Course) was developed to 'test' the system's response to various ideas about future-focused education. The research project described in the following chapters was an attempt to investigate the system's response. This chapter describes the design of the MOOC and sets out a justification for using this concept in a complexity-informed research project.

4.2 Overview of research methods

As outlined in Chapter Three, complexivists advocate the use of 'sense-and-respond' approaches, carried out by researchers who are within the system, as opposed to objective data collection 'at a distance'. In this research project the researcher was 'within the system' in a number of ways, one of which was as the designer and facilitator of the safe-to-fail experiment described here. This safe-to-fail experiment was a MOOC, which was entitled *Cyborgs, Schrödinger and school - Rethinking education for the future*. This MOOC was marketed as a free online course that will:

> Develop your capacity to understand education futures in deeper, more complex ways, whilst taking on a more active, informed role in experimenting with future-focused change (#edchatNZ, 2016).

The purpose of this safe-to-fail experiment was to see whether the system could be nudged in a direction that would involve more and deeper interactions about education futures ideas, and whether this would produce a change in people's thinking about education's future.

The Research Questions for this project were:

1. Do participants who have voluntarily enrolled in a MOOC discuss the ideas they are exposed to in the MOOC with colleagues and/or family and friends?
2. If they do, how in-depth/ extensive are these conversations?
3. Do these experiences change the way they think about education?

The development of these questions is discussed in Chapter Five.

As outlined earlier, because complexity thinking is an emerging approach in the social sciences, there are no 'tried and true' research methods. The sense-and-respond approach adopted in this project was developed for use in contexts outside conventional research. To address the difficulties involved in working in an emerging area, the research aspect of this project, takes the form of a modified case study. The research design is outlined in Chapter Five. However, in this

case study, the MOOC plays an important role. It is both the object of study and the case boundary. This chapter describes the process of—and the reasons for—its design.

4.3 A short history of MOOCs

Massive Open Online Courses, or MOOCs, as coined by Bryan Alexander and Dave Cormier, are new models for learning in a hyper-connected world. Bursting into popular media in 2012 (Pappano, 2012), these online courses seemed to hold immense promise, particularly for democratising education by making knowledge and learning accessible to groups who have traditionally been excluded from academia (Aguaded, 2013; Carey, 2015; Emanuel, 2013; Graham, 2012). Although many have argued that MOOCs have not lived up to this, these online courses do however have significant functional value to transcend some of the barriers to traditional modes of education (Carey, 2015; Graham, 2012; Pappano, 2012). While schools or universities are confined by physical space and time, the open and online nature of MOOCs make them immensely scalable, as well as enabling participation anytime, anywhere, as long as there is access to an internet connection.

MOOCs had their beginnings in distance learning (de Waard et al., 2011; Marques, 2013; J. L. Moore, Dickson-Deane, & Galyen, 2011). Early distance learning occurred through correspondence, then, with the development of technology, it shifted to include radio, television and videotapes (Marques, 2013; J. L. Moore et al., 2011). The rise of technology in all sectors, paralleled with greater technology use in education, has seen a significant increase in online courses since the first significant MOOC in 2008. The course *Connectivism and Connective Knowledge* (referred to as CCK08), convened and led by Stephen Downes and George Siemens, is regarded by many as a landmark online course. CCK08 combined both the available education technology of the internet and a new learning theory of connected learning. This MOOC had approximately 2000 participants from all over the world, but only 24 were enrolled for credit. (de Waard et al., 2011; Mackness, Mak, & Williams, 2010). CCK08 is frequently cited as the first 'cMOOC', representing connected learning pedagogy in an online space, since it distributed learning across platforms, and focused on how people learn in large open networks (Hew, 2015; Mackness et al., 2010). In 2011 Stanford University's now renowned course on Artificial Intelligence saw approximately 160 000 students enrol when the already popular Stanford Course was made available as a MOOC (Graham, 2012; Marques, 2013).

Since these early courses, there has been a rapid increase in the number of MOOCs, and a parallel increase in the number of platforms on which these are hosted. However, in 2012 MOOCs expanded beyond academia. The New York Times went so far as to call 2012, *"*the year of the MOOC*"*. The technology has given rise to new ways of learning and many new players have entered the education 'marketplace' (e.g. Coursera, Udemy, EdX, Udacity, Khan Academy (Dhiman, 2016). De Waard et al. (2011) writes that:

> In these times of great complexity, we believe a pedagogical format that embeds and even embraces this complexity, combined with a prevalent emerging technology, can be the means to arrive at a new educational order (p. 93).

This project picks up on this idea. Its aim is to investigate whether MOOCs can be a means for "arriving at a new educational order".

4.4 Methodological justification for using a MOOC in complexity informed research

4.4.1 MOOCs and complexity

De Waard et al. (2011) believe that MOOCs can be understood as complex systems because they display self-organising, open information flow, interconnectedness and emergence. They cite examples from their own research on MobiMOOC as evidence. Nakano, Padua, and Jorente (2015, p. 126) also describe MOOCs as complex systems, suggesting that their format and design is "complexity in education made possible". These authors argue that MOOCs enable the necessary interaction required for social learning. Pentland (2014) analysed sociometric data using mathematical models related to a range of communities. This work showed mathematically that the propagation of behaviours and beliefs through social networks can and does occur. And further, Pentland (2014) has shown that learning can be shaped and accelerated by social pressure.

Following this, in this project MOOCs are conceptualised as complex systems. The following properties of complex systems are identifiable in MOOCs:

- *Irreducibility* and *diversity,* in that MOOC participants will be located within their own context, each with their own *system histories*.
- *Interactions,* through each MOOC participant's personal connections within their own contexts personally and professionally.
- *Emergence*, as unexpected possibilities might emerge through interactions with and within the MOOC.
- *Redundancy,* as the shared participation in this MOOC creates a sense of coherence between normally disparate actors across a sprawling network.
- *Feedback loops,* in the way that MOOC participants might begin to notice ideas from the MOOC become apparent in other places such as in the media.

4.4.2 Safe-to-fail in education

As discussed in Chapter Three, safe-to-fail experiments are a tool developed to navigate complex systems, to nudge them in a desired direction. Given that both education and MOOCs can be considered complex systems, it is appropriate to use a safe-to-fail experiment in this context. What makes safe-to-fail an even more appropriate tool in education, however, are the perceived risks associated with change in education.

Experimentation in education is often accused of using students as 'guinea pigs' (Post Primary Teachers' Association, 2017). Where education is seen as a pathway towards a job or career, experimentation may be seen to put children's futures at risk. Thus, experimentation in education is generally not considered safe. By contrast, safe-to-fail experiments offer an alternative to potentially high-risk initiatives or costly policy implementation. In effect, safe-to-fail provides a way that we might experiment in education, within guardrails. As such, we might learn about the complex system that is education, and also begin to play with new approaches and conceptualisations that are more appropriate for post-normal times. Chapter One argued that our current education system is in need of radical change. However, change is difficult, challenging, and, for some, risky. Safe-to-fail experiments offer a tool for traversing the tension between risk and change in education.

Chapter Three outlined how complexity approaches offer researchers an alternative positionality. In the context of education reform, this allows researchers to be active participants in driving change (White & Levin, 2016). Researchers can design safe-to-fail experiments, adjust, amplify and manipulate these, and then make sense of their findings. This kind of social experimentation is very different from reductionist approaches that require the researcher to distance themselves from the research as much as possible in order to appear objective (Loughborough, 1991).

4.4.3 MOOCs as a safe-to-fail

This study used the alternate positionality offered to researchers in complexity, to design a safe-to-fail experiment that might nudge education in a more 'future-focused' direction. The safe-to-fail experiment, took the form of a MOOC that was called *Cyborgs, Schrödinger and school - Rethinking education for the future.*

While not all MOOCs would meet the criteria of a safe-to-fail experiment, the MOOC that is the focus of this study emerged from a set of unique and unusual circumstances. It was designed in response to the #edchatNZ community (see Section 4.5 below for more detail on #edchatNZ). The researcher's location in this community enabled the MOOC to meet the criteria for safe-to-

fail experiments as set out by Berger and Johnston (2015) and Snowden (2007) (also described in Section 3.4 above).

To ensure that this project was *safe-to-fail*, the following principles were established:

- The MOOC would require no financial investment, either from the researcher (who was also the designer and facilitator), from participants, or any other party involved in this project.
- No participant would gain academic credit for this course.
- No permission would be required to design or launch the MOOC. Instead, resources that are available to use free of charge would be used.
- The existing #edchatNZ community would be used as the primary audience for recruitment. This community has no formal membership, governance or contractual agreements.
- The course could be shut down immediately at a moment's notice, or more participants could be enrolled at any time. The course could also be repeated.
- The MOOC would include no formal assessment towards a predetermined learning outcome.

Further, this course would seek to act as a safe-to-fail in that it would attempt to nudge the system in a general direction, rather than move it towards specific pre-determined outcomes. It would aim to amplify more and deeper interactions about education futures, and to encourage change in the *way* people think, not what they think.

Additionally, the aim was to run numerous parallel experiments within and on the edges of the MOOC, which were designed to allow learning from multiple interactions simultaneously. For example, the timing of facilitator posts was experimented with, as was hosting webinars publicly rather than in the closed environment of the MOOC, and added summary video posts designed to 'set the tone' for each week. In effect, this means that the MOOC simultaneously nudged the system in a direction, while allowing the researcher to learn from how the system responded.

4.5 MOOC design

4.5.1 The #edchatNZ context

The MOOC that is the focus of this research project was initially conceived of in response to the #edchatNZ community (#edchatNZ is an abbreviation for 'education chat New Zealand'). #edchatNZ started as a Twitter chat in 2012. Chats are hosted by moderators who publicly post discussion questions on a predetermined education topic. Anyone can then participate in the discussion through responding to the question and adding the #edchatNZ hashtag to their

tweets. The discussion topics are always voted on by the community from a list of four possible options selected by the moderator to be both topical and offer scope for discussion. In 2015, an additional moderator was also introduced to the chat in an attempt to develop the depth of the Twitter chats. This additional moderator would use a 'devil's advocate' Twitter account and ask questions of those participating in the chat. While this community has no formal membership, numerous additional chats, two conferences, and a podcast have emerged out of #edchatNZ.

With no formal membership and no formal hierarchy, yet two conferences, podcasts, webinars, and numerous offshoot projects, the #edchatNZ community is an example of a complex system. It is self-organising and dynamic. It uses public and open information flow between agents in the system. The 'directions' it goes in are unpredictable and irreducible to the actions of its key influencers. It also displays strong emergence, catalysed by the numerous interactions of this community.

Cyborgs, Schrödinger and school - Rethinking education for the future, the MOOC that is the focus of this research, was designed with the #edchatNZ community as its primary audience. A number of factors contributed to this decision. Forte, Humphreys and Park's (2012) research indicated that educators who belong to, and regularly participate in, professional sharing and discussion in social networks are more likely to participate in reform efforts. Hence, this made #edchatNZ an appropriate context for a MOOC about education reform that drew from the future-focused education literature. Additionally, the informal membership of this group, as well as the researcher's relationship with this group, created the context that meant this MOOC could be designed as a safe-to-fail experiment.

4.5.2 Pedagogical and technical design

The design of this MOOC took into account a number of key ideas from the MOOC literature (Bangert, 2004; Hew, 2015; Liaw, 2008; Nawrot & Doucet, 2014; Xiong et al., 2015). For example, its design included:

- Autonomy and self-regulatory scaffolds,
- Personalised tasks,
- Instructor presence, and
- Critical discussion and social learning.

These ideas were integrated with concepts from the adult cognitive development and complexity literature, with the aim of allowing aspects of the MOOC to serve as safe-to-fail experiments.

Autonomy and self-regulatory scaffolds.

Nawrot and Doucet (2014) identify that time management, even for adults, is the greatest contributor to MOOC withdrawal. It is for this reason that the literature on good practice in

MOOCs advocates the inclusion of time management tools and strategies, effective learning environment management, and support for participants' developing personal management strategies (Hew, 2015; Nawrot & Doucet, 2014).

iQualify software was selected as the platform for the MOOC. iQualify includes software and user experience elements that would enable students in the course to help manage their time more effectively. iQualify features included the top of each course page having an estimated amount of time to complete the page, completion trackers, and accessibility from any device including smartphones. The inclusion of these features was influenced by Pink (2010), who shows how mastery, autonomy and purpose are deeply linked with motivation. It seemed that features such as completion trackers might assist in demonstrating mastery and contributing to motivation.

Pedagogically, the course included features such as goal setting and self-reviews to assist in developing the self-efficacy required for successful autonomous learning. Further, careful organisation of content contributed towards user experience, and as a result, engagement. Hence, the software selected was specifically designed to help the course facilitator and designer organise content through standardised (yet flexible) formats. These allowed the students to prioritise their engagement with the content, rather than spending time trying to make sense of the way it is organised.

Personalised learning

Personalised learning refers to learning designed to accommodate for personal intent, preference and development. The MOOC's design was influenced by Pink (2010) focus on autonomy. Xiong et al. (2015) argue that each student should be approached through recognition of their different intents. This is particularly important in the context of MOOCs where there are many different motivations for participation.

The MOOC literature indicates that students participate in a range of ways (Mackness et al., 2010). For example, some students may only engage in skim reading, some may only engage with particular activities, while others might complete the entire course (Mackness et al., 2010; Xiong et al., 2015). As a result, *Cyborgs, Schrödinger and school - Rethinking education for the future* was designed to work both as a cohesive whole, and as a set of smaller, standalone units. This was done by breaking the course into three major parts. One focused on the philosophical and historical underpinnings of education; the second focused on the way that the world and hence the context of schooling is shifting, and the third introduced some possible strategies for engaging with this change. (See Appendix C for the course outline). Additionally, each of the eleven weeks of the course had a specific focus to ensure participants could select a pathway that matched their intent and motivation for participating in the MOOC.

Within the course, content was carefully curated to ensure that concepts and ideas were illustrated to accommodate personal preferences in learning. Accommodating diversity has been shown to be critical for the self-regulation that is necessary for success in MOOCs (Bangert, 2004). For example, the course included the same concepts illustrated in a variety of ways (e.g. academic articles, books, videos, news magazine articles, and *edu*-pop – this term refers to distillations of academic ideas into blogs or other informal publications written by and for educators). Course participants could select resources that matched their personal learning preferences, their schedules and/or their level of interest or expertise. The final part of the course offered a choice in the complexity of the tools used to investigate their personally identified focus. Participants were offered a choice between using Design Thinking, Spirals of Inquiry, or Complexity Theory to understand their focus.

The diversity in content was complemented by 'psychologically spacious' tasks that allowed participants to engage with tasks from a range of developmental starting points (Gilbert et al., 2015). The intent was that this should contribute both towards the participant's experience of autonomy and personalisation, as well as their cognitive development.

Kegan (1994) advises that exposure to diverse perspectives and otherness in a supported environment is one of the primary contributors to adult cognitive development. To engage participants in their own cognitive development, tasks included asking participants to give examples from their personal experiences and to then try to make sense of these in new ways using the concepts introduced in the course. In other cases, participants were asked to explore alternate perspectives through deliberately arguing against their personal opinion, or through seeking perspectives from family members, friends and colleagues outside of the course, and then considering these within the MOOC.

In summary, the tasks were designed to meet the personal learning needs of participants, but they were also designed to 'push' the system in new directions. The aim was not just to get more people to know more about the education futures literature, but to support people *to act on* these ideas, in their contexts, with others.

Instructor presence

According to Hew (2015), instructor presence in an online course contributes enormously to the engagement of participants. This includes the extent to which the course facilitator is seen to be willing and able to engage with course participants, as well as their passion for the material in the course. Based on these suggestions, the course included webinars and social media to allow the course facilitator to engage with participants (Hew, 2015). In the webinars the course facilitator live interviewed some of the international authors whose work was considered in the course. Alongside this there was a parallel live discussion stream where participants could join the discussion and contribute questions for the interview. These webinars and the corresponding discussions were hosted as public #edchatNZ events (i.e. anyone could

participate, not just people enrolled in the MOOC). The first of these webinars was treated as a safe-to-fail experiment, and so, when social media analytics showed an increase in interactions during the webinar, it was decided to continue with this strategy. Another strategy for increasing the instructor's presence was to use the iQualify software to clearly identify comments made by the course facilitator in forums and social notes.

Critical discussion and social learning

Constructivist learning theorists argue that critical discussions with peers promote learning. This is important in many contexts, such as developing the practice of professionals such as teachers (Drago-Severson & Blum-DeStefano, 2014; Gilbert et al., 2015); engaging parent communities (Cooper & Christie, 2005) and in supporting learning between students. It is also a key factor in increasing engagement in MOOCs (Hew, 2015). Just as in physical classrooms, in online courses, critical discussion with peers supports deeper learning and engagement. For this reason, it was important, in designing this MOOC, to have a software platform that could support and encourage interactions between participants. However, it was also important, given this project's focus on increasing interactions.

While an assortment of MOOC software has become available over the past five years, much of which is free, not all products allow for the connectivist pedagogy required in a MOOC that is specifically designed to promote interactions. While most course software offers forums or even peer marking as a function, the iQualify software developed by New Zealand's Open Polytechnic includes page level discussion, overall course forums, as well as a function called 'social notes' on individual paragraphs (see Figure 1). Using this platform allowed participants to interact with each other at various levels.

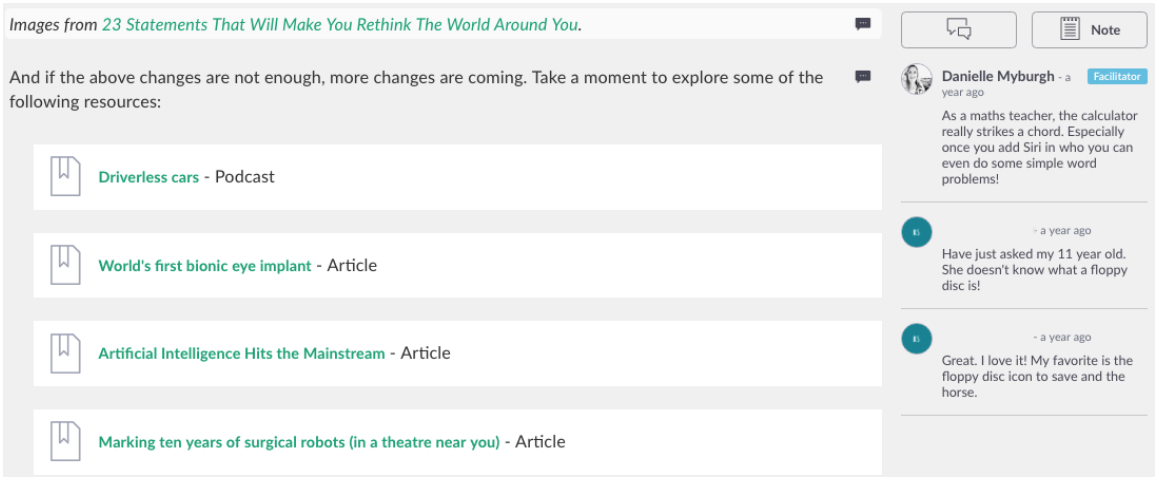

Figure 1: Social notes in the iQualify platform

The course design also allowed participants to interact with people outside the course. Webinars were hosted on Google Hangouts with a synchronous Twitter chat using the hashtag #edchatNZMOOC. These were promoted beyond the course, with the intent of encouraging

interactions between people within and outside the course. Thus the course was designed to deliberately facilitate interactions between course members (through the iQualify platform), but also to stimulate discussion beyond the boundaries of the MOOC (using other media, including Google Hangouts and the Twitter hashtag #edchatNZMOOC).

Course resources were selected only from content that is either creative commons, or freely available on the Internet. This decision was made so that participants could easily share any of the provocations or resources beyond the course. It was also done in the hope of provoking more and more in-depth interaction that might lead to change in the way people think about education futures. As part of the activities in the course, participants were asked to interview family, friends and colleagues. This was a further attempt to promote deeper interactions beyond the MOOC, to encourage participants to take these discussions into their personal contexts.

4.6 Conclusion

The complex nature of this study's context and the researcher's relationship with #edchatNZ, allowed the MOOC as a whole to be designed as a safe-to-fail experiment. However, within the MOOC, a series of smaller safe-to-fail probes were also attempted, in its pedagogical and technical design, and its facilitation. These safe-to-fail experiments were designed to nudge the system (defined as the MOOC and people connected to it) towards a greater number of deeper interactions about education's possible futures. Safe-to-fail experiments are a useful way to encourage the system in a particular direction, but in the context of this research, they are also important for what they can reveal about the system as a whole. Both of these are important to this project.

Informed by complexity thinking, the project has a focus on interactions. One aim was to investigate whether the MOOC could increase interaction. Underpinning this is the idea that *change* comes through large numbers of interactions within a system. The MOOC was designed as a way to experiment with this idea. The project's purpose was not, following conventional reductionist forms of research, to evaluate the *effectiveness* of the MOOC as an intervention. Rather, it was to use the MOOC to experiment within the system, to test how it reacts to being pushed. The aim was to see what might be revealed by doing this.

However, as outlined earlier, methodological tools for formal research in this paradigm have yet to be developed. It is for this reason that the research part of this project is a complexity-informed case study. This case study is described in the next chapter.

5 A complexity informed case study

5.1 Introduction

Chapter Four described how the sense-and-response positionality offered by complexity thinking was used to design a safe-to-fail experiment which took the form of a MOOC. This chapter describes the complexity-informed case study that was used to make sense of the MOOC's effect on the system.

5.2 Research questions

The research questions for this project are as follows:

1. Do participants who have voluntarily enrolled in a MOOC interact with the ideas they encounter in the MOOC with colleagues and/or family and friends?
2. If they do, how in-depth/extensive are these interactions?
3. Do these experiences change the way participants think about education?

The study focused on monitoring the number of interactions, the depth of interactions, and whether the experience changed the way participants think about education's futures. The research was not designed to evaluate whether MOOC participants acquired particular content or skills.

The research questions are informed by adult cognitive development theory and complexity thinking. They are designed to produce information about the experiences of the individuals involved in the MOOC but also to investigate the effects of the collective experiences of these individuals on the system they are part of. The underpinnings of each research question are elaborated on in the sections below.

5.2.1 Do participants who have voluntarily enrolled in a MOOC interact with colleagues and/or family and friends about the ideas they encounter in the MOOC?

The first research question is based on the premise that change will emerge from interactions within the system. If more people are engaging and interacting with others about ideas around future-focused education, new ideas and behaviours will emerge from the system. This is based on the work of Daly (2010) and Pentland (2014) who have shown empirically that diverse interactions are critical to social learning. By increasing the likelihood of new emergent behaviours, these interactions contribute to a community's ability to adapt, innovate and change (see also (Capra & Luisi, 2014; Pentland, 2014)).

5.2.2 If they do, how in-depth/extensive are these interactions?

While increasing the *number* of interactions is important, if change is to occur, so too is the *quality* (depth and breadth) of these interactions. The second research question is based on the premise that increasing the depth of interactions about education futures should provide opportunities for the kind of cognitive growth needed to engage with and act in complex systems. As outlined in Chapter Two, Gilbert et al. (2015) and Benade (2017) argue that future-focused education requires teachers to not only develop new practices, but to think in new ways about education, and about their professional identities. It also requires parents, community members and other stakeholders to think about and engage differently with education, but as yet it seems there is limited work in this area (Auerbach, 2011; Cooper & Christie, 2005).

5.2.3 Do these experiences change the way participants think about education?

Gilbert et al. (2015) and Drago-Severson and Blum-DeStefano (2014), argue that the rise of VUCA[2] in the national, global, political and economic landscape requires teachers and school leaders not just to know more, but to think and act differently. Change in the system will only occur when the system's elements are able to think and act differently. The third research question is based on the premise that system change in education requires change, not so much in *what* those involved think, but *how* they think.

5.3 Methodology

As discussed in Chapter Three, a major challenge in working with complexity thinking in the social sciences is that there are no 'tried and true' research recipes (Kuhn, 2008; White & Levin, 2016). As a result, researchers in this emerging field have engaged in what Gough (2012) refers to as "methodological borrowing" to develop methods for researching complex systems. This research project has used a modified case study method. Following Hetherington's (2013) example, the concept of a complexity-informed case study was used as a starting point for designing the research methods.

Case study research is considered appropriate for holistic investigations of single instances (Cohen, Manion, & Morrison, 2007; Tellis, 1997). These investigations can draw on multiple sources of data to develop depth. This kind of research is used to form rich and nuanced descriptions of a context in order to optimise what can be learned from a particular instance (Hetherington, 2013; Stake, 2005). Yin (2013) and Hetherington (2013) specifically emphasise that case studies are appropriate where contextual conditions are critical.

[2] VUCA is a common abbreviation used to refer to volatility, uncertainty, complexity and ambiguity.

Findings from highly contextual case studies are usually not generalisable beyond the case. However, they can be used for theory development (Baxter & Jack, 2008; Darke, Shanks, & Broadbent, 1998; Tellis, 1997; Yin, 2013), which can suggest directions for further research to develop statistical generalisability.

5.3.1 Case study research and complexity

Case study research has several identifying features. These include: a focus on context; flexibility in what constitutes boundaries; a range of data; explorative and descriptive rather than purely analytical outcomes; and a holistic approach (Cohen et al., 2007; Hetherington, 2013; Stake, 2005; Tellis, 1997; Yin, 1981, 2013). These features of case study approaches correspond to many of the features of a complex system. In fact, one may even go as far as to say that, case study research frequently involves investigating a complex system, whether or not the complexity is acknowledged. The sections below examines five of the key features of case study research that are also features of complex systems, in order to show how the case study method is appropriate for this research.

5.3.1.1 Boundaries, or the lack thereof

A key process feature of case study research involves establishing a boundary in order to define the 'case' (Cohen et al., 2007; Hetherington, 2013; Yin, 2013). In contrast, complexity thinking asserts that complex systems do not have clear boundaries, that they are dynamic, open, and not reducible to their parts. However, in case study research it is acknowledged that the boundary between context and phenomena is often not evident. Thus, there is significant flexibility in what constitutes a boundary, including but not limited to temporal, geographical, functional or other boundaries (Cohen et al., 2007; Yin, 2013).

Complex systems do not have clear boundaries, which is a difficulty when attempting to research them (Biesta, 2010; Hetherington, 2013). Imposing artificial boundaries to reduce complexity, so that the system can be studied, obviously interferes with the system, yet research needs boundaries. This project's boundary is established by combining the case study concept of boundaries, with complexity's property of redundancy. Redundancy in a complex system refers to the shared elements and relationships that give it coherence. In this project the MOOC (and its associated activities) is a coherent set of shared elements and relationships, which can also be seen as a boundary. For the purposes of this research, the MOOC is treated as the boundary of the case, the unit of analysis that can be fitted with the requirements of case study research and complexity thinking.

5.3.1.2 Contextual rather than generalisable

Case studies observe a 'case' in its real context as the method recognises that context plays a key role in causality (Qi, 2009; Yin, 2013). As a result, case study research is not usually generalisable outside this context in the way that quantitatively-oriented research aims to be (Yin, 2013). Similarly, in complex systems, emergence is highly contextual, arising as it does out of the very large numbers of interactions produced in that context. Because complex systems are dynamic, any patterns emerging from these interactions are unlikely to be repeated, and so are not generalisable (Capra & Luisi, 2014; Hetherington, 2013; Waldrop, 1993). Acknowledging that meaning is made in context(s), and so is not necessarily generalisable to new contexts, is common to both complexity and case study research. As Capra and Luisi (2014) put it, "to understand things systemically means literally to put them into a context" (p. 64). In this research project, the 'case' (the MOOC) is located in and connected to a series of contexts and systems that could not be replicated.

5.3.1.3 Holistic rather than reductionist

Sturman (1999), cited in Cohen et al. (2007)) "identifies that human systems have a wholeness or integrity" (p. 272). It is this *wholeness* that warrants the holistic approach that case study research can offer (Qi, 2009; Tellis, 1997). Complexity thinking also stresses the importance of viewing the system as a whole, seeing, for example, the forest ecosystem, not just the individual trees. This assumption of holism is another crossover point between case study approaches and complexity thinking. In this research the MOOC was treated as a whole, not just a collection of discernible parts.

5.3.1.4 Interactions, not just single actors

Complexity thinking involves a shift in focus away from the individual entities in a system, to the interactions and relationships between these entities (Capra & Luisi, 2014; Davis & Sumara, 2014). According to Tellis (1997), case study approaches emphasise not just the actors within the field of study, but the interactions between them. This is another area of similarity. As outlined earlier, the focus of this project was on interactions, not entities.

5.3.1.5 Emergence and the unpredictability

Descriptive and exploratory case studies are often used where clear outcomes are not possible at the outset (Tellis, 1997; Yin, 2013). They are useful in that the findings from a particular 'case' can allow the development of research questions for subsequent studies (Tellis, 1997; Yin, 2013). Similarly Yin (2013) says that case study research is appropriate for investigating 'how' or 'why' questions. This fits well with complexity-oriented research, where the questions

are always open-ended and clear outcomes are unlikely. Case study methods can accommodate the open-endedness, unpredictability and emergence that define complex systems (Capra & Luisi, 2014; Cilliers, 1998; Hetherington, 2013; Koopmans, 2017; Mason, 2008, 2009). They are therefore appropriate for the study of such systems.

5.3.2 Researcher positionality and reflexivity

Traditionally in case study research, reflexivity is presented as a weakness, since the researcher's presence is likely to influence the object of study (Tellis, 1997). However, as outlined in Chapter Three, complexivists see the researcher as unavoidably part of, and embedded in, the system. This embeddedness is seen as a positive, the role of the researcher being to initiate "purposeful perturbations" (White and Levin, 2016, p. 48; but see also Berger & Johnston, 2015; Snowden, 2005; Snowden & Boone, 2007; Snyder, 2013). However, there are some challenges for thinking about the role of researchers in the space between complexity thinking and conventional research. In this study, the researcher was embedded in the system in multiple ways, and, in addition, was the curator, learning designer, course facilitator and marketer of the MOOC. This required careful attention to be paid to the question of researcher positionality in the research design, but also to the various ethical considerations that arise from this approach.

5.3.3 Ethical considerations when using safe-to fail probes

Initiating perturbations in complex systems will, by definition, have unpredictable results. Thus there are some risks in this approach, which need to be managed differently from those encountered in conventional research assuming closed controlled systems. In the literature on safe-to-fail probes, the use of various "guardrails" is recommended to ensure the safety of the experiments and the system in which they operate. These include the following:

- Experiments must be able to be stopped at short notice.
- Experiments must not require permission from other parties to start or stop the experiment.
- Experiments are not too complicated to manage (Berger & Johnston, 2015; Cognitive Edge (2017))

5.4 Methods

5.4.1 Recruitment of participants

The research participants in this project were recruited in three ways. The survey participants self-selected by completing a questionnaire embedded within the MOOC. In the first week, this generated eighty-one survey responses. In the fourth and seventh week, twenty-two responses were received. Six responses were also received in the final week of the course.

The nine interview participants who had participated in the MOOC were recruited via an email invitation. This invitation was sent to everyone who had subscribed to receive updates or notifications about the course. Finally, three additional interviews were also conducted. MOOC participants recruited these individuals because they had discussed some of the ideas from the course with them.

5.4.2 Data collection

Case studies usually involve collecting data from multiple sources (Cohen et al., 2007; Hetherington, 2013; Stake, 2005; Tellis, 1997; Yin, 1981, 2013). Similarly, in complexity informed research, multiple perspectives are critical. Complex systems cannot be understood from the perspective of one actor (or group of actors), as each is operating in a series of localised interactions (Berger & Johnston, 2015; Capra & Luisi, 2014; Daly, 2010). Thus this project was designed to gather data from a wide variety of sources.

Three data collection methods were selected in the early stages of the project's design. The intention was to provide perspectives from across the system (Cohen et al., 2007). These three methods were: interviews with MOOC participants; surveys; and in-course reflections. As the project progressed, and various safe-to-fail experiments were instituted, other forms of data were collected. These included data obtained from software analytics, from social media analytics, and from social media posts that were relevant to the three research questions. The result of this was data that were collected using a range of methods, both quantitative and qualitative, and from a multiplicity of sources.

5.4.2.1 Interviews

Interviews were selected as a method for data collection as they provide insight into contexts with high social situatedness (Cohen et al., 2007; Travers, 2013). In the case of a complexity informed case study, this is significant because each research participant is embedded in a series of localised interactions (Berger & Johnston, 2015; Capra & Luisi, 2014; Daly, 2010). Interviews can provide in-depth insights into these highly contextualised positions, as well as providing alternate points of view across the much wider education system.

Additionally, in recognition of the absence of clear boundaries in complex systems (Biesta, 2010; Hetherington, 2013), this complexity-informed approach sought to incorporate aspects of the localised networks immediately beyond the MOOC. For this reason, two types of interviews were designed, occurring at two levels within the context of the safe-to-fail experiment. The first type involved interviews with individuals who had enrolled and participated in some or all of the MOOC. The second type interviewed individuals who, in most cases, did not participate in the MOOC, but who were involved in interactions about it with someone who did. This was an attempt to accommodate complexity, but it was also designed to contribute to internal validity (Yin, 1981, 2013) by not relying entirely on self-reporting.

Interviews were conducted after the conclusion of the MOOC using a structured, but open-ended interview (Cohen et al., 2007). Questions design was informed by questions developed for a prior research project (Gilbert et al., 2015). Participants were asked about the number and nature of their conversations about education futures (research questions one and two), as well as questions about their thinking and any changes they'd noticed (research question three). See Appendix B for the interview questions.

Nine interviews with individuals who had participated in some or all of the MOOC were conducted. Three interviews were conducted with individuals who were nominated by a MOOC participant as someone they had interacted with about the ideas from the course. One person was both a participant in the MOOC and had conversations in a different context with another participant. All participants who volunteered were interviewed. Participants included teachers, education facilitators, a teacher aide, a high school student, and a businessman. Research participants were located in urban, city and rural communities across New Zealand. Two were located outside New Zealand. Thus, the interviews reflect the perspectives of people from a variety of points in the larger education system.

5.4.2.2 Surveys

Surveys offer a versatile and efficient means to collect data, particularly for large populations (Walter, 2013). The questionnaire used in this research included a range of open and closed questions designed to provide nominal, ordinal and word-based data (Cohen et al., 2007; Walter, 2013). Surveys were included in the research design in case a very large number of people enrolled in the MOOC and also agreed to participate in the research. Because the MOOC was experimental, there was no way of knowing in advance how many people would participate. However, the surveys were also used to triangulate findings and establish internal validity in conjunction with other data sources (Cohen et al., 2007; Yin, 1981, 2013).

The survey involved embedding a voluntary questionnaire at various intervals in the eleven-week course. The questionnaire was included in weeks one, four, seven and eleven, and was

only available to people participating in the MOOC. The survey questions, like the interview question were derived from questions used in an earlier project (Gilbert et al., 2015). As in the interviews, participants were asked about the number and nature of their conversations (research questions one and two), and whether they noticed a change in their thinking (research question three). See Appendix B for the survey questions.

5.4.2.3 In-course reflections

As outlined earlier, contextuality is important in complex systems (Capra & Luisi, 2014; Hetherington, 2013; Waldrop, 1993). Each of the participants in this research is situated in a context which is different from that of other participants (Capra & Luisi, 2014; Mason, 2008, 2009; Waldrop, 1993). Each individual also has different background knowledge and experience. In order to explore this micro-level information, prompts designed to get participants to reflect on their own thinking, and any changes they noticed as the course progressed, were added into the course materials (research question 3). These prompts were added at several points, to allow data to be collected on changes over time. All coursework in the MOOC was informally monitored as part of the safe-to-fail experiment, but only the in-course reflections of participants who had provided formal consent were included in the data analysis. A total of 18 responses to in-course material was used in the analysis.

5.4.3 Secondary data

As outlined above, data were collected using two very different approaches. The first involved the use of conventional case study methods, such as interviews, surveys and reflections. The second approach to data collection, informed by complexity thinking, was more experimental. The aim was to allow for emergence, for unexpected data that might arise from the various safe-to-fail probes. As it turned out, these probes did produce some interesting—and unexpected—insights. Only data that were collected systematically, and that are relevant to the research questions are reported on here. Three additional sources of data were included: analytics from iQualify, social media analytics, and social media posts. These are described below.

5.4.3.1 iQualify analytics

iQualify software provides a facilitator view that displays individual participant's engagement ratings and completion scores. Additionally, iQualify developers are able to track a number of behaviours including:

- The total number of times individuals logged into the course per week;

- The average period of time participants were actively engaging with content on a course page per individual, per week;
- The total number of study notes created per individual, per week;
- The total number of social notes added per individual, per week; and
- The total number of discussion posts added per individual, per week.

This additional data from the developers provided further information on the participants' interactions. This software produces quantitative data that allows monitoring of behavioural patterns from participants that would not otherwise be possible. Additionally, since the surveys and interview required participants to self-report on any changes in the number of interactions, the iQualify data enabled triangulation of this self-report data.

5.4.3.2 Social media analytics and posts

Data was also gathered from the various social media platforms used in connection with this MOOC. Twitter provided opportunities to track live interactions both quantitatively and qualitatively. Using the #edchatNZMOOC hashtag, data could be sourced from social media analytics on the number of interactions and the content of public interactions. Scholars working in the complexity field have suggested that change tends to begin on the edges of complex systems (e.g. Cochran-Smith, Ell, Ludlow, Grudnoff, & Aitken, 2014; Pentland, 2014). The data obtained from social media analytics was included in the analysis for the insights it provided into interactions on the edges of the MOOC.

The MOOC hosted a number of public webinars on YouTube/Google Hangouts. These were complemented with synchronous Twitter chats using the #edchatNZ and #edchatNZMOOC hashtags. As described in Chapter Four, these webinars were public, the intention being to invite more people into the discussion. However, the analytics from YouTube and the Twitter chat activity provided interesting data from the edges of the case boundary.[3] This data was used as the MOOC progressed to amplify practices that might produce changes in interactions, but it was also added to the analysis process, where it contributed to internal validity.

Several MOOC participants published blog posts about their learning in the course. Information from these posts was included in the data analysis, where it was relevant to the research questions.

[3] It is worth noting at this stage that the MOOC as case boundary does not refer to the boundary created by the software, but instead makes the distinction between activities that were deliberately designed as part of the course.

5.5 Data analysis

The data analysis process in this research project was informed by complexity thinking. It used analytic approaches that looked for patterns of interaction, rather than laws and formulae. An inductive approach was adopted. Thomas (2006) describes inductive analysis as follows:

> approaches that primarily use detailed readings of raw data to derive concepts, themes, or a model through interpretations made from the raw data by an evaluator or researcher (p. 238).

Unlike deductive approaches, inductive methods do not aim to test a specific hypothesis or theory, but to allow themes to emerge from the data (Backman & Kyngäs, 1999; Thomas, 2006). This approach was used in this study. In addition, elements from grounded theory were borrowed. Grounded theory allows for on-going development of categories and, later, for creating theory (Backman & Kyngäs, 1999; Willis, 2013).

Data analysis occurred in three phases: on-going data analysis accompanied by researcher notes and reflections about potential categories and codes; systematic analysis including statistical analysis of quantitative data and the general inductive analysis of qualitative data; and triangulation of categories. These are described below.

5.5.1 Ongoing data analysis

In grounded theory approaches, data analysis begins with data collection (Backman & Kyngäs, 1999; Willis, 2013). In this study, as the MOOC progressed, notes were made on categories that seemed to be emerging within and on the boundaries of the MOOC. Data from interactions between participants, course contributions, or anything else that pertained to the research questions was included.

Grounded theory employs theoretical sampling as a means of testing potential categories for data analysis (Backman & Kyngäs, 1999; Willis, 2013). This research modified this approach, instead using emerging categories as data points to inform safe-to-fail experimentation in the MOOC. For example, the researcher noted that participants were often slow to start discussions in a public forum within the MOOC platform (participants only began discussions later in the week). Once this pattern was observed (sense), a safe-to-fail experiment was designed to respond to this finding. The following week, a response was included from the course facilitator in a public forum to ‘get the conversation started’. In accordance with the safe-to-fail literature, opposite probes were also tested where no initial response was included to see how participants responded. Therefore, while grounded theory may test potential categories for data analysis, this research modified the approach for a complexity informed study by attempting to further nudge the system in the desired direction (more interactions). Data on the responses to these probes was included in the analysis.

Other experiments included:

- To provoke more depth in course participants' responses, the researcher encouraged a participating colleague to think of their public forum responses as a model answer.
- To provoke more interactions with the ideas from the MOOC, the researcher converted webinars to MP3 files and shared these as podcasts.

5.5.2 Qualitative data analysis

Once the MOOC was finished, a more traditional general inductive approach was employed. This set of procedures complements grounded theory, as both use similar coding methods (Backman & Kyngäs, 1999; Thomas, 2006; Willis, 2013). Additionally, thematic coding (Braun & Clarke, 2006), as well as the concept of theoretical saturation (Backman & Kyngäs, 1999) contributed to the design of the data analysis process. These methods were used in addition to the others described here, as, because this study is rather unconventional, it wasn't possible to know in advance if anything at all would emerge. They were included as a back-up strategy.

The first two participant interviews were carefully transcribed, word for word (Braun & Clarke, 2006). The contents of these interviews were then categorised according to their relevance to each research question. There were many tangential conversations that did not pertain to the research questions. This data was omitted at this point (Thomas, 2006). The other interviews were not transcribed completely. Instead, only the parts of the interviews that were relevant to the research questions were transcribed. Once this was complete, a raw data file was compiled with all the relevant transcripts in a common format (Braun & Clarke, 2006; Thomas, 2006).

The next phase of the analysis involved numerous close readings of this raw data to generate initial ideas about potential themes. As recommended by Braun and Clarke (2006), preliminary codes were developed, allowing the data to be organised into meaningful groups to search for themes. Codes and themes were then refined to reduce overlap and redundancy (Braun & Clarke, 2006; Thomas, 2006), using initial ideas and researcher reflections and notes gathered throughout the data analysis process (Backman & Kyngäs, 1999; Braun & Clarke, 2006; Thomas, 2006). Themes were then further scrutinised after revisiting all interview recordings to check for additional data related to the identified themes.

5.5.3 Quantitative data

The quantitative data gathered (via the surveys) was subjected to basic statistical analysis. For the first seven questions of the survey, means were calculated to allow comparison between the sampling intervals (see Appendix B for the survey questions). As the number of participants in each survey attempt varied, averages were necessary to allow comparisons between weeks.

Quantitative data from iQualify was also analysed. As with the survey data, averages were calculated to allow comparisons between weeks of the course.

5.5.4 Further analysis

Finally, after all of the above data sources had been analysed, a second tier of analysis was carried out. Adding this in was informed by complexity thinking (Capra & Luisi, 2014; Davis & Sumara, 2014; Mason, 2008, 2009). The aim was to bring all the data together to analyse it holistically. An additional raw data file was created that summarised the qualitative and quantitative data together. This file was then treated in the same way as the interview data, involving close reading, assigning and organising codes, developing, and refining themes.

The themes from this holistic second-level analysis were then compared with the themes from the first level of analysis, and a final group of themes was produced. Extracts were selected to represent each theme in the reporting of findings. These final themes, along with the selected extracts and a brief explanation, were shared with the research participants for checking and comment. This multi-level analysis was necessary to attempt capturing the complexity of the case and to achieve internal validity.

5.6 Limitations

While every effort was made to ensure rigour, reliability and validity in this study, the research methods have a number of limitations. These are outlined below.

5.6.1 Limitations of the methodology

5.6.1.1 Methodological borrowing

As outlined earlier, because there are, as yet, no established methods for using complexity-informed research methods in education (Gough, 2012; Kuhn, 2008), a certain amount of 'borrowing' is necessary (Gough, 2012). However, as Gough (2012) cautions, complexity thinking's ontological assumptions are different, to the extent that it is not possible to simply import methodologies developed in other contexts. This was a difficulty for this project.

5.6.1.2 Reflexivity and alternate researcher positionality

In conventional research terms there is also a difficulty with the many different roles the researcher took in this project. As well as her researcher role, she was also the course designer and facilitator, the webinar host, and so on. She is also embedded in many of the participants' social worlds (Cohen et al., 2007). When interviewing it is possible that her presence influenced the interviewee's responses: for example, that they said what they thought she wanted to hear (Cohen et al., 2007; Yin, 1981, 2013). However, as argued earlier (in section 5.3 above), this embeddedness is seen as a positive in complexity-influenced research. The researcher's role is not to be a detached observer, but, by being part of the system, to initiate "purposeful perturbations" (White and Levin, 2016, p. 48).

5.6.1.3 Testing themes, internal validation and the complexity conundrum

There is a tension between the complexity-oriented framework and establishing validity in the adopted methods. Accepted practice in conventional case studies is to review themes that have been created in data collection by comparing these against coded themes and the entire data set (Braun & Clarke, 2006; Thomas, 2006). Additionally, Yin (2013) suggests that multiple sources of evidence should be used in order to test construct validity. However, when viewed through a complexity lens, these sources of evidence are likely to have been derived from different unique localised contexts, which are likely to have *changed* by the time the sources are compared with other sources. The notion of validity is problematic in complexity-informed research.

5.6.2 Limitations of methods

5.6.2.1 Self-reporting

Complex systems emphasise the space between agents in the system, rather than the agents themselves. In this study the focus was on the interactions MOOC participants engaged in, not the MOOC participants themselves. However, collecting data on these interactions posed some practical and technical problems. Many of the methods used to collect data about interactions were beyond the resources and scope of this study. For example, Pentland (2014) describes computational social science, a method that uses smart phones to collect second by second data simultaneously across multiple networks. This data includes:

- Digital sensing that maps activity, proximity and interactions, and
- Digital social network data collection that logs information about online social interaction and communication.

The methods he describes are able to show patterns of idea flow and changes in behaviour in large groups in far greater complexity (and far more quickly) than could ever be captured using conventional social science methods such as case studies and ethnographies. As the project progressed it became clear that, using the available methods, it was possible to do little more than 'scratch the surface' of what was going on. However, the methods Pentland describes require resources that were not available to this project. The pragmatic choice was made to rely on participants' self-reports of their interactions with others. These may or may not be accurate and, in practical terms, there are few ways to check this. So, this was a limitation.

5.6.2.2 Survey intervals

A second limitation had to do with the variation in participant numbers between survey intervals. As was expected (from other studies on MOOCs), participation dropped considerably over the eleven-week course. While the first survey had 81 participants, but by the final week there were only six participants. It is therefore inappropriate to draw significant statistical conclusions from some of the survey data. However, the other data sources mitigate this limitation.

5.7 Conclusions

This chapter explained how and why this study was conceived as a complexity-informed case study. It explored the difficulties involved in trying to link complexity thinking with the case study method, focusing in particular on the issues of boundaries, contextuality, interactions and emergence. The data collection and analysis methods used in the study were described, and their strengths and weaknesses outlined. The next chapter reports on the project's findings.

6 Findings

6.1 Introduction

This study focused on the three research questions below.

1. Do teachers who have voluntarily enrolled in a MOOC discuss the ideas they are exposed to in the MOOC with colleagues, family and/or friends?
2. If they do, how in-depth/extensive are these conversations?
3. Do these experiences change the way they think about education futures?

It found that MOOC participants did discuss the ideas they encountered in the MOOC with others. The MOOC participants who persisted in the MOOC had more in-depth conversations, and some of these participants said that these discussions changed the way they thought about education futures.

6.2 Context

6.2.1 Overall MOOC participation and engagement

From the publicity material circulated in advance of this project, 521 people expressed interest in participating in the MOOC that is the focus of this project. In the first week of the course there were 131 unique logins, and 342 logins altogether (according to iQualify analytics). These logins spent 10 minutes on average per session (see Table 3 below).

However, after Week 1 there was a sharp drop-off in participation, as indicated by Figure 2 and Table 3 below.[4] By Week 5, there were only 50 unique logins and in Week 11 there were only 13 (9.92% of the original number of unique logins in Week 1).

No new course material was published after Week 11 and the course officially finished in Week 12. However, the activities and discussion forums remained open for three weeks after this. iQualify data showed that there were 22 unique logins in Week 12, logging in a total of 47 times and spending on average 15 minutes per session. The participants who had made it this far appeared to remain engaged after the course had finished. Another trend was that the participants who stayed with the course had longer sessions with the course material as the course progressed, with the exception of Weeks 8-11 (these weeks occurred at the end of the New Zealand school term). See Figure 3 below.

[4] This seems to be common with MOOCs (Hew, 2015).

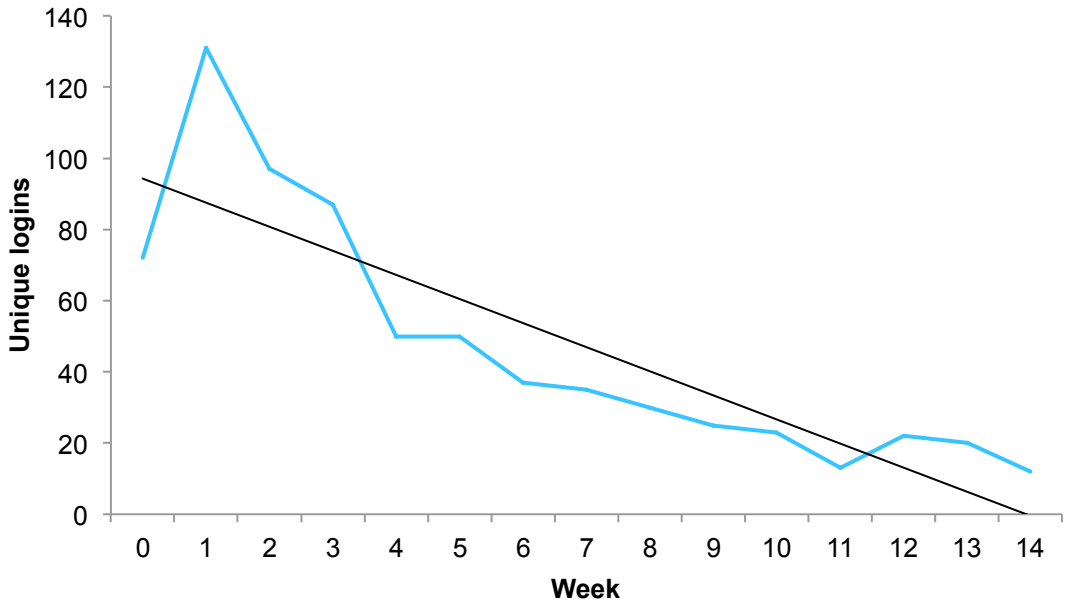

Figure 2: Number of unique logins over time in iQualify.

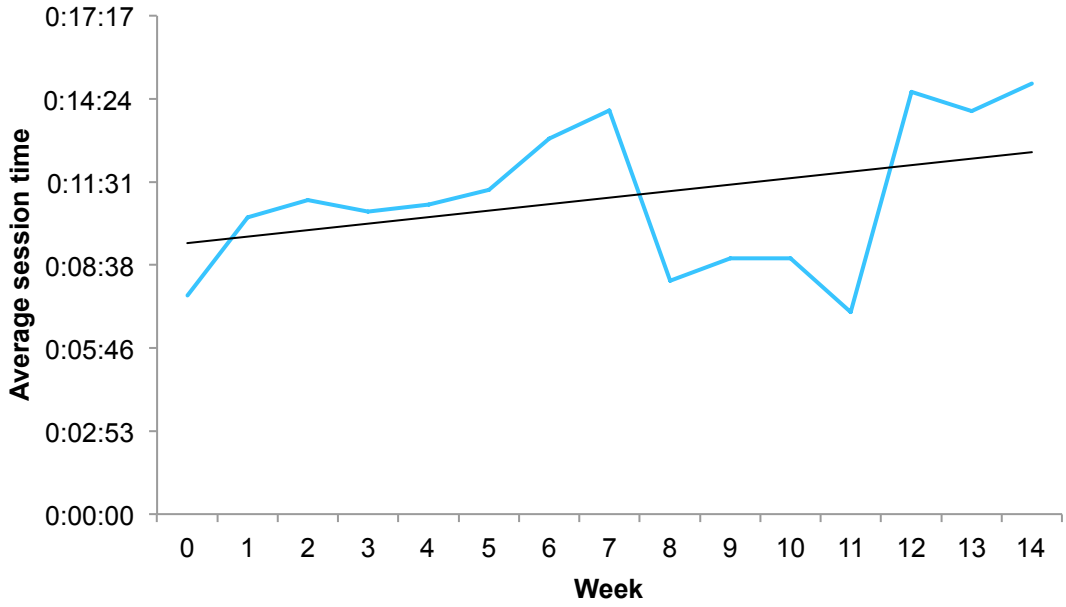

Figure 3: Participant average session time in iQualify

Table 3: Course participation from iQualify analytics.[5]

Week	Unique logins	Total logins	Sessions	Avg. Session Duration	Percentage of week 1 participants
0	72	110	118	0:07:35	54.96%
1	131	342	457	0:10:17	100.00%
2	97	267	361	0:10:54	74.05%
3	87	207	307	0:10:29	66.41%
4	50	112	167	0:10:44	38.17%
5	50	123	170	0:11:15	38.17%
6	37	78	137	0:13:01	28.24%
7	35	94	143	0:14:00	26.72%
8	30	87	132	0:08:05	22.90%
9	25	55	102	0:08:52	19.08%
10	23	50	88	0:08:52	17.56%
11	13	30	55	0:07:00	9.92%
12	22	47	59	0:14:38	16.79%
13	20	70	88	0:13:59	15.27%
14	12	25	33	0:14:56	9.16%

6.3 Research participants

The research participants were people who were enrolled in the MOOC[6] and who had agreed to participate in this research.[7] The number of research participants who remained engaged in the MOOC decreased as the course progressed, much as it had for the MOOC participants who were not participating in the research.

As described in Chapter 5, this research project involved multiple modes of data collection including a survey and interviews. This data was also supplemented with the iQualify platform's

[5] Week 0 refers to the beginning of the course when participants were able to access the iQualify software but did not have access to any content.

[6] With a couple of exceptions – see below.

[7] By accessing and completing the survey and/or agreeing to be interviewed (see Appendix A for details of the ethics approval).

learning analytics (used above), as well as participants' coursework. Further, secondary data was also collected from social media, including Twitter and blogs. The iQualify data and social media interactions were useful signposts for participant interactions at different points during the MOOC. The findings from each of these different forms of data are reported separately below.

6.3.1 iQualify findings

iQualify, the online learning platform that hosted the MOOC, collects learning analytics from enrolled users and their activity within the course. As described in Chapter 4, users were able to make discussion posts and social notes. The frequency of these was tracked by the platform. Table 4 summarises this kind of activity by MOOC participants during the course and for a short period afterwards.

Figure 4 shows the average number of social notes and discussion posts across the duration of the course. The data shows a weak positive trend, indicating that as time progressed, participants were interacting with each other more within the iQualify platform. Weeks 8 and 11 are an exception to this trend, as in these two weeks, there was a marked reduction in the number of interactions. Additionally, the positive trend in Figure 3 indicates that as time progressed, participants who remained in the course were more likely to spend longer periods of time per session. Further, as shown in Figure 5, iQualify data also indicated that over time, participants were more likely to log in more often (with the marked exception again of Week 11).

Overall, the iQualify data indicate that although participation rates decreased over time, the participants who remained in the course interacted more within the platform and spent longer periods of time doing so, as the course progressed. Thus, from this data, it appears that these participants increased the number of their interactions about education futures, and possibly also their depth.

Table 4: Activity within iQualify.

Week	Study notes created	Social notes added	Discussion posts added	Average
0	0	0	0	0
1	6	19	85	37
2	4	11	116	44
3	4	39	101	48
4	1	25	91	39
5	0	16	89	35
6	1	4	62	22
7	6	2	63	24
8	0	14	28	14
9	0	13	36	16
10	2	1	26	10
11	7	0	5	4
12	4	1	45	17
13	41	0	29	23
14	0	0	2	1

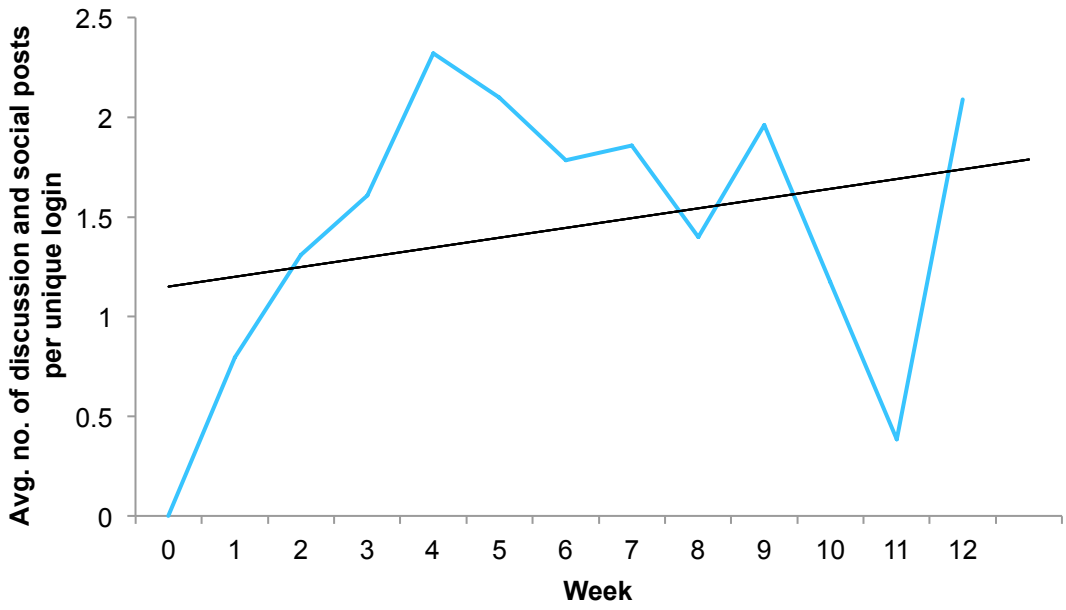

Figure 4: Average number of discussion posts and social notes per unique login over time, in iQualify.

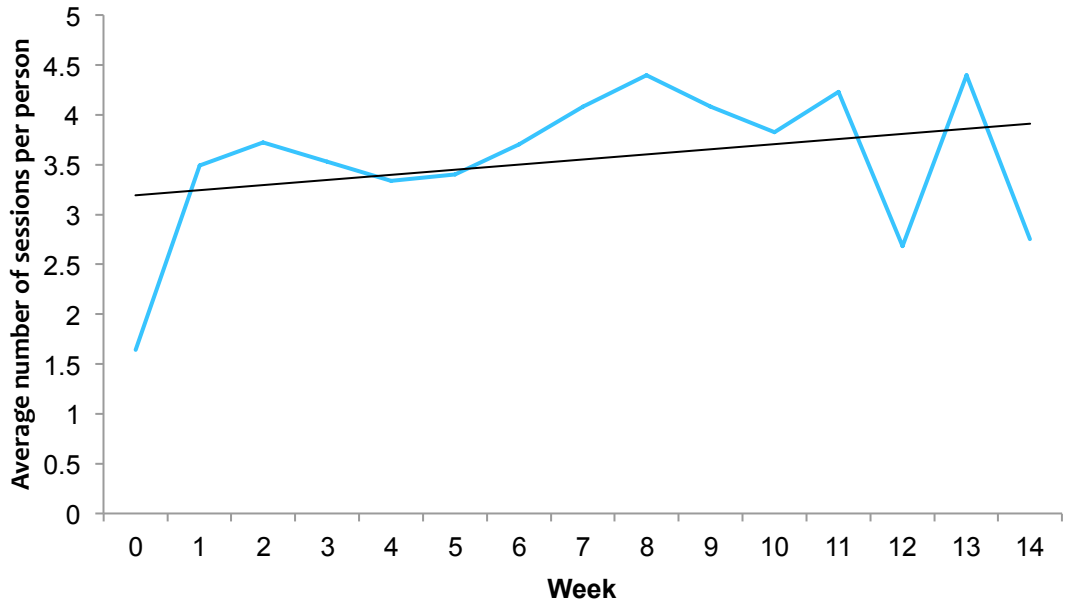

Figure 5: Average number of sessions per person over time, in iQualify.

6.4 Survey Findings

The survey was embedded in the course at four points, in Weeks one, four, seven and eleven. Participants were asked to report on their experiences of the number and depth of their interactions, and whether they felt anything had changed in their thinking as a result.[8]

[8] See Appendix B for the survey questions.

Eighty-one people completed the survey in Week 1 of the MOOC, but as the course progressed there was a significant drop off in participation (see Table 5). By Week 11 only six people were still filling in the survey (this also corresponds with the marked reduction of activity in iQualify at the time). The survey data should be interpreted in the light of this. However, despite these limitations there were some interesting trends.

Table 5: Survey participation compared to MOOC participation (from iQualify data)

Survey point	Number of survey participants	Number of active MOOC participants	Percentage of week one group
Week 1	81	158	51%
Week 4	22	42	14%
Week 7	22	32	14%
Week 11	6	23	4%

6.4.1.1 Who were the survey participants?

Survey respondents were asked to identify all the ways they are involved in education.[9] As can be seen in Table 6, slightly over half of those who began the survey were teachers. Roughly a fifth said they were parents and about one in ten identified themselves as education consultants. Only one was a current school student. As can be seen in Table 6, there were differences between these groups in terms of the extent to which their participation in the survey dropped off as the course progressed. By week seven, less than half of primary school teachers were left, and by the final week, there were none. Less than a third of secondary teachers were left by week seven, with only one present in week eleven. Drop-out rates were higher for school senior leaders and education consultants, 85 percent ceasing participation by Week four. From the information collected it is not possible to discern a reason for this trend.

[9] NB some respondents selected multiple alternatives, which is why the total sums to more than 81.

Table 6: Who participated in the survey?

	Week 1	Week 4	Week 7	Week 11
Parent of school aged child/children	25	8	6	2
Board of Trustee member	4	3	2	0
Student in school	1	1	0	0
Education consultant	12	2	6	2
Early childhood education teacher	1	0	0	0
Primary school teacher	18	6	8	0
Secondary school teacher	33	13	10	1
School senior leader	21	3	2	2
School middle leader	16	7	9	1
Tertiary lecturer	0	0	0	1
Other	10	3	1	0

6.4.1.2 What kinds of conversations did the survey respondents have?

Survey respondents were asked whether they had talked to others about the future of education in the last week, and, if they had, to classify their conversation/s via a typology provided in the survey.[10] Respondents were asked about the number and depth of these conversations, as well as the *context* of the conversation, and in what form it took place – e.g. face-to-face or on social media.

As Figure 6 below shows, survey respondents said that most of the conversations they had in the first half of the course were face to face, but, by the end of the course, most were through social media. However, little significance can be read into this, as this pattern could just reflect the preferences of the small number of respondents still participating at this point.

[10] See Appendix B for this classification scheme.

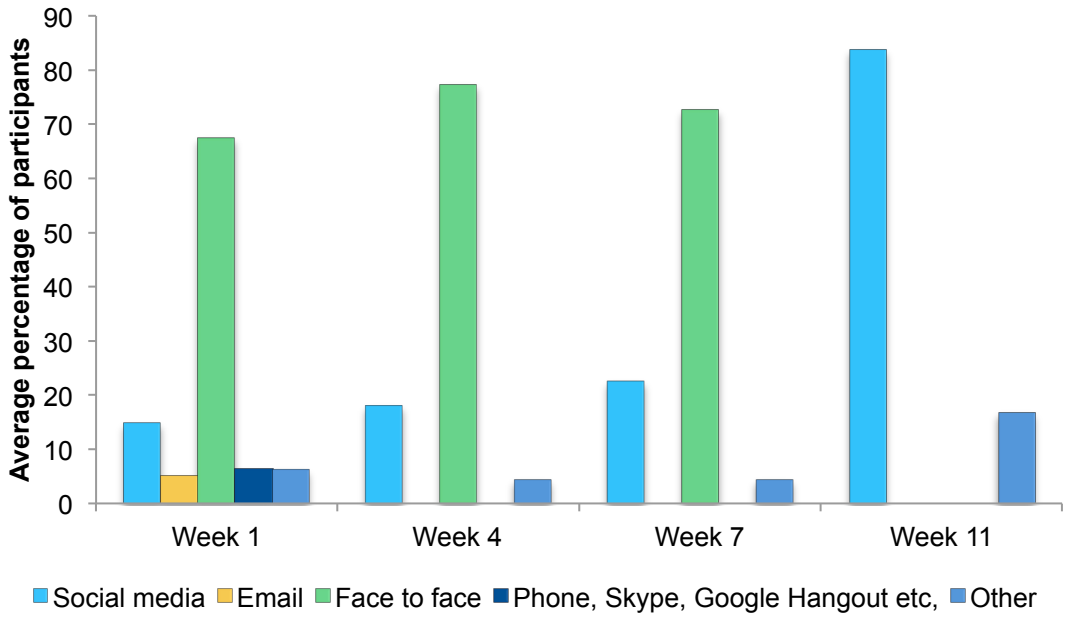

Figure 6: Mode of survey respondents' conversations about education futures.

6.4.1.3 How many conversations did the respondents have?

As Table 7 below shows, most respondents said that they did talk to others about education futures during Week 1 of the course (71/81 or 88%). By Week 4, of the 22 respondents left, all had at least one conversation about the future of education. During week 7, only one participant indicated that they had no conversations. Only six people responded to the survey in week 11, although all six had at least one conversation. Thus most of those who persisted in the course had one or more conversations about the future of education.

Table 7: Number of survey participants who had no conversations about the future of education.

	Week 1	Week 4	Week 7	Week 11
No conversations	10	1	0	0
Percentage of survey participants.	12%	4%	0%	0%

Table 8 shows that about 15 people said they had three or fewer conversations over the duration of the course. An average of 7 people said they had between four and seven conversations during this time, and an average of 3 people said they'd had more than seven. Thus most people had three or fewer conversations about the future of education, but some had many more.

Table 8: Average number of conversations in the last week about the future of education.[11]

		Between one and three	Between four and seven	More than seven
Week 1	**Average**	34.5	17.25	4.25
	Percentage	(42.59%)	(21.30%)	(5.2%)
Week 4	**Average**	11	5.25	3.5
	Percentage	(50%)	(23.86%)	(15.91%)
Week 7	**Average**	11.5	4	3.25
	Percentage	(52.27%)	(18.18%)	(14.77%)
Week 11	**Average**	2.5	1.75	0
	Percentage	(41.67%)	(29.17%)	(0%)
Average		14.9	7.1	2.8

6.4.1.4 How in-depth were survey respondents' conversations?

Survey respondents were asked to classify their conversations using a four-point scale designed to indicate whether their conversations were in-depth, robust, and/or sustained over time. Table 9 shows their responses.

This data shows an increase in the depth of respondents' conversations as the course progressed. As indicated in Table 9, 18.58% conversations (average of 15) were classified as in-depth during Week 1. By week seven, the number of in-depth conversations had increased to 36.36% (average of 28). This figure decreased in Week 11 but between Weeks 7 and 11 there was an increase in the number of on-going conversations built on over time. The number of brief conversations reduced from 13.62% (average of 11) in Week 1, to 11.11% (average of 3) in Week 11. Similarly, conversations classified as two to three exchanges decreased from 27.86% (average of 22.5) in Week 1, to only 14.81% (average of 4) in week 11.

Figure 7 below shows that the majority of conversations were classified as two or three exchanges in Week 1, but from Week 4 onwards, the majority of conversations were more in-depth.

[11] Percentage indicates the average number of conversations as a percentage of the number of survey participants in that week of the survey.
Table 8 provides the same data as, however presented as a table.

Table 9: Average depth of conversation summary[12]

		Brief conversation	Two to three exchanges	In-depth conversation	On-going conversation, built on over time
Week 1	**Average**	11	22.5	15	15.75
	Percentage	(13.62%)	(27.86%)	(18.58%)	(19.50%)
Week 4	**Average**	2.75	5.25	7	4.5
	Percentage	(12.50%)	(23.86%)	(31.82%)	(20.45%)
Week 7	**Average**	11	21	28	4.25
	Percentage	(11.36%)	(23.86%)	(36.36%)	(19.32%)
Week 11	**Average**	3	4	5	6
	Percentage	(11.11%)	(14.81%)	(18.52%)	(22.22%)

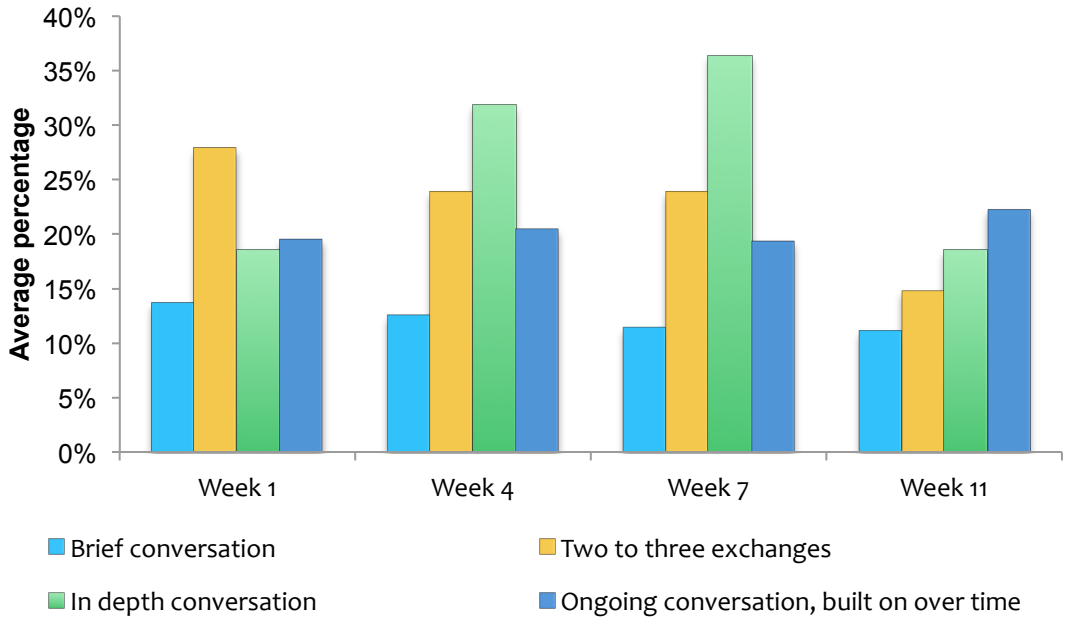

Figure 7: Comparison of depth of conversations across the duration of the course.

6.4.1.5 Who did respondents have in-depth conversations with?

As shown in Figure 8, the survey data shows that respondents were more likely to have in-depth conversations with someone at their local school, and less likely to have in-depth

[12] Summary compiled from survey questions three, four, five and six (see Appendix B). Table excludes data for those who had no conversations.

conversations about education futures with someone from outside education. Figure 8 also indicates that survey respondents had few or brief conversations about these ideas with school leaders. Interestingly some respondents also commented on this in the final survey question. One said that they were "getting frustrated by the people at the top, who are 'meant' to care more," and another said, "I am feeling a little unsettled by how many school leaders are not engaging in this level of thinking."

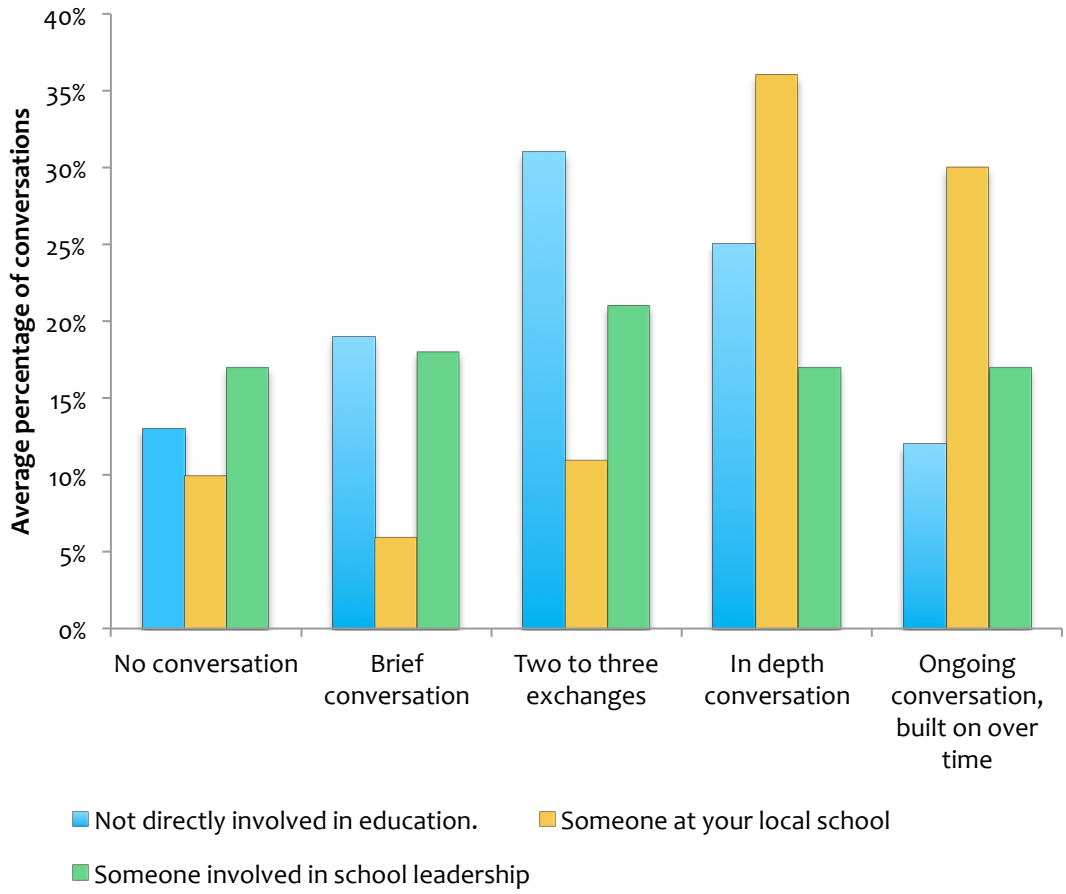

Figure 8: Average depth of conversations with groups of different levels of involvement in education.

6.4.1.6 Did anything change as a result of involvement in this project?

The final survey question asked how, if at all, had anything changed through being involved in this project? In the first week, 29 (36%) of the respondents (n=81) commented that nothing had changed yet, or that it was too early to tell. However, by Week 4, only two participants (9%) commented that they had not yet experienced a change (n=22). By Week 7 one participant said that the MOOC had not affected their interactions, however this person went on to comment that their thinking had been impacted, and that they were sharing ideas from the MOOC through social media more:

> I don't think much has changed in my interactions with others about the future of education. … The MOOC has really shifted my thinking and excited me - particularly

> in the past two to three weeks of the MOOC - around complexity theory etc. I will likely talk about this in very animated ways over the next while. The MOOC has caused me to post a lot more to social media on this topic - using the resources in the MOOC that I engaged with and talking about them a little.

Additionally, in Week 7, three participants mentioned that they were asking more questions, one saying for example, "I am more likely to initiate discussions about the future of education by asking disruptive and provocative questions..." A number of participants (5 in Week 7) also indicated that they were eager for more conversations about education's futures. One respondent commented as follows:

> I am seeing the real importance of these discussions and how they really are missing from staffrooms. I want to be able to discuss things further and I want decision making to be well informed.

Overall, the survey results show that participants who persisted in the MOOC were more likely to have more in-depth conversations, and more likely to notice the absence of these conversations in places they expected to have them.

6.5 Interview findings

As described in Chapter 5, the survey data was supplemented by data from a small group of people who agreed to be interviewed about their experiences in relation to the MOOC. Within this group there were two different types of participants. The first sub-group (N=10) were MOOC participants who responded to an invitation to be interviewed. The second sub-group (N=2) did not participate in the MOOC. They were recruited by people in the other group of interviewees, who nominated them as people they had talked to about ideas from the MOOC.[13] All of the interviews took place after the MOOC had concluded.[14]

6.5.1 Who were the interview participants?

Of the ten MOOC participants interviewed, six were teachers, two of whom said they have middle leader roles. One is a senior leader and two are education consultants. Eight of the ten live in New Zealand. Two currently live outside New Zealand but have taught in New Zealand and intend to do so again. Two of this group said they had school-aged children. Of the two interviewees who were not MOOC participants, one is a teacher aide, and the other said they were not directly involved in education. Both live and work in New Zealand and had family members involved in education.

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13 See appendix A for ethics application.

14 See appendix B for details of the questions the interviewees were asked.

6.5.2 What kinds of interactions did the interviewees have?

The interviewees were not asked directly about the number and type of interactions they had with others, as was the case in the survey, but this information emerged in the course of the interviews. Of the ten MOOC participants interviewed, all said they had at least one face-to-face conversation with others about the ideas they had encountered in the MOOC. At least three participants clearly identified that the MOOC provoked more interactions for them. One interviewee commented that they now "start more conversations." Another said that the MOOC "forced me to talk to other people."

6.5.3 How in-depth were the interviewees' conversations?

Interviewees were not asked, as in the survey, to categorise the depth of their interactions. However, they were asked about the *nature* of the conversations they'd had, and to comment on what, if anything, they *noticed* about their interactions with different people when discussing ideas encountered in the MOOC.

Many commented that the conversations they had about ideas from the MOOC were *different* from their "usual" conversations. For some these differences had to do with the way they related to the other person. Some commented that the conversations allowed them to see the other person in a new light. One participant said that "*you have different interactions with them ... whole different person*." For others, the difference lay more in the extent and depth to which they talked about ideas. For example, one (non-MOOC participant) interviewee said that the MOOC *"…made our conversations richer and more interesting*." Another, who had participated in the MOOC, described a conversation they'd had with another MOOC participant as follows:

> We had a really good one-hour chat about the kaupapa. So that was really cool. ... We actually just talked through what we had learnt, and really unpicked in terms of our own jobs. So [MOOC participant] talked about what it meant for her in her role, in her work. And how she was making sense of it. And I did the same. And then we sort of talked about big picture education as well. And [MOOC participant] and I are good friends and we often talk about our jobs in detail and the people we come across and the challenges we have. But this made us talk bigger picture education. So it lifted our heads up into a more strategic place to think more broadly about the state of education I guess. … It was nice to have that conversation with [MOOC participant] because that is something new for us in our relationship. So that was cool. (Interview 2)

Many of the interviewees said that they wanted more of these kinds of conversations. Some participants indicated that they see value in these more in-depth conversations, saying things like "If you are willing to dig deeper, it will have a bigger impact" and "things will only change if we look below the surface a lot more." However, for some, it was clear that they felt that they do not have access to appropriate people to talk to. This was particularly evident for three of the teachers. For example, one said that "you have to choose the right people", explaining that in special needs education, "we hardly talk about these things." Another noticed that, "little education conversations happen unless initiated." Another commented that their teacher friends

say things like, “Let’s leave school at school, and let’s have a coffee on the weekend and talk about everything else.” Another said that she wanted to be challenged, although she explained that “… when you are a strong woman, there are people who won't challenge you. I want to be challenged!”

Others lamented the difficulties they saw in engaging school leaders in debate about ideas on educational futures, with one participant commenting as follows:

> I think my biggest wondering, and it has been an ongoing conundrum, is … how we help schools, or school leaders in my case, to innovate. And not tweak. … I am always looking for ways… because what I find when I work with clusters, is that when it comes to designing new practices together once they have a vision, … they come up with the most conservative, risk free, same-as-we-have-always-done practices. And I am still grappling with ways to get them to think differently. … What we want to do is get right away from that factory model, just kill it and start again. … And there are so many factory model practices in schools, even brand-new schools … I played a video of what is going on inside High Tech High to a couple of principals in Auckland I was working with. And we were planning to play these videos to staff and I said ‘What do you think? This is aspirational. It’s a starting point to work backwards from. They don’t have to be this, but what is it about this that inspires us?’ They both said that is a step too far, it’s going to scare people. What can we do to show them that’s just a small tiny baby step forward? (Interview 2)

Thus the interviews indicated that participants did discuss the ideas they were exposed to in the MOOC, often in great depth. However, participants also identified challenges in finding people to have these more in-depth interactions with. In particular, they found it difficult to engage school leaders in discussions about education futures.

6.5.4 Did interviewees change the way participants think about education futures?

As with the survey, interview participants were also asked if anything had changed for them since their involvement in the project. Interview participants were also asked if they had found themselves thinking, engaging or acting differently.

Two interviewees were able to articulate explicitly how the MOOC had prompted them to act differently. One participant explained the impact of the different discussions she was having as a result of the MOOC:

> From the debates, from the discussions I am having with my colleague, she is starting to open up, and we are starting to make a compromise. (Interview 12)

The same participant later went on to describe how the debates and conversations prompted by the MOOC’s focus on alternate curriculums, led to them making a change in their learning programme:

> Last term we have started with our integrated Maths and English programmes. So I told her [co-teacher], we have to come to a compromise here, we can’t keep working in silos where the kids find a totally different thing in English where they come and they come to for Maths and find a totally different thing. They have to find a sense of connection somewhere. So last term we decided to embark on a maths and English integrated programme centred on Matariki week. (Interview 2)

Another participant described how the action they had taken as a result of the MOOC revealed a new approach with a group of struggling learners that resulted in more engagement within their literacy programme. Interestingly, for both these participants the change in their thinking and actions had implications for people who had no direct interaction with the MOOC.

Other participants made a deliberate shift in behaviour. For example, they said that "The big thing for me was to be assertive, to take some risks." Another identified that although they had always been reflective, the MOOC made them think deeper. A further group of participants identified that the MOOC changed the way that they were feeling about the future of education. One participant described this as unsettling and uncomfortable, while another noted, "Sometimes you struggle to sleep."

In summary, it appears that at least three of the interview participants may have experienced some shift in their thinking. This was seen as either a change in their actions or experiencing new feelings about the current education climate. However, the results leave some ambiguity about the extent to which participants thought differently about educational futures.

6.6 Secondary data findings

The findings from iQualify, interview and survey data were supported by trends elicited from secondary data, mainly social media interactions.

6.6.1 Twitter

The MOOC hosted a number of public webinars on Google Hangouts, complemented with synchronous Twitter chats using the #edchatNZ and #edchatNZMOOC hashtags. These produced significant spikes of interactions: on two occasions during the MOOC #edchatNZMOOC became the number one trending hashtag on Twitter New Zealand.

6.6.2 Google Hangouts and YouTube

Webinars for the MOOC were public, available to MOOC participants but also anyone else who was interested. They were hosted using Google Hangouts and YouTube.[15]

Table 10 summarises the YouTube analytics of the webinars hosted for this MOOC, compared to the number of unique logins in the MOOC platform. The analytics indicate that the webinar with David Weinberger, which occurred in Week 5 of the course, had about a hundred views in

[15] YouTube and Hangouts are both Google products. Hangouts functions as a videoconference tool, however the Hangouts are streamed live and archived through YouTube.

this week. However, this same period shows only 50 unique logins on iQualify during the same period (see Table 3). By the end of July (3 weeks after the end of the MOOC), the views on the archived video of the chat had increased to approximately 190 views. Similarly, the webinar in Week 9 of the course had about 90 views in this week. However, in that week there were only 25 unique logins by MOOC participants in iQualify. These results suggest (along with the asynchronous Twitter conversations paired with the webinars), that people who were not enrolled in the MOOC were engaging with the ideas from the webinars.

Table 10: Views of webinars

Webinar	MOOC Week	Approximate No. of views in Week of webinar	Total views by end of MOOC	Unique logins in iQualify
David Weinberger	5	100	190	50
Keri Facer	7	90	170	35
Grant Lichtman	8	30	60	30
Rachel Bolstad	9	90	140	25

6.6.3 Blogs

In the course of the interviews, three of the MOOC participants mentioned that they had shared and discussed ideas from the course on their personal or professional blogs, and one said that they had posted material from the course content on their organisation's blog. Two MOOC participants who were not involved in the research also posted about the MOOC and the ideas in it on their blogs.[16] These publically shared blogs also show that participants were discussing, and inviting further discussion of the ideas they were exposed to in the MOOC with colleagues, family and/or friends.

6.7 Other findings

Further analysis of the various data sources also revealed additional trends that were beyond the scope of the research questions. These findings are described briefly because they raise questions about the system that could be significant in understanding the disruption of debates about education futures.

[16] Consent was gained from these individuals to use their blogs in this research.

6.7.1 Responsibility

A recurring theme across the data indicated that at least five of the interview participants were grappling with the question of responsibility. Specifically, whose responsibility is it to ensure that public education adapts to post-normal times? One interviewee explicitly asked, “Whose responsibility is it?” One of the education consultants said, “I think we have a professional responsibility.” One interviewee indicated their frustration with “people at the top, who are 'meant' to care more." Another described the attitude of a family member by saying that, “They kind of trust the school, trust the system. And they would only question it if something maybe goes wrong.” One interviewee commented that “I am just one person, what can I do?”, going on to talk about the need for wider political shift (by others). Interestingly, while participation in the MOOC was entirely voluntary and the work involved was additional to participants’ everyday work, one participant reported that they had asked their principal for permission to participate in the MOOC. A school-aged interviewee commented that “It’s not normal for someone my age to be involved in education”, referring not to their schooling, but to commonly held beliefs about whether students should have opinions about what school should be like. In contrast, a few participants talked about taking action within their spheres of influence, for example, one said "It has promoted us [senior leadership team] to take action", while another recognised that “there are little things I can do”. For some this produced conflict, one participant saying that, for them, “The main clash has actually been with other educators and how out of step I am with my colleagues’ views on education.” They then went on to say “I fear I am becoming a revolutionary … I am challenging too much.”

6.7.2 Time

Another repeating theme was the concept of time, and the lack thereof. Seven of the participants talked, without prompting, about time in their interviews. The subject of time also came up in the survey.

These discussions centred around two major themes. The first had to do with how participants managed their own time in order to participate in the MOOC. Some were quite deliberate about this. One of the teachers interviewed allocated a non-contact block during school time, while one of the education consultants allocated an evening during the week. In contrast, other participants said that they did not have enough time to engage with the material to the extent that they had hoped. For example, one survey respondent said, “I had good intentions, but I didn't make if very far in the course due to workload demands at school.”

The second linked theme emerged from the teachers in the interviews. They had noticed that in their schools, it was often difficult to engage others in discussions about education futures. One interview participant described this as "It doesn't get pushed to the forefront, not what we need

to talk about right now." Another interviewee said, "Very few people have time to do this at my school." A third interview participant described this problem in some detail:

> The one thing that I think that I noticed is that you never ever have enough time to talk about these things, with anybody. And it's not because people are not interested, they are. Everyone wants to talk about education but when you've got time pressures, and you've got commitments and you've got the constant need to work to the deadline… there just never seems to be the time dedicated to that thinking and the discussions from this course. You are always too busy doing other things. That's one of the most frustrating things about being a teacher. (Interview 9)

6.7.3 Diversity

A number of participants identified that the MOOC exposed them to new perspectives. One of the survey participants suggested that the MOOC "Provided [them] with fresh perspectives on the future of education." At least two other participants in the surveys also mentioned this, commenting that "People outside of education had a different perspective." An interview participant also talked about this:

> I noticed that people have very different perspectives on these issues depending on what they value as important, on their past/current experiences and what worked (or did not work) for them when they were at school or were involved in some sort of learning process. (Interview 9)

The quantitative data showed that most people's interactions were with someone at their local school, rather than with someone not directly involved with education (see Figure 8).

6.7.4 Interpersonal skills

A number of research participants made comments about the nature of their interactions, and what was demanded from them at a personal level. For example, at least two interviewees identified that their interactions could get heated. One described one of the interactions they'd had as follows:

> She was really quite aggressive. … And I thought, we are in for a big fight tonight. … I use the term aggressive, because they are quite personal when they are talking, and they are loud, and they get angrier." (Interview 1)

This participant also identified the role of interpersonal skills and expertise in navigating this conversation, by saying, "The people skills are definitely part of it … I would never say it's just people skills, but certainly is about having a really good foundation knowledge."

Another participant who indicated that the person they had a conversation with learnt something from their interactions, identified that, "You have to choose the right people" with which to have these interactions. Others identified that they were "… better at throwing [my] colleagues off their usual arguments and making them think about what they have always thought." In

comparison, one of the participants who had not indicated that another person had learnt something from their interactions said they "… send stuff on but [I] don't know who reads it." Each one of these four themes identified in the other findings section of this chapter (see 6.7) may signal factors in the education system that may mitigate against the uptake of ideas about educational futures. While the research was not explicitly designed to focus on these four themes, the holistic approach needed to make sense of complex systems require us to pay attention to its emergent properties.

6.8 Conclusions

These findings indicate that the MOOC did appear to amplify the number and depth of interactions about education futures in and beyond the course. However, this applied mainly to the participants who persisted in the course. Additionally, at least some of the participants appeared to experience change in the way they think, and, in a few cases, change in their actions. Some additional themes, that emerged when the various data sets were analysed together, were also discussed. These four themes—responsibility, time, diversity and interpersonal skills—were included because they provide a more nuanced view of participants' interactions about education futures. However, they are also interesting for what they reveal about feedback patterns in the complex system that is education. The next chapter discusses this in more detail.

7 Discussion

7.1 Introduction

The previous chapter set out the findings from the complexity-informed case study described in this thesis. This chapter attempts to 'make sense of' these findings in terms of what they reveal about the education system, seen as a complex system. There is a particular focus on what the findings tell us about the various impediments to future-focused change. The argument is made that using a complexity lens allows us to think differently about future-focused change in education. While this study has shown that it is possible to increase the number and depth of interactions within the education system, it is unlikely that this, on its own, will produce the kinds of change needed. Some of the study's unintended findings point to the effect of various detractors in the system, negative feedback loops that are likely to constrain attempts to 'push' the system in more future-focused directions.

7.2 Number and depth of interactions

The findings from this study showed that the MOOC was able to increase the *number* of interactions in the system. This was true for MOOC participants and for people connected to them. In addition, the MOOC was also able to increase the *depth* of some participants' interactions in their localised networks.

Some of the secondary findings (e.g. the number of webinar views exceeding the number of active course participants, or the spike in MOOC activity after the course had finished) suggest that the MOOC's disruptive effects were felt outside the eleven-week course and its official participants. However, further research would be necessary to investigate this.

Looking at the findings in complexity terms, we might see the MOOC acting as an attractor, able to amplify idea flow across the network. The MOOC's ability to do this tells us that it is possible to increase idea flow in some parts of the education system. Some parts of the education system are open enough for new ideas/energy to enter. In complexity terms this is important if we hope to see emergence from new configurations of self-organisation.

7.3 Change in the way people think

The findings also showed that the MOOC contributed to changes in some participants' thinking or their actions. These changes were produced not so much through the MOOC's content, but through the interactions participants had as they discussed and debated its content with others. This points to a new way of thinking about system change. Instead of seeing change as necessarily produced through top-down implementation of system-wide policy, it could be that it

can be produced via localised interactions across the system. Connected nodes within the system can effect change, without formal positions or roles*, through their connections.*

However, the case study described here involved a set of individuals with links to the #edchatNZ network. It may be that the MOOC's effects are not generalisable across the system as a whole. For example, it is possible that this group of individuals are disproportionally well-connected and/or influential, and that it was their connectedness that produced the observed changes. If this is the case, then it is less likely that the MOOC would have the same effect with other groups. As Daly (2010) points out, agents who are not well connected in the system are unlikely to produce change. System change comes about when ideas flow to all parts of the system through large numbers of 'quality' interactions right across the system (Hargreaves & Fullan 2012).

7.4 Secondary findings

Secondary findings from this study indicate that while the MOOC appears to have nudged the system, the changes are likely to be short-lived and/or have limited impact. Almost all participants identified significant impediments to their ability to engage in these disruptive discussions. Some of these impediments are discussed below, and a complexity framework is used to try to understand what they tell us about the system.

The research participants identified several common problems in relation to the interactions and change in thinking that were the goals of the safe-to-fail experiment. These were as follows:

- Participants who were teachers specifically identified that they and their colleagues did not have enough *time* to engage in these conversations as other things were often prioritised (see page 82).
- Participants indicated that they were grappling with where the *responsibility* fell for transforming education for post-normal times (see page 76).
- Participants reported that they were less likely to have in-depth conversations about education futures with someone from *outside* of education (see page 69).
- Participants indicated that interacting with *school leaders* frequently and in-depth about education futures was a challenge (see page 69).

Rather than seeing these as *problems* in implementing change, complexivists might instead consider what these trends reveal about the system. As outlined in Chapter 3, the purpose of safe-to-fail experiments is to learn about the system (Berger & Johnston, 2015; Snowden & Boone, 2007). Safe-to-fail experiments are designed to illuminate complexity in the system, to bring unanticipated complexity into focus. Instead of seeing the 'challenges' identified by participants as obstacles to be overcome, as they might be in conventional reductionist, top-down change models, a complexivist might see them as evidence of feedback loops that are

having a homeostatic influence on the system. Each of the above 'challenges' are discussed below in these terms.

7.4.1 Feedback loops

Positive feedback loops amplify specific qualities in a system, while negative feedback loops act to diminish the effects of changes in a complex system (Davis & Sumara, 2014). Positive feedback loops are a key property of complex systems that allow new possibilities to emerge and redirect lock-in (Capra & Luisi, 2014). In the context of this study, a positive feedback loop might be seen as the attractors in the system that encourage transformation in education. A negative feedback loop, in contrast, might be seen as interactions that diminish or discourage the system from acting in a way that might transform education.

7.4.1.1 Time

As identified earlier, time appears to be a huge factor for educators, to the point that it is a cliché for teachers to say that they need more time. A 2016 report from the Post Primary Teachers' Association found teachers felt that both the amount and complexity of their workload had increased in recent times (New Zealand Post Primary Teachers' Association, 2016). The New Zealand Education Institute study found that the greatest sources of stress for senior leaders in schools is the sheer quantity of work, followed closely by too little time to focus on teaching and learning (Riley, 2016). In the context of this study, several participants specifically said that there is never enough time to have the necessary conversations about education futures. They explained that this was either because they personally did not have enough time, or because their colleagues did not, as there were always more pressing matters at hand.

Using a complexity lens, we might reconceptualise time, or at least the perception and use of time, as a potential negative feedback loop in education. To understand this, it is useful to consider the education system as an ecosystem. Ecosystems are generally accepted as a common example of a complex system:

> The ecosystem concept – defined today as a community of organisms and their physical environment interacting as an ecological unit. … we can picture an ecosystem schematically as a network with a few nodes. Each node represents an organism, which means that each node, when magnified, appears itself as a network. … At each scale, under closer scrutiny, the nodes of the network reveal themselves as smaller networks. (Capra & Luisi, 2014, p. 67)

Ecosystems have been described using the Red Queen Hypothesis. The name is taken from Lewis Carroll's (2012) Alice in Wonderland, where the Red Queen cries

> Now, here, you see, it takes all the running you can do, to keep in the same place. If you want to get somewhere else, you must run at least twice as fast as that! (p. 161)

In an ecosystem, this is understood as organisms competing with other organisms to survive and reproduce, thus constantly having to adapt, evolve and change (Valen, 1977).

Applying the Red Queen Hypothesis to the complex system that is education, we might infer that educators and educational institutions constantly have to adapt and evolve in order to 'survive'. Schools, school leaders and teachers would constantly need to keep running just to maintain the status quo in the presence of accelerating change. Thus, we might begin to understand why teachers always feel that there is never enough time. This apparent shortage might in fact be the Red Queen Hypothesis at play. Further, expecting teachers to deeply think about and discuss the future of education would then be asking them not to just keep up the pace, but to accelerate. This issue becomes even more pressing when we consider the accelerating rate of change at a global scale in exponential technology, political volatility and economic instability (as discussed in Chapter 2). As the pace of change outside of schools accelerate, it is likely that time will evolve to be even more of a problem. We can thus see how time, both the perceptions and use thereof, might act as a negative feedback loop, diminishing the likelihood that teachers might engage with education futures at a deep enough level to make deliberate change.

7.4.1.2 Complexity reduction in schools

The idea that teachers are time-poor and that this makes it difficult for them to engage with education futures is hardly a revelation to any educator. But if we look at time through a complexity lens, things can look rather different. The focus on time is one of the many complexity-reducing measures that are a feature of, and constrain change in, education systems. According to Biesta (2010)

> School buildings reduce the complexity of human learning by isolating it from everyday life and giving it a material location. The school year, time tables and curricula put learning within temporal boundaries (p. 7).

Timetables, curricula, classroom organization, hierarchies and other measures in school act to reduce complexity, and hence mitigate "against conditions for emergence" (Hetherington, 2013, p. 74). Compounding this is the levels of standardisation that are required. Teachers, are told what to teach, to whom and when, through extensive policy, curriculum statements, and schemes of work. All this decreases the possibility of diversity within the system. While complexity reduction is not in itself good or bad (Biesta, 2010), in the context of this study it could be argued that complexity reduction in education has negative implications for the system's capacity to engage with ideas about educational futures. It produces negative feedback loops that diminish diversity, idea flow, and the time/space for reflection, negotiation, and debate, and, in so doing, it limits the opportunities for emergence (Biesta, 2010; Frelin & Grannäs, 2010; Hetherington, 2013; Pentland, 2014). Under these conditions, it is unlikely that future-focused change will emerge from within the system.

7.4.1.3 Responsibility and autonomy

This study's secondary findings point to some other effects of complexity reduction in education. It could be argued that micro-managing the time and minimising the decision-making power of education's professionals diminishes their autonomy and sense of agency. And, that this constrains their professional and/or cognitive development. An interesting example from the study is the teacher who felt the need to ask their principal's permission to participate in the MOOC, which was free of charge, and to be worked on outside participants' normal working hours (see Section 6.7.1 above). Study participants who were not education professionals did not feel a sense of responsibility or agency in relation to the education system. For example, one participant, talking about a family member, said *"*They kind of trust the school, trust the system. And they would only question if when something maybe goes wrong." Or the school aged student who said, "It's not normal for someone my age to be involved in [thinking about] education". This lack of autonomy, seen in complexity terms, is likely to serve as a negative feedback loop. In the case of teachers, it is de-professionalising and disempowering (Pearson & Moomaw (2005), but from the point of view of this study, it also reduces the likelihood of teachers engaging in discussions of educational futures. As one participant put it, "I am just one person, what can I do?" (see Section 6.7.1 above).

7.4.1.4 Adult cognitive development theory

Another effect of this lack of autonomy is to reduce teachers' opportunities to have the kinds of experiences that can allow them to professionally grow and develop (e.g. by reflecting on, examining, evaluating and developing their practice, alone and with colleagues). There is a large literature on this – see, for example, work using the adult cognitive development theory of Kegan (1994) (Drago-Severson & Blum-DeStefano (2014).

From the point of view of this study, however, reducing teachers' opportunities for cognitive development reduces diversity and the possibilities for emergence. Lack of diversity and opportunities for emergence constrains change, but, conversely, it also limits the opportunities for adult cognitive development (Kegan, 1994). In complexity terms, this can be seen as another negative feedback loop that is likely to diminish the chances that teachers will engage with education futures in ways that might produce system change.

In this context, while some individuals or schools will try to be autonomous and professional, and to seek out cognitive development opportunities, they will be outliers. These individuals or schools are likely to feel unsupported by the system and to find it difficult to engage others in discussion/debate. The findings from this study support this, one participant reporting that they felt *"*out of step*"* with their colleagues, while another commented that they had to choose very carefully who they had their conversations with.

7.4.1.5 Negative feedback loops, a summary.

The starting point of this study was that a complexity framework is useful for thinking differently about educational transformation for post-normal times. Looking at the study's findings through a complexity lens makes it possible to see the multiplicity of 'signals' in the education system, mainly negative feedback loops, that are shutting down efforts to produce future-focused change from within (and outside) the system.

7.4.2 Sub-groups and super-hubs

For some theorists, sub-groups and super-hubs are important features of complex social networks. Daly (2010) describes these as areas with more densely connected relations. For Davis & Sumara (2014), they are connectivity hubs where the localised relationships of actors in the system form nested structures.

7.4.2.1 Echo chambers and filter bubbles

The survey and interview data from this study show that the participants experienced challenges in engaging school leaders and people outside of education in deep discussions about education futures (see Figure 8). Many of the participants reported being exposed to new ways of thinking in the MOOC, and some noticed that "People outside of education had a different perspective". From this, it seems that people in education are, in general, exposed to, and/or expected to engage with only a limited number of perspectives.

Looking at this using a complexity framework allows us to see this, not as a problem to be solved, but for what it tells us about the system. If a system is made up of interacting agents, perspectives, values, ideas and information, then if there are only a limited number of agents, perspectives and so on, diversity is reduced, there is a tendency to group-think, and change is unlikely. This reduced diversity is referred to as an 'echo chamber' by Weinberger (2011), and a 'filter bubble' by Pariser (2011). If, as indicated in this study, this is the case in our education system, then future-focused change from within the system is unlikely.

Diversity

For complexity thinkers, it is the diversity within a system that allows adaptation and change. Variation provides a resource of possible responses to change (Davis & Sumara, 2014). In a social system, the system adapts, innovates or self-organises in response to problems, and new

possibilities emerge. However, the number and quality of the possibilities that can emerge is a function of the system's diversity. Diversity is acknowledged as a key ingredient for innovation and creativity (Bassett-Jones, 2005; Pentland, 2014; Sardar, 2010; Vezzali, Gocłowska, Crisp, & Stathi, 2016), and for the emergence of new possibilities from within the system. The presence of echo chambers reduces diversity, which in turn reduces the availability of resources for change.

As discussed earlier, schools have a tendency to reduce complexity. This has the effect of reducing (or alienating) variation and diversity, which in turn reduces the resources available for adaptation/change. This limits the possibilities for change, but it also has other effects, which while probably unintended, could threaten the future of public education.

Outside the public education system, transformation in education is well under way. For example, in the United States, charter school enrolments have nearly tripled over the last ten years, increasing from 1.2 million students in 2006-07 to an estimated 3.1 million in 2016-17. Three hundred new charter schools opened in the United States in 2016 (National Alliance for Public Charter Schools, 2017). One explanation for this immense growth is that, because these schools are not subject to the extensive regulation and standardisation public schools have, the possibilities for experimentation and innovation are much greater (Lichtman, 2014; Wagner & Compton, 2012). There has also been substantial growth in the number of new 'niche' private schools, often set up by wealthy entrepreneurs to provide for the education of their children (for example, Ad Astra, High Tech High). Until very recently a similar pattern was starting to emerge in New Zealand. However, in 2017 there was a change of government. The new government has stopped the development of new charter schools and required the existing charter schools to assimilate into the 'mainstream' public system. The effect of this will be to reduce diversity (and therefore resources for adaptation) within the system.

Idea flow

When parts of a network are isolated from other parts, such as in an echo chamber, there is reduced idea flow within the network (Daly, 2010; Pentland, 2014; Weinberger, 2011). Idea flow can be defined as *"*the propagation of behaviours and beliefs through a social network by means of social learning and social pressure*"* (Pentland, 2014, p. 20). Although this definition is taken from data science, the concept is also useful for describing the way knowledge in a complex social system might travel in the system and how it might contribute to its feedback loops. Daly (2010) identifies elements that can support or constrain knowledge movement in a social system. These include super-hubs that interact with large segments of the network; isolated actors who are not connected and therefore struggle to leverage knowledge in support of the larger system's goals; and sub-groups that are identified as parts of the network with more densely connected relations. Sub-groups have been shown to lend support or inhibit system goals through becoming overly focused on their own goals, therefore limiting their

connection to the larger network.[17] The extent to which sub-groups are connected with the rest of the network can make a significant difference to the way the group functions.

The findings from the study described here suggest that there is limited idea flow between and beyond different parts of the education system (e.g. senior leaders in education). These findings are supported by the OECD's Deputy Director for Education and Skills, Andreas Schleicher, who points out that;

> Knowledge of strong educational practice tends to stick where it is and rarely spreads without effective strategies and powerful incentives for knowledge mobilisation and knowledge management. That means New Zealand will have to think much harder about how it will actually shift knowledge around pockets of innovation and better align resources with the challenges. (Education Gazette, 2013 as cited in Ministry of Education, 2016b, p.17).

The findings also indicate that sub-groups in the system (e.g. individual schools or school leaders) tend to be overly focused on their own goals and interests, to the extent that they are echo chambers, not well-connected to the wider education system. Those within these echo chambers have their views reinforced by others with similar views or orientations, and in general do not engage with and/or look for challenge from outsiders. This inhibits idea flow and limits the possibilities for system-wide change. Innovations within schools do not spread beyond these filter bubbles. Although the proponents may 'share' their practice with outsiders, rigorous debate (about the *ideas*) is not usual practice, with the result that, although superficial aspects of the ideas may be picked up by others, real idea flow across the system does not usually occur (Daly, 2010).

7.5 Conclusion

This study set out to test whether complexity might be a useful framework for thinking differently about future-focused reform in education. It has found that the concepts and tools of complexity thinking provide a useful lens for bringing the system's unanticipated complexity into focus. This is helpful, not for solving the immediate problems right in front of us, but for providing new insights into how reform efforts might be directed to where they will have the most impact.

[17] Daly (2010) identifies other elements important for idea flow in social systems. However, because these are not relevant to this discussion, they are not included here.

8 Conclusions and implications

8.1 Overview

This study's aim was to test whether complexity thinking could be a useful framework to think differently about future-focused reform in education, via an initial pilot. Drawing on work using complexity thinking in research/leadership contexts, this pilot was conceived of as a 'safe-to-fail experiment. It took the form of a MOOC, which, by exposing participants to various ideas about future-focused education, was intended to 'nudge' the education system in a more future-focused direction. The MOOC was designed to encourage participants to interact with others, to discuss and develop their ideas about education futures, in the hope that this might increase idea flow in the education system, and that this might lead to change.

The research part of the project was a complexity-informed case study of some of the MOOC's participants. It looked at whether these participants discussed the ideas they were exposed to in the MOOC with colleagues, family and/or friends, and, if they did, at the depth of these discussions. Participants were also asked if they thought their experiences in the MOOC had changed the way they thought about education futures. Data were collected mainly through interviews and a survey, but other secondary data (using social media and/or the analytics linked to the software used to set up the MOOC) were also collected. A general inductive approach, with some elements from grounded theory, was used to analyse the data.

8.1.1 Findings

As often happens in MOOCs, there was a large drop-off in participation as the course progressed. However, the participants who remained in the course did discuss ideas from the course with others. The time they spent doing this increased as the course progressed, as did the depth of their conversations. Some participants reported interacting in new ways with their colleagues, family and friends, and some acknowledged an increased awareness of the importance of in-depth conversations. Some said that their involvement in the MOOC had changed the way they think or behave, and a few said that this change had impacted on people who were not involved with the MOOC.

It appears that the MOOC was able to nudge its participants towards more and deeper interactions about education futures, and that some of these interactions produced change. However, the study was also designed to see what could be learned about the system by nudging it in this way. In terms of this aim, the study's secondary findings were perhaps more telling. Some interesting negative feedback loops that are likely to constrain future-focused reform efforts were revealed. Some of the implications of this are discussed below.

8.2 Implications

This study has identified a number of negative feedback loops (lack of time, autonomy, diversity, and idea flow; complexity reduction; and the presence of echo chambers) that are likely to act against the emergence of future-focused change in education. These have wider implications, some of which are already emerging. Two of these are discussed below.

8.2.1 Burnout

Despite the negative feedback loops outlined above, there are innovators at work within the system. Various individuals, schools, organisations and initiatives are attempting to catalyse future-focused change. In New Zealand these include schools such as Hobsonville Point Secondary School, Haeata Campus and organisations such as The MindLab. However, the findings from this study suggest that these innovators are likely to be at odds with and/or not supported by the wider system. This will eventually be problematic for those individuals, schools or organisations, and for reform efforts.

Some of the participants in this study said that their behaviour (talking about the future of education) was unusual. One commented that they had “become out of step” with their colleagues. Another identified that their involvement in this kind of talk was “not normal”. These people saw themselves as outliers and thought that they were probably perceived this way by others. While some people are personally comfortable with this, it requires considerable energy to maintain, and puts them at odds with the system. These people are likely to be those who are most willing to engage with new thinking. If the system cannot support them, they are at risk of burnout and/or being lost from the system as they struggle against enormous system momentum. This has obvious personal consequences for these people, but it also has wider consequences, in that their ideas and energy are also lost from the system. Initiatives they may have developed are abandoned, replaced, assimilated to the status quo, or recycled under new names, but things go on much as they always have. This failure to disrupt the existing system’s momentum makes it very vulnerable to disruption from outside.

8.2.2 The real concern: disruption from outside the system

If transformational future-focused change is unlikely to emerge from within the system, it might mean that education is more likely to be disrupted from outside the system. There are many examples that this is already taking place. At the informal level, YouTube has become a ubiquitous source for new learning, the Khan Academy website tutors thousands of students every month, while Apple, Microsoft and Google run professional learning programmes for educators the world over. At the institutional level, in the United States, an increasingly large

number of families are choosing charter and/or private schools, because they think the public system is not meeting the needs of their children (National Alliance for Public Charter Schools, 2017), and several wealthy individuals have set up new schools (e.g. the Ad Astra school for the children of employees of SpaceX). In New Zealand, especially in the larger cities 'alternative' schools are proliferating in response to a demand for 'something different' from the mainstream (e.g. forest schools and democratic schools), and the home-schooling and un-schooling movements are growing. A film about the California-based charter school High Tech High has been widely shown at public gatherings in New Zealand, and attempts have been made to set up charter schools using its model. The MOOC that is the focus of this study was an initiative from outside the public education system. While these innovations have different drivers and/or different underlying principles, together they express a level of dissatisfaction with the current public education system.

This is significant for the future of education, in more ways than one. Public education plays a critical role in democracies (Biesta, 2009; Dewey, 1956; Egan, 2001; Gilbert, 2005). The capacity for democracy is to a large extent dependent on public education. Students need to know 'about' democracy – they need to know how it operates, why it matters, and the role they should play in it. But they also need to be intellectually prepared to participate in it: they need the knowledge, the capacity, and the disposition to deliberate, to make informed choices, and to participate with others in making informed choices about their collective future/s. The decline of public education is likely to put the political stability of nations at stake (Glaeser, Ponzetto, & Shleifer, 2007). Disruption of education from outside the public education (e.g. by YouTube, Apple or Microsoft), because it is unlikely to pay attention to this, could disrupt the foundations of our current social and political structures. The case could be made that this is already under way, the recent surprise results from the Brexit referendum in the UK and Donald Trump's election win in the US being two obvious examples. If education's response to the trends identified in this thesis is left to 'the market', outside and uninformed by current educational knowledge, we can expect to see this volatility increase, with an accompanying increase in social inequalities.

8.3 Significance

The starting point of this research was that the reductionist assumptions that have underpinned past education reform efforts are incapable of supporting and sustaining future-focused change. This study has experimented with complexity thinking as an alternate theoretical framework.

When examined through a reductionist linear cause and effect lens, we might conclude that the MOOC experiment was successful. The MOOC was able to amplify the number and depth of interactions about education futures, as well as apparently producing change in the thinking and actions of participants. However, the complexity thinking framework adopted in this study reveals a significantly more nuanced reality and an alternate perspective.

Chapter Two described the unanticipated complexity encountered by past education reform attempts. However, adopting a complexity thinking lens has allowed this study to illuminate aspects of interaction within the system that effectively shut down reform efforts. In particular, the feedback loops and echo chambers that became evident suggest an alternative to top-down policy reform, expressed through the rollout of new initiatives. Targeting patterns of interaction across the system might be a more productive focus for future-focused reform efforts.

This research is significant in that it provides the basis for a model that might be used to further investigate the patterns of interaction that diminish reform efforts. Instead of attempting to overwrite the state of the system with endless new policies and initiatives, it might be more productive to foster change from within, by focusing on improving the density and quality of interactions, right through, and in all parts of, the system.

8.3 Recommendations for further research

The findings from this study are of course highly contextual and based on limited empirical evidence. Future research might seek to provide a more rigorous empirical foundation for understanding the patterns of interaction within the system. Methods such as those employed by Pentland (2014), using sociometric data and mathematical modelling, would allow the tracking of ideas about future-focused education beyond the scope of a single case. These methods would allow a much better understanding of potential feedback loops and echo chambers that diminish or amplify reform efforts.

Future research might also investigate the systemic structures that might act to diminish future-focused change in education. Specifically, an evaluation of complexity reduction measures both at a system and school level.

Further exploration of using safe-to-fail experiments in education research is also recommended. Given that the findings from this research revealed a number of important questions about how we might understand education reform, future research might consider a more iterative approach. While a recursive approach might be useful in amplifying change, it would also enable a more focused approach with successive safe-to-fail experiments, targeting more specific sites for disruption as patterns of interaction within the system become apparent.

8.4 Final thoughts

If nothing else, this study has validated complexity's claim that localised interactions can have influence at scale. The acknowledgements that appear in the frontmatter of this thesis recognise the researcher's localised interactions, yet the findings showed impact far beyond these. While

much remains unknown and unpredictable in complex systems, this research project concludes with the knowledge that our diverse connections hold potential for influencing hopeful possibilities for our education futures.

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Appendix A: Ethics

Ethics approval

AUTEC Secretariat

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22 March 2016

Jane Gilbert

Faculty of Culture and Society

Dear Jane

Re Ethics Application: **16/56 Using MOOCs (massive open online courses) and complexity thinking to disrupt current debates on educational futures.**

Thank you for providing evidence as requested, which satisfies the points raised by the Auckland University of Technology Ethics Committee (AUTEC).

Your ethics application has been approved for three years until 22 March 2019.

As part of the ethics approval process, you are required to submit the following to AUTEC:

- A brief annual progress report using form EA2, which is available online through http://www.aut.ac.nz/researchethics. When necessary this form may also be used to request an extension of the approval at least one month prior to its expiry on 22 March 2019;
- A brief report on the status of the project using form EA3, which is available online through http://www.aut.ac.nz/researchethics. This report is to be submitted either when the approval expires on 22 March 2019 or on completion of the project.

It is a condition of approval that AUTEC is notified of any adverse events or if the research does not commence. AUTEC approval needs to be sought for any alteration to the research, including any alteration of or addition to any documents that are provided to participants. You are responsible for ensuring that research undertaken under this approval occurs within the parameters outlined in the approved application.

AUTEC grants ethical approval only. If you require management approval from an institution or organisation for your research, then you will need to obtain this. If your research is undertaken within a jurisdiction outside New Zealand, you will need to make the arrangements necessary to meet the legal and ethical requirements that apply there.

To enable us to provide you with efficient service, please use the application number and study title in all correspondence with us. If you have any enquiries about this application, or anything else, please do contact us at ethics@aut.ac.nz.

All the very best with your research,

Kate O'Connor
Executive Secretary
Auckland University of Technology Ethics Committee

Participant Information Sheet

Date Information Sheet Produced:

18 January 2016

[survey participant]

Project Title: Using MOOCs and complexity thinking to *disrupt* current debates on educational futures.

What is the purpose of this research?

My name is Danielle Myburgh and I am completing a research project for an MEd from Auckland University of Technology. My project is looking at whether an online course (MOOC – massive open online course) can be used to engage more people in discussion of ideas about education futures. I have designed and facillitated a free MOOC that anyone can sign up for. It is for academic credit – the idea is to get people talking about education's future. It is aimed at teachers – as individuals or working in clusters, but also at people on boards of trustees, parents, and anyone else interested in education's future.

How was I identified and why am I being invited to participate in this research?

I want to find out if a MOOC is an effective way of supporting discussion of these issues in diverse groups. I would like to use your survey responses from the MOOC coursework to inform my research. I will keep these responses confidential so that no one except me will know where they came from. It is unlikely to cause you any discomfort or risk. Participating in the survey is unlikely to cause you any discomfort or risk. Your contribution will be very helpful to me and my research.

What will happen in this research?

You may choose to participate in this research by agreeing to any of the following:

- Agreeing for the researcher to analyse your submissions in the ~~in course~~ survey.

What are the discomforts and risks? How will these discomforts and risks be alleviated?

Participants are not likely to face any discomfort or risk by participating in this research.

What are the benefits?

This research will contribute towards my Masters of Education hence will be included in my thesis. Additionally, it is likely that this research will lead to academic publications, conference presentations and social media posts.

How will my privacy be protected?

The survey is anonymous, hence your contributions will not be identifiable in any published material.

What opportunity do I have to consider this invitation?

Should you wish to participate in this research, you will have up to one week to give consent. If you would like to do this, please reply to Danielle@edchatNZ.com with your contact details. I will contact you to set up a time and date for the interview. I will also send you a consent form to sign.

How do I agree to participate in this research?

Should you wish to participate in this research, you will have up to one week to give consent. If you would like to do this, please reply to Danielle@edchatNZ.com with your contact details. I will contact you to set up a time and date for the interview. I will also send you a consent form to sign.

Will I receive feedback on the results of this research?

If you wish to follow the development of this research, or if you are interested in the findings, a summary of the research will be made available on the researcher's blog at www.MissDtheTeacher.blogspot.com.

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, *Jane Gilbert, jane.gilbert@aut.ac.nz, +64 9 921 9999 ext 8159*

Concerns regarding the conduct of the research should be notified to the Executive Secretary of AUTEC, Kate O'Connor, ethics@aut.ac.nz, +64 9 921 9999 ext 6038.

Whom do I contact for further information about this research?

Please keep this Information Sheet and a copy of the Consent Form for your future reference. You are also able to contact the research team as follows:

Researcher Contact Details:

Danielle Myburgh, Danielle@edchatNZ.com , +64 21 049 3299

Project Supervisor Contact Details:

Jane Gilbert, jane.gilbert@aut.ac.nz, +64 9 921 9999 ext 8159

Approved by the Auckland University of Technology Ethics Committee on *22 March 2016*, AUTEC Reference number *16/56*

Participant Information Sheet

Date Information Sheet Produced:

22 March 2016

[Name of MOOC participants]

Project Title: Using MOOCs and complexity thinking to *disrupt* current debates on educational futures.

What is the purpose of this research?

My name is Danielle Myburgh and I am completing a research project for an MEd from Auckland University of Technology. My project is looking at whether an online course (MOOC – massive open online course) can be used to engage more people in discussion of ideas about education futures.

As you know, because you have already enrolled in it, I have designed and facilitated a free MOOC that anyone can join. Participants' contributions to the MOOC are not graded in any way and they cannot credit their participation towards an academic qualification – the MOOC's purpose is just to provide a space for people to get together to talk about education's future. It is aimed at teachers, but it will hopefully also be useful for school trustees, parents, and/or anyone else interested in education's future.

Linked with this MOOC is a research project. This is designed to look at how people interact with each other as they participate in the MOOC, and how, if at all, these interactions affect their thinking about education and its purposes.

I am interested in this because much current work on educational futures has a policy focus and/or is rather abstract and inaccessible, and I want to explore the possibilities for teacher-led change in this very important area.

How was I identified and why am I being invited to participate in this research?

You have been identified as a potential participant in this research due to your involvement in the the MOOC. All enrolled participants have been invited to participate in this research. I would like to analyse your course reflections and submissions, as well as interview you as one of the people who participated in the course about your experiences, in particular, your interactions with others.

If, after agreeing to participate in this research, you later change your mind, this is fine. You can withdraw from the research at any time up until the end of the data collection phase, just by sending me an email to let me know. I would then delete any of your information from my research data.

What will happen in this research?

If you agree to participate in this research, I will ask you about your interactions with others throughout this course, including what you talked about, how long the conversation went on for, how in depth it was, and what if anything it made you wonder about and/or do differently as a result of this conversation. I will also ask you about any interactions you may have with other people not involved in the MOOC. This will take no more than two hours of your time, and will hopefully be interesting to you.

I will also ask you if you can nominate someone you have talked to about any of the ideas you have come across in the MOOC that I could interview about your conversations. This person could be someone who is also participating in the MOOC, or someone who is not involved. This person will also need to give consent to be involved in the research.

I will take notes during our interview and record and transcribe it so that I can study it later. I will keep these notes and recordings in a safe place until the research is finished. Your contribution will be very helpful to me and my research.

How will my privacy be protected? What are the discomforts and risks? How will these discomforts and risks be alleviated?

The interview is unlikely to cause you any discomfort or risk. I will keep our conversation private, any information you give me will be anonymised, so no one except me will know where it came from. Confidentiality of the participants will be managed through the use of

pseudonyms in any published material about this study. If interview quotes are used, participants' identity will be kept confidential through the use of pseudonyms in any published material from this study. Additionally, the diverse locations and size of the MOOC means that participants will be extremely challenging to identify. Also, it is likely that findings will be expressed as aggregated data.

What are the benefits?

This research will contribute towards my Masters of Education hence will be included in my thesis. Additionally, it is likely that this research will lead to academic publications, conference presentations and social media posts.

What opportunity do I have to consider this invitation? How do I agree to participate in this research?

Should you wish to participate in this research, you will have up to one week to give consent. If you would like to do this, please reply to Danielle@edchatNZ.com with your contact details. I will contact you to set up a time and date for the interview. I will also send you a consent form. This should be signed and returned before the commencement of the interview.

Will I receive feedback on the results of this research?

If you wish to follow the development of this research, or if you are interested in the findings a summary of the research will be made available on the researcher's blog at www.MissDtheTeacher.blogspot.com.

What do I do if I have concerns about this research?

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Researcher Contact Details:

Danielle Myburgh, Danielle@edchatNZ.com , +64 21 049 3299

Project Supervisor Contact Details:

Jane Gilbert, jane.gilbert@aut.ac.nz, +64 9 921 9999 ext 8159

Approved by the Auckland University of Technology Ethics Committee on *type the date final ethics approval was granted*, AUTEC Reference number *16/56*.

Participant Information Sheet

Date Information Sheet Produced:

22 March 2016

[Name of person nominated by MOOC participant]

Project Title: Using MOOCs and complexity thinking to *disrupt* current debates on educational futures.

What is the purpose of this research?

My name is Danielle Myburgh and I am completing a research project for an MEd from Auckland University of Technology. My project is looking at whether an online course (MOOC – massive open online course) can be used to engage more people in discussion of ideas about education futures.

Linked with this MOOC is a research project. This is designed to look at how people interact with each other as they participate in the MOOC, and how, if at all, these interactions affect their thinking about education and its purposes.

I am interviewing some of the people who participated in this MOOC about their experiences, in particular, the dicussions they have with other people, not involved in the MOOC. [MOOC participant] has nominated you as someone they talked to about ideas they encountered in the MOOC, and, with your permission, I would like to interview you about the conversation/s you had.

Participants' contributions to the MOOC are not graded in any way and they cannot credit their participation towards an academic qualification – the MOOC's purpose is just to provide a space for people to get together to talk about education's future. It is aimed at teachers, but it will hopefully also be useful for school trustees, parents, and/or anyone else interested in education's future.

I am interested in this because much current work on educational futures has a policy focus and/or is rather abstract and inaccessible, and I want to explore the possibilities for teacher-led change in this very important area.

How was I identified and why am I being invited to participate in this research?

I want to find out if a MOOC is an effective way of supporting discussion of these issues in diverse groups. I am interviewing some of the people who participated in this MOOC about their experiences, in particular, the dicussions they have with other people, not involved in the MOOC. [MOOC participant] has nominated you as someone they talked to about ideas they encountered in the MOOC, and, with your permission, I would like to interview you about the conversation/s you had.

If you agree to participate in this research, please fill in and sign the attached consent form and send it to me at Danielle@edchatNZ.com.

If, after agreeing to participate in this research, you later change your mind, this is fine. You can withdraw from the research at any time up until the end of the data collection phase, just by sending me an email to let me know. I would then delete any of your information from my research data.

What will happen in this research?

If you agree to be interviewed, I will ask you about what you talked about, how long the conversation went on for, how in depth it was, and what if anything it made you wonder about and/or do differently. This will take no more than one hour of your time, and will hopefully be interesting to you. I will take notes during our interview, as well as record and transcribe it so that I can study it later. I will keep these notes and recordings in a safe place until the research is finished.

How will my privacy be protected? What are the discomforts and risks? How will these discomforts and risks be alleviated?

The interview is unlikely to cause you any discomfort or risk. I will keep our conversation private, any information you give me will be anonymised, so no one except me will know where it came from. Confidentiality of the participants will be managed through the use of

pseudonyms in any published material about this study. If interview quotes are used, participants' identity will be kept confidential through the use of pseudonyms in any published material from this study.

What are the benefits?

This research will contribute towards my Masters of Education hence will be included in my thesis. Additionally, it is likely that this research will lead to academic publications, conference presentations and social media posts.

What opportunity do I have to consider this invitation? How do I agree to participate in this research?

If you would like to do this, please reply to Danielle@edchatNZ.com with your contact details. I will contact you to set up a time and date for the interview. I will also send you a consent form to sign.

Will I receive feedback on the results of this research?

If you wish to follow the development of this research, or if you are interested in the findings, a summary of the research will be made available on the researcher's blog at www.MissDtheTeacher.blogspot.com.

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Approved by the Auckland University of Technology Ethics Committee on *22 March 2016*, AUTEC Reference number *16/56*

Appendix B: Research Tools

Interview Questions

Table 11: Interview questions for MOOC participants

Interview Questions
Tell me about your current work/involvement in education?
Tell me about your experience of participating in the MOOC?
Tell me about your involvement in the MOOC? How did you participate?
Who have you interacted with about the ideas from the MOOC? At your school/organisation/work In education, but not at your school Not directly involved in education (eg. Parent, etc.)
So you didn't interact with anyone. What stopped you?
What, if anything, did you notice about the nature of your interactions?
Tell me about your interactions with someone in particular (*Y*).
What impact, if anything, do you think your interactions had?
How, if at all, has anything changed since you hae been involved in this project?
Have you found yourself thinking, engaging or acting differently since the start of your involvement in this project?
What are you now wondering about as a result of your involvement with the MOOC?
So you feel that you are not wondering about anything as a result of your involvement in the MOOC? Can you tell me more about this?
… is one of your activities from the MOOC. Can you tell me about your thinking around this response?

Table 12: Interview questions for someone who interacted with a MOOC participant

Interview Questions for those who interacted with MOOC participants
Tell me about your current work/involvement in education?
Tell me about the interactions you have had with X about education ideas/issues/futures.
How, if at all, has anything changed since X's involvement in this project? In your opinion, what is responsible for this? (change or lack of change)
What are your thoughts about the interactions you have had with X?

Sample survey

Using MOOCs and complexity thinking to disrupt current debates on educational futures.

* Required

Survey

1. How are you involved in education? *

Check all that apply.

- [ ] I am currently not directly involved in education
- [ ] I am currently a parent of a school aged child/children
- [ ] I am currently a board of trustee member at a school
- [ ] I am currently a student in a school
- [ ] I am currently an education consultant
- [ ] I am currently an ECE teacher
- [ ] I am currently a primary school teacher
- [ ] I am currently a secondary school teacher
- [ ] I am currently a senior leader within a school
- [ ] I am currently a middle leader within a school
- [ ] I am a tertiary lecturer
- [ ] Other:

2. Which of the following types of conversations did you have in the last week about the future of education? How many conversations? *

These conversations may have been with family, friends, colleagues, whānau, etc.

	None	Three or fewer	Between four and seven	More than seven
One of us mentions that we've read something, one of us offers a brief comment, and the discussion moves on to something else.	○	○	○	○
One of us talks in some detail about something we've read, and we say what we think about this (two or three exchanges).	○	○	○	○
One of us talks in some detail about something we've read and we exchange views. Then, one of us talks about something related we've read, and we talk more about what these ideas have to do with each other.	○	○	○	○
We do one or more of the above and then later come back to this discussion to build on it.	○	○	○	○

3. What were the majority of your conversations about the future of education like, when speaking to someone not directly involved in education? *

- ○ One of us mentions that we've read something, one of us offers a brief comment, and the discussion moves on to something else.
- ○ One of us talks in some detail about something we've read, and we say what we think about this (two or three exchanges).
- ○ One of us talks in some detail about something we've read and we exchange views. Then, one of us talks about something related we've read, and we talk more about what these ideas have to do with each other.
- ○ We do one or more of the above and then later come back to this discussion to build on it.
- ○ I did not have a conversation with anyone not directly involved in eduction.

4. What were the majority of your conversations about the future of education like when speaking to someone in education, but not at your (local) school? *

Your local school may be the school in your neighbourhood, the school where your children attend, etc. If you are a teacher, this may be your place of work.

- ○ One of us mentions that we've read something, one of us offers a brief comment, and the discussion moves on to something else.
- ○ One of us talks in some detail about something we've read, and we say what we think about this (two or three exchanges).
- ○ One of us talks in some detail about something we've read and we exchange views. Then, one of us talks about something related we've read, and we talk more about what these ideas have to do with each other.
- ○ We do one or more of the above and then later come back to this discussion to build on it.
- ○ I did not have a conversation with anyone not at my (local) school.

5. What were the majority of the conversations about the future of education like, when speaking to someone at your (local) school? *

Your local school may be the school in your neighbourhood, the school where your children attend, etc. If you are a teacher, this may be your place of work.

- ○ One of us mentions that we've read something, one of us offers a brief comment, and the discussion moves on to something else.
- ○ One of us talks in some detail about something we've read, and we say what we think about this (two or three exchanges).
- ○ One of us talks in some detail about something we've read and we exchange views. Then, one of us talks about something related we've read, and we talk more about what these ideas have to do with each other.
- ○ We do one or more of the above and then later come back to this discussion to build on it.
- ○ I did not have a conversation with anyone at my (local) school.
- ○ I am not currently involved with a school.

6. What was the majority of your conversations about the future of education like, when speaking to someone involved in school leadership? *

- ○ One of us mentions that we've read something, one of us offers a brief comment, and the discussion moves on to something else.
- ○ One of us talks in some detail about something we've read, and we say what we think about this (two or three exchanges).
- ○ One of us talks in some detail about something we've read and we exchange views. Then, one of us talks about something related we've read, and we talk more about what these ideas have to do with each other.
- ○ We do one or more of the above and then later come back to this discussion to build on it.
- ○ I did not have a conversation with anyone in school leadership about the future of education.

7. My interactions were mostly *

- ○ Online using social media
- ○ Email interactions
- ○ Face to face discussions
- ○ Phone or Skype, Google Hangout etc, conversations
- ○ Text messages
- ○ Other:

8. How, if at all, has anything changed since you have been involved in this project?

Your answer

BACK NEXT

Never submit passwords through Google Forms.

Appendix C: MOOC Course Outline

	Overview
Week 1	Introductions
Week 2	This week's section of the course begins the journey to develop our ability to challenge our own thinking and assumptions. Our thoughts are inevitably shaped by the cultures and paradigms that we are part of, and so we cannot begin to think differently about education or its future, until we examine our beliefs and assumptions. This week we will start to examine some of the features of the box we think inside, so that we can eventually move towards thinking outside it.
Week 3	Although we often feel that the battles that we fight in education are new, more often than not, they are very old. This week, in order to further help us examine the box we are thinking in (so that eventually we might think outside it), we will examine some of the influences from the past that still underpin our thinking about education.
Week 4	As we have seen, schools are very much a product of the past. Not only are the physical structures impacted by the past, but our mental models are too. However, things are changing... This week, we will start to look at how the foundations that our current schooling models were built on, are shifting. We kick off this next phase looking at the impact of technology.
Week 5	Although we can speculate about the likely impact that technology will have on our communities and lives in the future, we could simply start by examining the impact it has already had. In this week's section of the course we examine one of the foundations of school: knowledge. Just as the printing press had massive impacts on the way knowledge was stored and distributed, so too has the internet had an impact on knowledge.
Week 6	Last week we explored how knowledge might be changing. However, we need to consider what this means for schools. If the nature of knowledge has shifted, should its purpose, place and function in school shift too? Join us to explore the place of knowledge in our curricula; the questions, the tensions and the perspectives.
Week 7	So far, we have discovered that there are many things changing in the world. We have thought about technology, the future of work, and even knowledge. But the shifting foundations of society do not end there.

This week we delve into the Futures literature, further examining some of the larger forces at work in our world, and then dabbling with a few ways to think about our future world.

Week 8 Over the duration of this course, we started by trying to understand why education is the way it is. Kieran Egan introduced us to the conflicting ideas about education's purpose, while our discussions with friends and families showed us just how pervasive these ideas are. From there we changed our focus, looking at big trends in the world that are impacting education, particularly technology. We realised that technology is now such a big part of our lives, that most of us couldn't even give up the internet for 24 hours. We even thought about climate change and inequality in our quest to really grapple with rethinking school.

Last week we started examining some of the Futures literature, using the ideas from this discipline to think about the future of education. This week, we continue to dabble with Futures thinking, by examining how others have re-conceptualised school, and inviting you to do the same.

Week 9 We have examined education's past and we have attempted to imagine many possible futures, however now it is time that we focus on taking action. This week we will focus on three different tools which we could use to navigate the complex space of schools and education, so that we might being to move towards active experimentation.

Week 10 Last week we each identified an area that we care about, and a place that we could act or influence. This week we explore a little deeper into our chosen focus, and start to actively experiment with change.

We also presented you with three ways in which you might engage with your focus:

- Design thinking
- Spirals of inquiry
- Safe-to-fail experiments

The common factors however between each of the three strategies are that they all attempt to make sense of complex systems with many interactions and perspectives. Where in Design thinking the focus is on empathy, the Spirals of inquiry have the scanning and focusing stages. Safe-to-fail probes on the other hand, uses active experimentation to learn more about the system. Additionally, each of these tools allows us to test our own ideas and assumptions about the systems we are involved in.

For this week's section of the course, you will only need to visit the relevant page

for you. You will however need to check back over the course of the week as you make progress on the various activities that requires action outside of this course.

Week 11 You have reached the final week! This week we focus on synthesising all that we have learnt over the past eleven weeks. We will consider what we have learnt about our thinking, and how we might act different as a result. You may also choose to do a final assessment task this week, allowing you to gain digital credit for your learning over the past two months.
