

3D Computer Graphics Self-Directed Learning: A Proposal for Integrated Demonstration and Practice

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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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Ethical Approval

This research obtained ethical approval 10/307 from the Auckland University of Technology Ethics Committee on the 23rd of February 2011.

Abstract

This research study examines 3D computer graphics (CG) self-directed learning (SDL). The study identifies learning and teaching problems with 3D CG SDL, proposes improvements, and then carries out the recommendations for improvement by building a proof of concept 3D CG SDL resource. The study is guided by three research questions: 1. *What are the problems with 3D CG SDL resources perceived by learners?* 2. *Using the knowledge gained on problems with 3D CG SDL, can improvements be made?* 3. *How will these improvements function in practical application?*

This research draws on a heuristic theoretical position with a practice-based approach. Data collection and analysis utilize both quantitative and qualitative methods. The scholarly investigation of CG SDL sits within the theoretical framework of technology-mediated pedagogy as outlined by (Leinder & Jarvenpaa, 1995) but, due to the interdisciplinary nature of 3D, also crosses over to concerns of right and left hemisphere learning (McCracken, 2006; Comninou, et al, 2009). A key aim of this study seeks to demonstrate that improvements in 3D CG SDL learning and teaching are not only vital to the success of self-directed resources but that these improvements can also be implemented in a low-cost technological environment.

The research has answered all the research questions in succession. The knowledge gained was on specific problems, recommendations and improvements, and how the improvements would work in practice. The study shows 3D CG SDL authors that there are problems with current resources, that there is room for improvement, and provides details on how these improvements could be made.

1 Introduction & Overview

1.1 Introduction

This research is built on the perception that 3D computer graphics (CG) education has vast room for improvement. However, while the need for improvement has been identified (e.g. McCracken, 2006), little knowledge exists on what exactly needs improving or how to improve it.

To limit the wide subject of 3D CG education, the research focuses solely on 3D CG self-directed learning (SDL) resources. These resources are of high educational significance to learners as they fill those knowledge gaps educational institutes are unequipped or lack the time to provide. The researcher, through his role as an educator of 3D CG artistry, became aware that there is room for improvement in these SDL resources. A review of the literature reveals an absence of data on best practice and on problems specific to 3D CG SDL. Identifying a lack of knowledge on the subject, this research project aims to gain data from learners so as to identify perceived problems with 3D CG SDL, proposes improvements, and proposes a prototype introducing improvements to 3D CG SDL.

Learner satisfaction, 3D CG education and SDL resources still present a scope that is too wide for a single research project within the space of a Master's thesis. To narrow down the variables, this research is limited to an exploration of how the learning tools of presentation, demonstration and practice are facilitated by 3D CG SDL. Presentation teaches people by showing and explaining the content of a topic. Demonstrations involve showing by reasoning, proving, or explaining through the use of examples and experiments. Practice is rehearsing or engaging in a behaviour so as to improve or master it. The research then proposes how these learning tools can be improved. The researcher focuses on the learning models "demonstrations" and "practice" as these didactic activities are the main tools for instruction in technological operations, commonly referred to as "procedures". Presentations have a much smaller role in the research, reflecting their much smaller role in 3D CG SDL compared to demonstrations and practice. The ideas for improving presentation, demonstration, and practice are then implemented in a written design concept and a prototype CG self-directed learning resource. The prototype aims to give an understanding of how technology can support the proposed improvements.

1.2 Chapter Overviews

This research study is broken into 11 chapters. The first chapter outlines the premise for the research and presents an overview of all the chapters. Following in the second chapter the research problems are stated, the background and need for the study are discussed, and the research questions are defined.

The third chapter reviews literature on the current state of 3D CG education and the place of 3D CG SDL place therein, theories of learning and their application to technology, and learning and teaching practices presently used in 3D CG SDL.

The methodology and research design are presented in chapter 4. Heuristic research and practice-based research are discussed in the context of this research study. Following is an outline of the methods selected for application to this research and how they function together.

Chapter 5 presents all information pertaining to the surveys conducted in this research study. The survey design section presents all the methods used to implement the survey. The survey analysis procedure section explains how the captured data would be processed. Following are the survey results and their graphical representation. Finally, the chapter discusses the results of the survey.

Chapter 6 presents all information pertaining to the interviews conducted in this research study. The interview design section presents all methods used to implement the interviews. The analysis procedure used for the interviews is then presented, followed by the results which fall into nine themes. These themes are then discussed.

A list of recommendations for 3D CG SDL is then presented in chapter 7, created from the data analysis in the preceding chapters.

Chapter 8 presents a conceptual design for a 3D CG SDL resource built on the recommendations. Ideas for a theoretical 3D CG SDL resource and the intentions of these ideas are presented.

Chapter 9 presents the technological translation of the design concept. Tools were selected based on their abilities to accomplish the conceptual design and recommendations. These tools were then trialled.

The practice-based research element of this research study is presented in chapter 10. It begins by discussing a method for CBI authoring. Following is the documentation captured from the creation of a 3D CG SDL resource proof of concept. The proof of concept and its creation are then discussed.

Chapter 11 presents key findings, limitations of the research, implications for the field of 3D CG SDL, and future research ideas.

2 Purpose, Objectives and Approach of the Research

This chapter states the problems associated with 3D CG SDL. The background and need for this research study are presented, followed by the research questions used to guide this study.

2.1 Statement of the Problem

3D CG education is still in its infancy. Consequently, a number of areas in 3D CG education are still being developed or need to be developed. 3D CG is an extremely technological field, ever going through rapid changes. Given the young and rapidly changing nature of 3D CG and the infancy of its education, the researcher identified there is little research or discussion on the sub-field of 3D CG SDL resources. This research, in recognition of these factors, had to limit the aspects for investigation so as to avoid becoming lost in the plethora of areas that have potential for ameliorations. The researcher, after a critical review of the literature and upon critical reflection of his own practice as a 3D CG educator, narrowed the problems to be explored based on their importance, lack of existing knowledge, and alignment to the researcher's background.

- Very few studies have been conducted to identify problems with 3D CG SDL.
- Very few studies have explored best practice or proposed improvements for 3D CG SDL.
- No specific SDL design exists that is tailored to teach the knowledge required by 3D CG learners.

2.2 Background and Need

The researcher became aware that students may be dissatisfied with 3D CG SDL resources through his role as a 3D CG educator. This was alarming as 3D CG SDL is pivotal in the education of 3D CG artists. The importance of 3D CG SDL resources is a result of education institutes' inability to overcome time and resource constraints needed to educate on the technological aspects of 3D CG subjects. McCracken's (2006) work highlighted a need for the problems caused by the technological aspects of 3D CG to be remedied. Some schools have tried to fill this gap. For example, Comninos, McLoughlin, & Anderson (2009) outline a model degree program that heavily incorporates computer sciences. However, even a student from the best of schools will still need access to SDL resources, as it is highly unlikely that staffing can cover every highly specialised technological aspect within studio's 3D pipelines. This gap left by schools can be clearly witnessed in the success of businesses that provide 3D CG SDL resources, such as Gnomon, Digital Tutors and Lynda.com.

Having established the importance of the need for 3D CG SDL resources and the fact that learners may be dissatisfied with these resources, the need for this research became apparent. The research explores the problems with 3D CG SDL. The knowledge gained about these problems is used to generate improvements for 3D CG SDL.

Because of the technological nature of 3D CG arts, this research project attempts a proof of concept to examine further the affordances and constraints of improvements in the authoring technology and media for 3D CG SDL. Having a proof of concept helps examine and verify the improvements through practical application. It also provides an opportunity to design a blueprint for 3D CG SDL resources.

2.3 Research Questions

The study proposes to examine 3D CG SDL within specific questions that address the problems of 3D CG SDL as outlined in the section above. These research questions are:

- What problems do learners perceive with 3D CG SDL resources?
- Using the knowledge gained on problems with 3D CG SDL, can improvements be made?
- How will these improvements function in practical application?

2.4 Summary

The infancy, rapid evolution, and technological factors of 3D CG have lead to a lack of knowledge in the domain of 3D CG SDL. 3D CG SDL is important as it fills knowledge gaps left by educational institutes that lack ability and/or resources. Given the importance of 3D CG SDL, it was alarming to find that learners may be dissatisfied with these resources. The research therefore attempts to document problems with 3D CG SDL, find improvements, and understand how these improvements would work in practice. Attempting this will contribute new knowledge to the field of 3D CG SDL.

3 Literature Review

This chapter reviews the literature relevant to areas of 3D CG SDL. These areas are summarised as 1) the state of the field of 3D CG education and SDL's place therein; 2) theories of learning and their application to technology relevant or potentially relevant to 3D CG SDL; 3) learning and teaching practices common to 3D CG SDL; and 4) screencasting and computer-based instruction.

3D CG education in its present state is examined and discussed, in particular issues resulting from its infancy and rapid evolution. Following is a discussion of present attempts to overcome these issues. 3D CG SDL is then given focus to establish its position and importance within the domain of 3D CG education.

Learning models and their pedagogical assumptions are then discussed, as all education reflects these assumptions. Specifically the objectivist, constructivist, co-operative, and cognitive information processing models are examined as they commonly are applied to computer-mediated learning. Following is a discussion of a selected number of information technologies that may be utilised for education in 3D CG artistry and how the pedagogical assumptions of the learning models occur within these technologies.

Teaching and learning practices common to 3D CG SDL are identified. Two practices, *problems-based learning* and *worked examples* are described, noting their strengths and weaknesses. Additionally, *worked-out examples*, a practice that aims at mitigating the constraints of *problem-based learning* and *worked examples*, is discussed.

Last, screencasting is addressed as this medium has been identified as popular in 3D CG SDL. The popularity of screencasting is discussed, followed by an outline of a screencast's constituent factors.

3.1 Present State of 3D CG Education

Presently, 3D CG is still young and, as with most emerging practices, education in this practice is younger still. A formal animation curriculum has existed for just over 50 years now (Comninos, McLoughlin, & Anderson, 2009). The 3D CG discipline within the field of animation was initially, and until around the early 1980s, perceived as an unsystematic fringe practice. However, today 3D CG is an essential constituent in working in the entertainment industry (McCracken, 2006). Comninos, et al (2009) and McCracken (2006) emphasise that 3D CG has gained popularity only in recent years.

Despite the rising demand for 3D CG artists, competition is fierce among graduates and many graduates will not be able to launch themselves in the industry (McCracken 2006). This struggle, at least in significant parts, appears to relate to a lack of preparedness. McCracken (2006, p. 1) notes that “*many employers find that even for beginner positions, animation applicants fall short of the level of skills needed.*” This view aligns with the researcher's experiences with various New Zealand studios when placing his own graduates. Also, the wide-spread use of internships, where graduates receive the opportunity to learn the skills they still lack after their education, seems to support the claim that education is not delivering the skills needed.

This lack of preparedness or skill can be attributed to novice artists' struggles with learning the technological components such as software (Comninos, et al, 2009; McCracken, 2006). McCracken (2005, p 4) explains this difficulty stating that: *"The technological component of 3D is 100x that of cel animation and other digital media."* This technological component is in part seen to be stifling the artistic nature of graduates as their energy is focused on learning or overcoming software problems. Despite this, every year 3D CG artists are expected to know more and more current software by industry (Comninos, et al, 2009). The authors understand that where once the tools an animator was expected to know were relatively simple and limited, now one must be computer literate and have mastered a plethora of the latest specialised software.

The problem of needing a wide knowledge of highly refined skills in order to apply 3D CG technology has in recent years seen a wide-spread fracturing of 3D CG professions into specialised fields and job roles (Watkins, 2005). This can be witnessed in any 3D studio's employment criteria or pipeline overview; Blue Sky studio's website (Blue Sky Studios, 2011) provides an example, showing the flow of their pipeline and how all the specialised fields are placed within it. This move was made to streamline industry pipelines, such as Blue Sky's, and has somewhat alleviated the problem 3D CG learners had of trying to learn a battery of skills and software with very different concerns. However, this fracturing has created yet another problem: the specialised roles pose an incredible challenge to educational institutes which now must teach to accommodate the highly refined specialised skill sets and associated software (Gnomon, 2008). Gnomon, a corporate publisher, may have authored a biased view as it profits by providing distance learning for specialised roles in the 3D CG artistry. However, whether there is bias in this view or it is a reaction to reality is hard to establish.

Comninos et al (2009) describe that historically education in 3D CG arts fell into two disciplines that evolved informed by, yet unique to, one another. The first, computer science, developed a scientific approach to 3D CG, examining photo realism and simulations, while the second discipline, design, developed a more artistic approach to 3D CG, examining emotive and aesthetic aspects. This separation mirrors the Cartesian split, representative of education in the nineteenth century, separating science and art. This split within the 3D CG arts has been noted as problematic by both Comninos et al (2009) and McCracken (2006). The authors have called for this separation to be removed in order to solve issues in 3D CG education. The authors raise a valid point that this separation is not desirable, as technology and art go hand in hand in 3D CG. With educational institutes providing education that separates technology and art for 3D CG artists, one can confirm Gnomon's view, as graduates would be missing skills.

Comninos et al (2009) realised that the problem created by the split of science from art and attempted a solution in their curriculum at the National Centre for Computer Animation (NCCA, UK). NCCA offer a program that, based on high graduate employment rates, is considered highly successful at providing 3D CG education. NCCA's success is attributed to offering *"university degrees that aim to blur the difference between artists and scientists / technologists"* (Comninos et al, 2009, p. 1). This is achieved by integrating technology, production, and arts units all within one degree. Despite the course being highly successful, as gauged by placement rates, the authors admit that their students are still weighted to one side of the technological/arts spectrum, stating: *"... our current BA program, while good at producing*

TDs [Technical Director] and TAs [Technical Assistant], was not ideally suited for producing character animators or animation directors” (Comninou, et al, 2009, p. 7). Also, the authors note the NCCA curriculum is not appropriate for producing specialist graduates. The findings of Comninou et al (2009) showing a lack of ability to produce specialists is not surprising, given how challenging specializing within such a broad and demanding program would be. It would appear from these findings that solving one problem has created another. In overcoming the problem of graduates struggling with technological factors, the problem now exists of learners lacking the specific skill sets desired by industry. This again suggests that Gnomon’s view, that educational institutes struggle with teaching specialised roles, has validity.

With no programs offered in the classroom that target all facets of 3D CG arts appropriately, learners have turned to SDL to ensure the success of their education. Providers of 3D CG SDL such as Gnomon realised the gaps in education early and moved to capitalise on them. Gnomon (2008) sums up the problem by stating:

“High-end three-dimensional software packages are tools which have become incredibly deep and versatile. However, there is an unfortunate lack of well-designed, production-specific curriculums. The reasons for this are clear, as large educational facilities are not able to add the necessary facilities and courses as quickly as the toolsets change.”

While one could look at this statement by Gnomon as marketing propaganda, it does seem to highlight the root of the problems that have been identified by Comninou, et al (2009) and McCracken (2004). The solution offered by Gnomon is topic-specific SDL, usually containing a couple of hours of screencasts by on a specialised topic. While no studies containing empirical data exist on the consumption of 3D CG SDL, anecdotal evidence in the form of SDL’s presence on almost every CG forum, and the amount of 3D CG SDL providers offering such resources, would suggest consumption of SDL in 3D CG education is high.

While SDL has been identified as a solution for the shortcomings of educational institutions’ lack of expert staffing, facilities and specialist training, surprisingly few have researched best practice for 3D CG SDL. Few have thought that perhaps by improving 3D CG SDL and addressing its problems, if it has any, one could fix the low skill level of graduates. Even more surprising, little knowledge exists on the problems of 3D CG SDL. In fact, little knowledge on 3D CG SDL exists at all. This could be due to 3D CG SDL resources originally being created by studios for use by interns out of necessity, which anecdotal evidence in the form of historical forum posts alludes to. It may be attributed to the new nature of education in 3D CG, as McCracken (2006) highlights. The lack of 3D CG SDL research may also have to do with the fact that all who have tried to identify and answer the problems of 3D CG education have done so in a classroom context, as with Comninou et al (2009), McCracken (2006) and Watkins (2005).

A critical review of the literature suggests that 3D CG education is far from consolidated. Graduates’ skill levels are not where they need to be as a result of the inability of educational institutions to staff and resource this still growing and evolving field. As a result, the knowledge gaps in learners left by educational institutions have prompted commercial SDL resources to become widespread and popular in the education of 3D CG artists. However, despite the importance of SDL in 3D CG education, little is

known about 3D CG SDL. While researchers have tried to improve 3D CG education within the context of their educational facilities, none have investigated or sought to improve SDL in the context of 3D CG. In light of this, further knowledge is needed to understand and potentially improve 3D CG SDL.

3.2 Theories of Learning and Their Application to Technology

When applying the various technologies required by computer-mediated learning used for SDL, one must first consider the pedagogical assumptions underlying the technology. This is achieved by exploring models of learning. Learning models are a collection of pedagogical assumptions organised in a systematic way to be applied to learning situations. These models are reflected in all computer-mediated learning. Following is a small selection of the most common learning models used in computer-mediated learning and a small portion of the information technologies commonly used in education.

Selection of these models and information technologies was based on either their present application or potential to be applied to 3D CG SDL. The objectivist model is used frequently in screencast materials. The constructivist and co-operative model are used frequently at 3D CG institutes to train students. The cognitive information processing model holds promise in catering to individual learners' needs so is of interest to this research study. Computer-based instruction (CBI) offers a means of consolidating separate media. Distance learning is used commonly for 3D CG SDL. Simulations have the potential to offer practice to learners in a more structured environment than what is presently offered by 3D CG SDL.

3.2.1 Objectivist Model

The principle of the objectivist model according to Leinder & Jarvenpaa (1995, p. 266) is *"that there is an objective reality and that the goal of learning is to understand this reality and modify behaviour accordingly."* The goal of teaching in this model is the effective transfer of knowledge from expert to novice. If errors in understanding occur, they can be attributed to imperfect or incomplete knowledge transfer (Bednar, et al, 1991). This model makes several assumptions, noted by Jonassen (1993): first, there is a reality agreed upon by individuals that is seen as objective. Second, the objective reality can not only be represented, but transferred, to learners. Third, a learner's mind reflects reality rather than interprets it. Last, representing and processing the world is essentially the same for all learners.

This model of learning can be witnessed in more classic forms of education; lectures are a good example. When using this model, presentation of material is the key. Any mechanism that can enhance the communicability of knowledge should directly enhance the transfer of knowledge (Leinder & Jarvenpaa, 1995). The model is commonly accepted as very effective for learning procedural and factual knowledge (Leinder & Jarvenpaa, 1995). The objectivist approach to learning is therefore of high importance to 3D CG SDL because of the significant amounts of procedural knowledge that must be learned.

Despite the strengths of the objectivist learning model, it is still somewhat limiting in the context of 3D CG education because of this learning model's lack of ability to cope with tacit or practical knowledge. In

the context of 3D CG education, using this model solely would result in graduates who cannot perform even the most fundamental skills in 3D CG. Polanyi (1958, p. 50) elaborates on this problem:

“Rules of art can be useful, but they do not determine the practice of an art; they are maxims which can serve as a guide to the art only if they can be integrated into the practical knowledge of the art. They cannot replace this knowledge.”

This learning model therefore only caters partially for what 3D CG learners require.

3.2.2 Constructivist Model

Compared to the objectivist learning model, the constructivist learning model takes a counter position to how it views reality. Reality is seen as subjective. As such, knowledge needs to be constructed or created by a learner, not transmitted to them (Jonassen, 1993). Leinder & Jarvenpaa (1995, p. 267) state that *“the mind is not a tool for reproducing the external reality, but rather the mind produces its own, unique conception of events.”* This means each learner's mind is seen to process its own unique interpretation of events and form its own unique understanding of an event. The constructivist model however does not completely ignore the potential for an objective reality – after analysing multiple interpretations of data a learner should be able to detach from personal experiences and form abstract concepts that represent reality (O'Loughlin, 1992).

Learners are assumed to learn better under this model when they are required to discover and to explore on their own terms. The teacher's role is that of a facilitator, helping learners form their own interpretations (Leinder & Jarvenpaa, 1995). This style of learning focuses on immersing learners in real world contexts relevant to learning, discovering conceptual relationships and exploring multiple representations or perspectives (Jonassen, 1993). This model is therefore of importance to 3D CG SDL, as having 3D CG learners construct their own knowledge affords the opportunity to learn tacit knowledge, identified as important to artists by Polanyi (1958).

This model also presents an advantage to 3D CG education when one considers the concept of higher-order thinking. The concept states that learning which is more demanding on cognitive processes generally has more benefits for learners (Bersin, 2004). These benefits include complex judgment skills such as critical thinking and novel problem solving (Bersin, 2004). The researcher understands these skills to be essential as most problems are novel when practicing 3D CG artistry due to the unique quality of individual art pieces.

The constructivist learning model does have limitations however. There is a lack of provision for knowledge to be transferred to learners. This leads to learners searching for knowledge that in some instances can be transferred far more efficiently (Leinder & Jarvenpaa, 1995). This is a concern in the context of 3D CG education for two reasons. First, large amounts of procedural and factual knowledge are required to be learned. Second, the search by 3D CG learners for knowledge can lead to uncovering and learning inefficient technique, a problem quite common in 3D CG education as there are often a vast variety of ways to complete a task.

3.2.3 Cooperative Model

This learning model is commonly referred to as the cooperative or collaborative model. It is an offshoot of the constructivist model and as such shares many similarities. The key difference is that while learners are interacting with objects under a constructivist model, the cooperative model's goal is for learners to interact with other learners (Slavin, 1994). This interaction leads to formation of a shared knowledge that is achieved through discussion and information sharing. As a result, this promotes growth in communication and listening skills. This learning model also elicits participation (Slavin, 1994).

The model shares the same pedagogical assumptions as the constructivist learning model. Leinder & Jarvenpaa (1995) state four additional assumptions that are made by this model. First, knowledge is created when it is shared. Second, a learner with prior knowledge can contribute to discussions. Third, participation is critical to learning. Fourth, learners will participate when conditions are optimal (Leinder & Jarvenpaa, 1995). The implications of this model are that the role of teaching is not about controlling content, but about facilitating maximum interaction among learners and offering feedback (Leinder & Jarvenpaa, 1995).

The cooperative learning model has qualities desirable to 3D CG education. The ability to enhance social skills (Leinder & Jarvenpaa, 1995) is desirable, as *"with very few exceptions, studios work in collaborative teams"* (Watkins, 2005, p. 1). 3D CG learners therefore would benefit from having enhanced social skills so as to operate within studios more effectively.

This model's limitations, like its advantages, are the same as those found in the constructivist learning model. These and their relationship to 3D CG are outlined in the preceding section. An additional concern of this learning model is the requirement to work in groups. Watkins (2005) highlights the issues associated with group work when learning 3D CG arts. These stem from the potential for some learners to disengage from the entirety of the 3D CG learning process. Watkins (2005) overcomes this by implementing rigorous controls including lecturer supervision and careful planning. These controls do not translate to SDL, however, as they require a supervisor to be present to direct the learning. Therefore, for the cooperative learning model to be used for 3D CG SDL this issue would need to be resolved.

3.2.4 Cognitive Information Processing Model

This model of learning is an extension of the constructivist learning model. The key difference is cognitive processes are given focus. Instructional input develops, tests, and refines schemata until a learner's knowledge is reliable enough to be applied to problem solving (Shuell, 1986). The processing of this input by learners facilitates learning. This means pace of learning is entirely dictated by a learner's cognitive processing abilities. This also means unnoticed or unprocessed input will have no effect on mental models and thus no effect on learning (Shuell, 1986).

The foremost assumption of this model is that learners differ in their preference of learning style. It is assumed methods of instruction that match an individual's learning style will be the most effective (Bovy, 1981). As a result, learning under this model requires individualised instruction. It is also assumed that *"prior knowledge is represented by a mental model in memory and that the mental model, or*

schemata, is an important determinant of how effectively the learner will process new information" (Leinder & Jarvenpaa, 1995, p. 269). This link means that instructional effort is inversely related to a learner's prior knowledge and effectiveness of their information processing style (Bovy, 1981). This model assumes that because of a learner's limited cognitive processing abilities, the learner's attention is selective (Bovy, 1981).

The need to cater for individual learner's learning preferences presents a great challenge to teachers and requires more resources (Gibbons & Fairweather, 1998). The resources and time required in using a less resource-demanding learning model for 3D CG SDL are already heavy due to the technological nature of the subject. Adding the requirement for considerably more resources would not be cost or time effective. This may account for the lack of use of this model in educating 3D CG artists. This learning model, therefore, is most likely not suitable for 3D CG SDL.

3.2.5 Computer-Based Instruction

Computer-based instruction (CBI) is a teaching model that allows for interactive instruction aimed at increasing learners' knowledge by presenting information in either sequential or nonlinear modes. This type of technology tries to automate learning and teaching (Gibbons & Fairweather, 1998). A goal of CBI systems is to give control of the learning process to learners (Leinder & Jarvenpaa, 1995). This goal is in line with constructivist assumptions, letting students explore and discover by themselves. The technology can also allow for learners to select from a variety of modes and media used to present knowledge, favouring the assumptions of cognitive information processing. These pedagogical assumptions however have come under criticism, as knowledge provided through CBI is predetermined by the designer (Leinder & Jarvenpaa, 1995).

Other pedagogical assumptions made by CBI are: learners learn more effectively and efficiently when they are in control of the pace; active involvement is required for effective learning; and feedback is important (Leinder & Jarvenpaa, 1995). These assumptions align CBI with the stimulus, response and feedback pattern often used in education methods using the objectivist model. This pattern breaks down tasks into three components. First, stimulus, or a cue, informs learners it is time to perform a particular behaviour. Second, learners perform the prescribed behaviour. Third, learners are provided feedback. The objectivist learning model makes the pedagogical assumption that any mechanism that can increase the ability to communicate will increase learning (Leinder & Jarvenpaa, 1995). This assumption aligns with CBI's ability to dynamically adapt, hosting whichever digital medium is most suited for the transfer of a specific piece of knowledge. Gibbons & Fairweather (1998) refer to this ability as *dynamic display*.

Gibbons & Fairweather (1998) and Leinder & Jarvenpaa (1995) describe pedagogical assumptions that align CBI with numerous learning models. This is because of CBI's flexibility. All digital media can be assimilated by this technology (Gibbons & Fairweather, 1998) and, as a result, the pedagogical assumptions of each medium can also be assimilated. Therefore, CBI's pedagogical assumptions are influenced by whatever media it hosts.

3.2.6 Distance Learning

Distance learning is a system of transferring knowledge over distances in space or time, or both, so that learning courses may be offered to locations lacking the resources to provide the courses locally (Leinder & Jarvenpaa, 1995). There are many types of distance learning, using many different technologies and practices. Distance learning is generally categorised as synchronous or asynchronous (Leinder & Jarvenpaa, 1995). Synchronous distance learning includes video and web conferencing, telephoning, radio, streaming, or any technology in real time. Asynchronous learning includes mail correspondence, video and audio recordings, email, message boards, or any media that is recorded by a teacher for a learner's later use.

Distance learning best fits an objectivist learning model (Leinder & Jarvenpaa, 1995). The transfer of knowledge occurring in distance learning is essentially the same as that outlined by the objectivist model with the exception of occurring over much greater distances. Also, it is important to note that distance learning can be augmented by connecting learners through the use of something as simple as an electronic mailing list or an electronic forum, providing the chance for learners to interact and share knowledge, thus facilitating pedagogical assumptions found in a cooperative model (Leinder & Jarvenpaa, 1995).

There are four additional advantages that are specific to distance learning as outlined by Oblinger (2000): the ability to expand access, alleviation of course capacity constraints, capitalization on emerging markets, and the potential to act as a catalyst for educational reform. These are worth noting as they can be seen in the context of 3D CG education. Most notably, expanding access to specialist knowledge is a goal of 3D CG SDL publishers. Gnomon (2008) states this as part of their mission.

3.2.7 Simulations

Simulation is a technological tool where a model of a system, environment, expert behaviour, or a combination of these, is created for educational purposes (Gibbons & Fairweather, 1998). Usually, these models are created for the purpose of conducting demonstrations, practice, or both. Simulations can be created as stand-alone educational systems or integrated into a larger system such as CBI (Gibbons & Fairweather, 1998). Simulations can provide real, condensed or vicarious experiences, based on the assumption that learners learn best when they directly experience the subject matter (Leinder & Jarvenpaa, 1995).

This method of learning has proven effective in training situations where learners have to perform the learned material as well as possible (Guralnick & Levy, 2009). Simulations are *"widely appreciated as a powerful tool for instructing higher-level principles, procedures, and cause-effect relationships"* (Gibbons & Fairweather, 1998, p. 197). Statements like this and the use of experiences to facilitate learning may seem to align simulations with the constructivist model; however, this is not the case. In fact, simulations take a neutral standpoint, with the ability to be adapted to meet several different pedagogical assumptions or learning models (Gibbons & Fairweather, 1998).

This medium for learning however is one of the most difficult technologies to work with, and as such requires more resources and time than most other learning technologies (Gibbons & Fairweather, 1998).

This difficulty is attributed to the lack of specialised tools for creating simulations, as simulations can vary greatly.

3.3 Learning and Teaching Practices

As there is little research on learning and teaching practices for 3D CG SDL, the researcher reviewed five mainstream 3D CG SDL resource publishers – Autodesk Maya Press, New Riders, Gnomon, Digital Tutors and Lynda.com. It was found that two didactic units were commonly present. Demonstrations and practice formed the majority of SDL didactic styles. This is not surprising as these didactic activities together are commonly used for teaching procedural knowledge (Gibbons & Fairweather, 1999), which accounts for most knowledge in 3D CG SDL.

Demonstrations and practice occurred predominantly as *worked examples* and *problem-based learning* (PBL) respectively in all the publishers' materials reviewed. A critical review of the literature on these pedagogical strategies examines the strengths and weaknesses of each. The review then turns to a theoretical pedagogy, the *worked-out examples* principle, which holds promise to ameliorate the deficiencies of the first two pedagogical strategies and to be useful for the creation of a 3D CG SDL specific framework.

The review then looks at the media used to implement these strategies. *Screencasting* is reviewed because it was found to be the most common medium used for 3D CG SDL. The factors that constitute *screencasting* are explored in an attempt to understand what educational practices can be supported.

3.3.1 Worked Example

"A *worked example* is a step-by-step demonstration of how to perform a task or how to solve a problem" (Clark et al, 2006, p. 190). Worked examples, not to be confused with the worked-out examples principle occurring later in this chapter, are frequently used in both print and screencast 3D CG SDL resources.

This practice's key strength is its ability to teach complex problem-solving skills (Van Merriënboer, 1997). By using this pedagogical stance, a learner is presented with expert solution steps, or schemata, to solve novel and complex problems. This approach fosters understanding of solution steps for novice learners. For this reason, worked examples are more effective than other pedagogies in initial skills acquisition (Sweller, 2006). Generally 3D CG problems faced by learners are novel and complex, as learners are encouraged to demonstrate originality in their work. As this practice educates how to solve novel and complex problems, it is potentially of high importance to 3D CG learners. This may explain the popularity of this practice in 3D CG SDL. Worked examples popularity could also be attributed to the popularity of screencasting. A screencast can record a 3D CG artist working on an example fairly easily, allowing for worked examples to be created with ease.

Despite the popularity of worked examples in 3D CG SDL, Sweller (2006) notes problems with this pedagogy. Learners with prior experience may not benefit from this practice. The author attributes this to a lack of ability to reconstruct knowledge and the redundancy learners with prior knowledge face with this pedagogical practice. Bersin (2004) reinforces the notion that learners with prior experience will not benefit. He ranks the effectiveness of reading, seeing, hearing, and the combination of all, as for novice or lower modes of learning. Worked examples fit Bersin's (2004) description of lower modes of

learning. Bersin (2004) continues to state expert skill levels or mastery of knowledge can only be obtained by higher modes of learning such as practice. Both Sweller (2006) and Bersin (2004) highlight that this practice might benefit novices but does not allow them to progress on to be experts, and as such is of little educational value to learners with prior experience. This highlights a potential flaw in the majority 3D CG SDL resources, as the many of these resources use worked examples, and many exclusively use worked examples.

When implementing worked examples, care must be exerted in their creation as they have a potential to become ineffective as a result of extraneous cognitive load (Sweller, 2006). Cognitive load theory states that working memory is limited with respect to the amount of information it can hold and the number of operations it can perform on that information (Van Gerven et al, 2003). Cognitive load is the amount of resource our mind must commit in order to understand something. Avoiding cognitive strain can be achieved by integrating text and diagrams, or, in multimedia, the use of audio with a flashing mechanism to visually highlight the areas of discussion (Mayer, 2001). This integration of elements can be thought of as overcoming an attention-learning effect known as the split-attention effect (Chandler & Sweller, 1992). This effect is a result of dividing the attention of a learner, causing extraneous cognitive load.

3.3.2 Problem-Based Learning

Problem-based learning is defined by Anderson (1977, p. 185) as follows:

“Problem based learning (PBL) derives from a theory which suggests that for effective acquisition of knowledge, learners need to be stimulated to restructure information they already know within a realistic context, to gain new knowledge, and to then elaborate on the new information they have learned.”

The stimulation referred to by Anderson (1977) is initialised by asking open-ended, complex, multifaceted, and realistic questions for learners to solve. Rhem (1998) explains that this style of learning is usually conducted in groups, but this is not a rule. The teacher takes on the role of facilitator of learning. Learners are encouraged to take responsibility for their own learning, which is reinforced by allowing learners freedom to choose goals and strategies within a problem's context (Rhem, 1998). The researcher's examination of 3D CG SDL commercial resources found practice typically follows this model with the exception of group work. The omission of group work, as explained by Watkins (2005), is due to the need of novice learners to understand the interlocking nature of 3D CG and gain understanding of the entire pipeline. Group work encourages learners to divide a process and therefore only engage in a small role within a project. The points by Anderson (1977) and Rhem (1998) are of importance to 3D CG SDL because 3D CG artists require the ability to apply their knowledge in a real world context in order to be successful as commercial artists. Also, 3D CG artists who are responsible for their own learning are better equipped to continue learning and adapt to changing technologies throughout the span of their careers.

The five commercial 3D CG SDL publishers examined, Autodesk Maya Press, New Riders, Gnomon, Digital Tutors, and Lynda.com, commonly use problem-based learning. The literature does not provide a

definitive reason for this. However, Thompson's (2006) ideas on demo reels may shed light on why, stating *"If you are an artist, it is essential that you have an outstanding demo reel and portfolio."* With Thompson's statement in mind, while examining the outcome of PBL, the cause of this practice's popularity becomes clear. Work completed while practicing can be used on a learner's demo reel, which is of high importance in obtaining a job in the 3D CG industry. This welcome side effect of PBL in 3D CG SDL may highlight the popularity of the technique. It may also highlight that teaching practice in 3D CG education should go beyond merely educating and afford students the opportunity to create their own unique art.

PBL is not free from problems, though, and has a somewhat controversial past. The controversy stems from the issue of initial skill acquisition. Novice learners do not perform well under this pedagogy (Sweller, 1988). Questions have arisen on the poor outcomes of novice learners using PBL, noted by Jolly (2006). How do learners solve problems in an attempt to learn if they do not know the subject? If learners attempt to learn with no prior knowledge will they form incorrect schemata? These questions still remain unanswered by PBL. Jolly (2006) and Sweller (1988) both note some serious concerns, all stemming from the inability of PBL to teach novice learners. Given this, one can assume that 3D CG SDL using this practice may inherit these flaws. One could use these negative implications noted by Jolly (2006) and Sweller (1988) to argue for a replacement practice for 3D CG SDL. However, this would also replace the positive outcomes, such as the opportunity to learn while potentially creating demo reel work.

3.3.3 Worked-Out Examples Principle

The literature indicates that both worked examples and PBL have a margin for improvement. As such, one can conclude that there will be room for improving 3D CG SDL, as it is based on practices which are identified as having weaknesses. By examining the strengths and weakness of the worked example and PBL methods one can conclude that they are, in a way, inverse opposites. Where worked examples are effective in facilitating learning for novices, PBL is not. Where PBL is effective for learners with prior knowledge, worked examples are not. As such the two teaching practices could be consolidated to form a stronger single practice due to their somewhat complementary nature. This refined pedagogical practice would form, in theory, a more efficient and effective practice for 3D CG SDL than what is presently offered.

Understanding the strengths and weaknesses of both worked examples and PBL, Ward & Sweller (1990) attempted in a study titled "Structuring effective worked examples" to unify the two in order to eliminate each other's weaknesses. The mating of worked examples with PBL was done in a very straightforward manner. A worked example would be followed by a problem. The concept offered by Ward & Sweller (1990) in theory seems to be a well rounded solution that allows optimum learning. However, further review of the literature reveals several studies showing that Ward & Sweller's (1990) practice of moving from worked examples to problem-based learning had negative implications. This was due to the low level of beginner learners causing two problems as described by Renkl (2004). First, learners are unable to apply solution procedures specific to a given task, so fall back onto general problem-solving techniques. Second, learners cannot build bigger, meaningful chunks of information, leading to extraneous cognitive load. This is interesting as Renkl's results not only show negative

implications, but show that these negative implications are similar to the negative implications of PBL. It would appear from Renkl's (2004) findings that, while this practice overcomes the negative factors of worked examples, it does not overcome the negative factors of PBL.

A more consolidated and considered approach to combining worked examples and PBL is offered by Renkl (2004), called *worked-out examples*. A worked-out example is a worked example faded into problems. This works by moving a learner through a progression of steps from: 1) a worked example, 2) worked examples with individual steps replaced with problems, and 3) a problem in line with PBL (Figure 3-1). This progression of steps makes the solution steps needed for executing procedures salient. Renkl (2004) discovered learners using worked-out examples could learn free from the demands of counter-productive cognitive loads. This deepens learning and allows for germane, relevant to learning, cognitive load. Renkl's (2004) description of the principle can be thought of as an evolutionary step to Ward & Sweller's (1990) practice of giving an example followed by a problem, moving more tightly to integrate the two practices.

Problem 1 Worked example	Problem 2 Worked example with integrated problem solving	Problem 3 Worked example with integrated problem solving	Problem 4 Problem based learning
Step1 - Example Step2 - Example Step3 - Example	Step1 - Example Step2 - Student exercise Step3 - Example	Step1 - Student exercise Step2 - Student exercise Step3 - Example	N/A
Answer = Example	Answer = Example	Answer = Student exercise	Answer = Student exercise

Figure 3-1. An illustration of how a worked-out example may occur.

There are some limitations to worked-out examples. Renkl (2004) found that worked-out examples only work when learners are at a beginner level with any given subject. If learners have ample experience in a domain they will find the worked-out example approach a less beneficial learning model. This makes sense, as these are the same limitations of worked examples as stated by Sweller (2006), on which worked-out examples are based. This could potentially be overcome by allowing expert learners to skip the worked examples and fading, and move directly to PBL, a practice described by Rhem (1998) as beneficial for learners with prior experience. It was also found by Renkl (2004) that worked-out examples must, like worked examples, avoid the split-attention effect by integrating text and diagrams or audio and moving image.

The following are the guidelines for creating a worked-out example provided by Renkl (2004).

- Use sequences of faded examples.
- Accommodate student learning for self-explanation.
- Provide a well-designed help system to help support student self-explanation.
- Do not divide a student's attention.
- Teach in way that allows students to understand structural features rather than surface features.
- Teach in a way that allows sub steps to be fully explained.

Renkl (2004) claims that following the above guidelines will allow learners to understanding the principles behind problems. This enables learners to deal with novel problems and acquire a deeper knowledge.

While worked-out examples have a solid research base and appear to be an effective and efficient educational practice, there are limitations to Renkl's (2004) principles. Renkl (2004) addresses the four potential problems he perceives. The first perceived issue is that focusing on a single solution in worked-out examples has the potential to limit a student's learning. Second, there is presently no mechanism for error-triggered learning while learning from worked-out examples. Error triggered learning is where errors act as triggers for reflection that deepens understanding. Third, the research results can only be applied confidently to a limited domain. Fourth, the studies are from small ecological settings and thus of limited validity.

3.3.4 Media to Implement the Learning Process

As no studies could be identified on media preferences for 3D CG SDL, five mainstream 3D CG SDL resource publishers were examined (see section 3.3). While conducting this examination it was found that screencasting was by far the most commonly used medium. Screencasting is a means, using software or hardware, to capture a digital recording of a computer's screen output. Screencasts typically include narration describing on-screen actions. Even a portion of paperback books reviewed had DVD inserts containing screencasts for learning. Anecdotal evidence in the form of forum posts shows screencasting is popular among learners using 3D CG SDL too.

The common consensus among authors on the emerging practice of screencasting suggests that learner preference of this model is rooted in screencastings' ability to be streamed on a web browser. Cvetkovic & Lackie (2009, p. 278) quote statistics on web video consumption, such as *"48 percent of internet users have been to video sharing sites such as YouTube"*, to assert such claims. This line of thinking is echoed by Farkas (2007, p. 202). Under the title *"Benefits of Screencasting"*, he addresses the significance of web browser access and streaming. These authors' arguments however are simplistic, favouring the recent trends of e-learning and its drive to bring education to the internet. The authors' claims do have validity in the sense that web access to asynchronous learning can be both useful and convenient. Also valid is that recent generations have embraced the internet as a learning platform. These authors, however, do not touch on the core of screencasting's success, at least not in the context of 3D CG education. This can be stated as the largest publishers of 3D CG SDL do not provide internet streaming. These publishers, Gnomon and Digital Tutors, both provide 3D CG SDL resources as large format digital video, usually QuickTime, mp4 or flash video, on DVDs.

A more solid argument is offered in Mayer's (2001) multimedia principle. Mayer states that people learn better from words combined with pictures than from words alone, or, more specifically, that people learn more or more deeply when appropriate pictures are added to text. This is further supported by a study Mayer & Anderson (1991) conducted comparing four teaching practices: animation with narration, animation alone, narration alone, and a control group with no instruction. This study found that the animation and narration group, as well as the narration-only group, tested higher than the other groups in retention (of knowledge) performance. It additionally found that the animation and narration group

significantly outperformed all other groups in measures of transfer. Another set of studies was conducted a year later by Mayer & Anderson (1992) with the same groups. The animation and narration group was still found to significantly outperform the other groups when measuring transfer. This positive performance can be attributed to dual-coding theory. This theory was first advanced by Allan Paivio (1986), who stated that there are two independent but complementary cognitive subsystems. One is used for the processing of imagery and the other is used to process verbal information. The different cognitive processing channels can work to reinforce each other. This entails a reduction in cognitive processing requirements, and increases the chance that information will be transmitted to long-term memory. Mayer & Anderson's (1991, 1992) studies make a more convincing argument for the success of screencasting – that the popularity is rooted in its effectiveness as a media for learning.

Attributing the preference of screencasting to its effectiveness as a medium for learning is problematic in the context of 3D CG SDL as screencasts are constructed predominantly as worked examples. Worked examples are known to have issues, detailed earlier in this literature review. In light of worked examples issues, a description of screencastings' constituent factors by Sugar, Brown & Luterbach (2010) was reviewed so as to explore if other pedagogies could be supported by the medium. From analysing 37 screencasts authored for the purpose of teaching software, Sugar, Brown & Luterbach (2010) distilled the defining factors that a screencast should have. They did so by dividing screencasts into structural and instructional elements. These elements were then deconstructed, resulting in the individual factors that constitute a good screencast. These factors are:

- Structural features
 - Bumper
Equivalent to a radio sign on or sign off, e.g. "Hi, this is Matt from 3D CG training".
 - Screen movement
Observed as being either: 1) dynamic, where the screen capture frame moves around the screen, or 2) static, where the screen capture frame remains constant. Dynamic screen captures are not as frequent and are most often developed for advanced users. Static capture frames are better for novice learners.
 - Narration
Commentary is either: 1) explicit description – explanation coincides with what is happening on screen, e.g. "Now click on the file menu and from the drop down menu choose new", or 2) implicit description. For example, the narration says "create a new file" then the student sees the mouse cursor click on the file menu and then they select new from the drop down menu.
- Instructional
 - Provide overview
Concentrated on providing an overview of a particular topic by introducing the topic, giving a rationale for studying the topic, and connecting the lesson topic to future lessons.
 - Describe procedure

Demonstrating a procedure with an explanation of the steps; for example demonstrating how to extrude a poly face.

- Present concept
In addition to imparting procedural knowledge within screencasts, it was found that several screencasts offered an explanation of a specific concept related to the screencast topic. For example, the differences between a JPEG file and a PNG file.
- Focus attention
The narration and/or cursor location direct learners' attention to a particular component on the screen or to a certain part of an overall procedure.
- Elaborate content
Screencasting instructors elaborated beyond the topic with regard to a particular procedure, concept or other aspect of the screencast. This instructional strategy facilitates opportunities to enrich learners' understanding and to encourage learners to consider other aspects of the process or concept associated with a screencast's subject-matter.

In Sugar, Brown & Luterbach's (2010) outline of what factors define a screencast, no such mention of worked examples is made. This set of defining factors shows screencasts will allow for a multitude of pedagogical practices. However, screencasting only allows for transfer of knowledge. This is not ideal in the context of 3D CG SDL, as there is no allowance for practice and the construction of knowledge. This is of concern, as practice and higher modes of learning are identified as important to mastering a skill (Bersin, 2004), and skill level is of importance to obtaining employment in the 3D CG industry (McCracken, 2006).

3.4 Summary

Despite demand for 3D CG artists, graduates struggle to find a place in the industry. This is due to a lack of preparedness, which is attributed to a lack in the skills needed to apply the technology required by 3D CG arts. To improve their education, 3D CG learners have turned to 3D CG SDL to supplement their training. Despite 3D CG SDL's importance, there appears to be a lack of knowledge on how to best conduct it.

Models of learning and their application to technology are then reviewed so as to understand common pedagogical assumptions and how they relate to common SDL technologies. The objectivist model assumes that reality is objective. The constructivist, co-operative, and cognitive information processing models assume that reality is subjective. The objectivist learning model attempts to transfer knowledge to learners. The models that assume reality is subjective attempt to encourage learners to construct knowledge. CBI provides learners with interactive instruction in an attempt to automate teaching and learning. CBI can be made to host all digital media and as such can inherit the pedagogical assumptions of its content. Distance learning is transferring knowledge over distances in space or time. Distance learning uses the objectivist learning model. Simulations are a tool for providing a simulated experience on the assumption that learners learn best when they experience the subject matter.

Learning and teaching practices found commonly in present commercial 3D CG SDL are identified as worked examples, PBL and screencasting. Worked examples are effective for teaching novice learners. PBL is effective for teaching learners with prior knowledge. Worked-out examples are then discussed, as they integrate worked examples and PBL so as to consolidate each other's weaknesses. Screencasts are an effective medium for 3D CG SDL. What constitutes a screencast is discussed and it is identified that this medium can support learning and teaching practices that use an objectivist learning model.

4 Methodology and Research design

In this chapter the methodology applied to this research is discussed. Following that, the research design used to conduct this research study is outlined. Next, the particular methods for conducting the research are presented and how the different methods work together is discussed.

4.1 Methodology

This sub-section describes the methodologies in this research study. Heuristics, practice-based research, and mixed methods qualitative and quantitative research are discussed in the context of this research study.

4.1.1 Heuristics

Heuristics is a field of research where personal experience is used as a valid research method, described by Moustakas (1990, p. 9) as *“a process of internal search through which one discovers the nature and meaning of experience and develops methods and procedures for further investigation and analysis.”* Moustakas (1990) also states that as the understanding of the research grows, so too does self awareness and knowledge. Given the researcher’s background as a 3D CG educator, an approach incorporating the researcher’s knowledge appears not only appropriate, but also beneficial to the study.

Heuristic enquiry begins with the initial engagement phase, where a question or problem is defined which the researcher will later attempt to illuminate or answer. The question is described as being *“a personal challenge or puzzlement”* (Moustakas, 1990, p. 15) to the researcher. Therefore, this is a process derived from a personal thirsting for understanding, and driving this thirst is discovery. Polanyi (1960, p. 301) states *“From the first intimation of a hidden problem and throughout its pursuit to the point of solution, the process of discovery is guided by personal vision and sustained by personal conviction.”*

The driving force of a personal question and a desire to solve it fits the conception of this research project. The researcher, in his role as a 3D CG educator, seeks to improve 3D CG education and realises both the importance of, and room for improvement in, 3D CG SDL.

A central concept to heuristic research is the notion that tacit knowledge is the key to discoveries. Polanyi (1960, p. 4) states that all knowledge is comprised or sourced from acts of comprehension that are facilitated by tacit knowledge, *“we can know more than we can tell”*. To further elaborate, one can think of this as knowledge that cannot be written down or verbalised easily, knowledge that is not purely cognitive. Tacit knowledge refers to knowledge that is not easily transferred to learners.

Tacit knowledge is of importance to 3D CG artistry. This is knowledge such as motor skills, having a critical eye, and having a feel for 3D space and form. Therefore, this study will include decisions informed by the researcher’s tacit knowledge gained from practicing and teaching 3D CG artistry.

Another important aspect of heuristic research is the process of indwelling. Moustakas (1990, p. 24) describes this as the *“process of turning inward to seek a deeper, more extended comprehension of the nature of meaning of a quality or theme of human experience. It involves a willingness to gaze with unwavering attention and concentration into some facet of human experience in order to understand its*

constituent qualities and its wholeness." Moustakas (1990, p. 24) further elaborates that indwelling is *"conscious and deliberate, yet is not lineal or logical."* Patience and increasing understanding in increments are considered the guidelines required to undertake this process.

Moustakas (1990) also states the requirement for practice, namely creative expression. This phase is referred to as *"creative synthesis"* in heuristic research. Before entering this stage, a researcher must ensure they are thoroughly familiar with all the data collected. Once the knowledge of the materials is mastered, the researcher is challenged to put the components and core themes into a creative synthesis.

The practice element in the context of this research is the creation of a 3D CG SDL proof of concept. This enables the researcher to become aware of his tacit knowledge and tap into it. This knowledge can then be observed, described and documented. Prior to the creation of the proof of concept, themes and important concepts need to be understood and well illuminated.

4.1.2 Practice-Based Research

Practice is identified by Moustakas (1990) as being important to heuristic research. Practice-based research is the undertaking of an investigation so as to advance knowledge, partly by means of practice and the outcomes of that practice (Candy, 2006). It includes the practical exploration of ideas and artefacts which lead to new or improved insights. This methodology, practice-based research, should not be confused with a practitioner's research for their own practice. While a practitioner's research is conducted to improve their own knowledge, practice-based research aims to add to a subject domain's shared knowledge. This knowledge informs the subject beyond just the practitioner and the viewers of the artefact (Candy, 2006).

Practice-based research is still an emerging approach and as such has much variation in its methods. Morgan & Walters (2011, p. 269) state that *"the problem lies in the lack of tools available to interpret the information... practice-based research has to draw on a seemingly infinite supply of methodologies and concepts rather than developing a consistent specific design ideology."* In respect to a lack of well defined methods for practice, this research study's practice-based research draws on heuristics. The practice methods have been selected to allow decisions to be observed, described and documented as required by heuristic research. The practice must also afford the ability to produce new ideas and artefacts as required by practice-based research.

4.1.3 Mixed Methods: Quantitative and Qualitative Approaches

Quantitative methods are those which focus on capturing numbers and frequencies. Data collected by quantitative methods provides information which is easy to analyse statistically and fairly reliable. Quantitative methods are criticised for not providing an in-depth description of the phenomena under investigation (Creswell, 2009). Qualitative methods are ways of collecting data which are concerned with describing the meaning of a phenomenon under investigation. Although qualitative methods are criticised regarding their validity and reliability, they provide much deeper and richer descriptions than quantitative methods do (Creswell, 2009).

This research study selects methods aimed at both capturing quantitative and qualitative data. Using mixed methods of quantitative and qualitative research lends depth and clarity to this research study. The depth and clarity come from a process called triangulation. Triangulation refers to using multiple methods to seek convergence, corroboration and correspondence across the results of different research methods (Brannen, 1992). Triangulation is facilitated by collecting separate quantitative and qualitative data sources, using separate quantitative and qualitative methods, and analysing the data sets using separate quantitative and qualitative procedures.

The integration of methods required by mixed methods research happens sequentially in this research study, whereby one set of methods builds upon the other. The quantitative survey is triangulated by the qualitative interviews, and the results of the survey inform the implementation of the interviews. This allows for themes and ideas to be returned to, allowing for more accurate and detailed explications of 3D CG SDL and its user's perceptions. The quantitative methods are used to make generalizations about 3D CG SDL users and 3D CG SDL resources. This reasoning is known as inductive logic. The qualitative methods gather descriptions about phenomena identified through the qualitative methods and use them to test and refine what is known of the phenomena. This type of reasoning is known as deductive logic.

4.2 Research Design

The methods used to conduct this research were selected so as to answer this study's research questions. The methods were also selected due to their alignment with the phases of heuristic research and practice-based research. Moustakas (1990) identifies seven phases of heuristic research. (1) Initial engagement. For the purpose of this research, initial engagement is the defining of the research questions and is explained in the context of this research in section 4.1.1. (2) Immersion in the topic and question. Immersion is where the question is lived in waking, sleeping and even dream states. This requires alertness, concentration and self-searching. Virtually anything connected with the question becomes raw material for immersion. (3) Incubation. This requires a retreat from the intense, concentrated focus, allowing the expansion of knowledge to take place at a more subtle level, enabling the inner tacit dimension and intuition to clarify and extend understanding. (4) Illumination. This involves a breakthrough, a process of awakening that occurs naturally when the researcher is open and receptive to tacit knowledge and intuition. (5) Explication. This involves a full examination of what has been awakened in consciousness. This requires organization and a comprehensive depiction of the core themes. (6) The culmination of the research in a creative synthesis. This is the practice-based research aspect of this study. (7) Validity. This is explained in the following paragraph in the context of this research.

This research uses the methods that step in a manner that incrementally increases knowledge, as recommended by heuristic research. The incremental increase in knowledge aids the indwelling and focusing process, as the researcher must return to the collected data and manifestations of a participant's experience multiple times, consider them, and clarify them. The return to the data and manifestations, required by indwelling, is stated by Moustakas (1990) as the technique used for the validation of heuristic research. As heuristic research has no quantitative measurements, validity of the results is a question of meaning. Moustakas (1990, p. 32) elaborates, "*does the ultimate depiction of the*

experience derived from one's own rigorous, exhaustive self-searching and from the explications of others present comprehensively, vividly, and accurately the meanings and essences of the experience?" This judgment can only be made through reflection by the researcher. It is facilitated by the researcher's constant checking and judging. The methods selected are arranged so that constant checking and judging happens, helping ensure the validity of the study, its questions, processes and outcomes.

First a survey is used to gather broad data on 3D CG SDL resources as perceived by learners. The survey questions are designed drawing on the researcher's initial engagement with the research problems and informed hunches as a 3D CG educator. Quantitative data is collected on learner satisfaction with 3D CG SDL resources and their specific factors (see chapter 5 and appendix ii).

The collected survey data is then analysed. The data of significance to this research is identified and graphed. Broad themes are inductively identified from the results. These broad themes can be thought of as areas for further investigation and the starting point of the more refined themes identified in the interview chapter (see chapter 5).

The themes identified by the survey are then used to inform questions for the interviews. The interviews are structured to gather qualitative data on learner experiences, both as a whole and on specific facets of a learner's experience with 3D CG SDL (see chapter 6 and appendices v and vi).

The data collected is analysed deductively to expand, test, and solidify the broad themes into more refined and explicit propositions. These propositions consist of learner preferences, learner perceived problems, suggested ameliorations, and guides relevant to 3D CG SDL (see chapter 6)

For the conceptual development of the practical component of this study, the deductively gained propositions are checked and reworked into a set of guiding recommendations, linking themes, propositions with the pedagogical and theoretical framework of this study (see chapters 7, 8 and 9).

The 3D CG SDL proof-of-concept then demonstrates how the recommendations can be translated into teaching media and practices (see chapter 10).

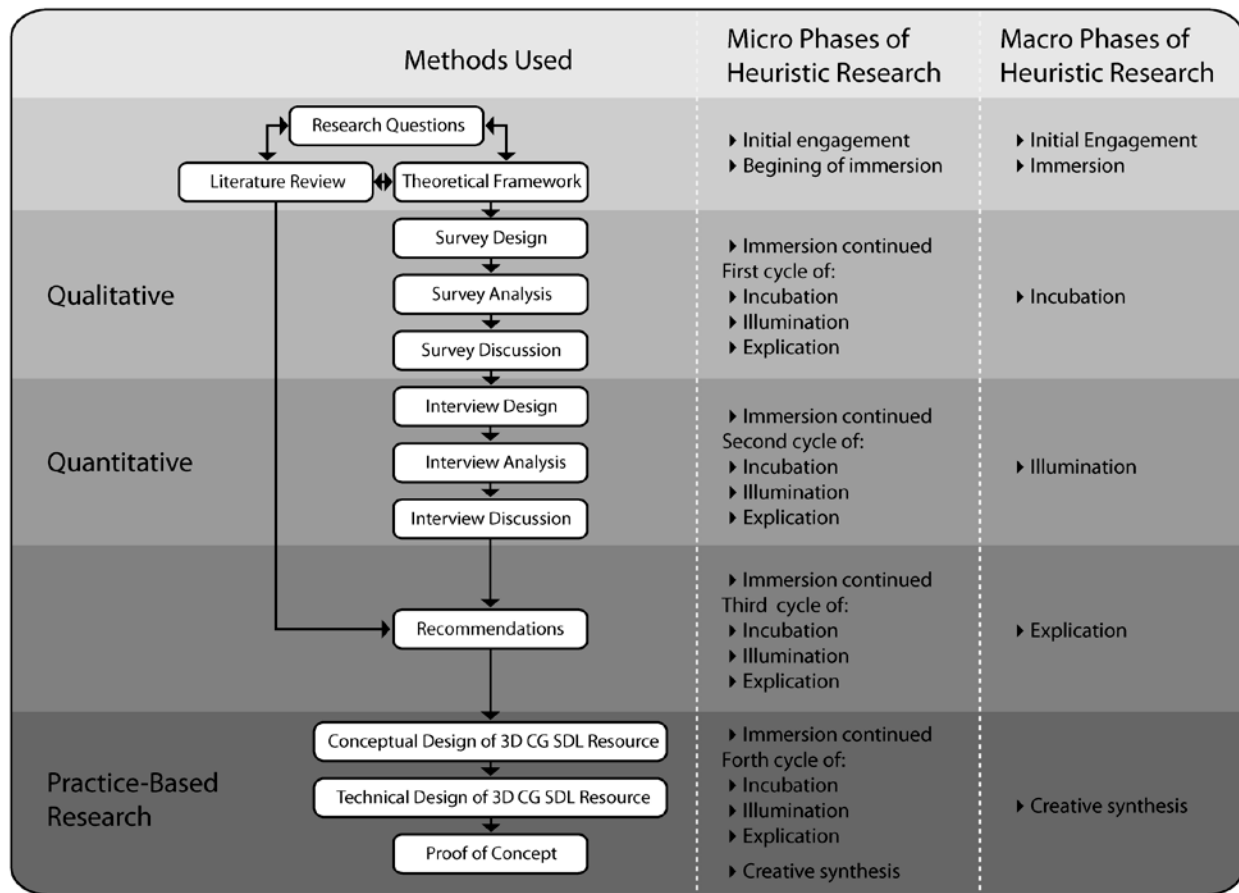


Figure 4-1. A diagram showing how the methods selected function as a whole and how they relate to the phases of heuristic research.

While the above research design is explained and presented in a linear diagram, this is far from the case in reality. As heuristic research requires the researcher to constantly return to the data to maintain validity, it would be very difficult to step from phase to phase or method to method without reflectively overlapping or looking back. Additionally, as knowledge increases incrementally, the requirement for additional work in earlier phases becomes apparent. For example, the researcher backtracked to the literature review, which now includes a discussion of worked-out examples because the interviews uncovered learner's perceptions of demonstrations and practice within SDL.

4.3 Summary

This research study's theoretical framework draws on three methodologies. Heuristics research was selected because its approach incorporates the researcher's knowledge, which is of value given his background as a 3D CG educator. Also, the initial engagement phase, a personal desire to answer a question, matched the concept of this research study. Tacit knowledge, which is implicit knowledge, is identified as important to heuristics research. Indwelling, the process of turning inwards to increase comprehension, is also identified as important. Heuristic research requires a creative synthesis – practice-based research is used to achieve this. This requires decisions to be observed, described, and documented while generating new ideas and artefacts. Mixed methods qualitative and quantitative

approaches can be utilised to triangulate results. This allows for more accurate and refined explications of the aspects of 3D CG SDL.

The methods selected to conduct this research are selected so as to incrementally increase knowledge, aiding in the indwelling process and adding validity. A quantitative survey inductively identifies broad themes. The knowledge gained is used to refine the qualitative surveys, which are used to deductively expand, test and solidify the themes. This results in propositions, including preferences, problems and suggested ameliorations. These are reworked into guiding recommendations used to link the propositions with the pedagogical and theoretical frame work. A proof of concept then demonstrates how the recommendations work in practice.

5 Survey

This chapter details the methods used to conduct the survey, the procedures used for data analysis of the collected data, and the results of the survey, followed by a discussion of outcomes.

5.1 Survey Design

The specific research design of the survey was selected to provide an overview of 3D CG artists' satisfaction with present 3D CG SDL. The survey was designed to be self-administered and deployed on the web, so as to make it easy for respondents to participate. This survey aimed to provide a cross-sectional snapshot of 3D CG artists' satisfaction with 3D CG SDL. This survey in the context of heuristics was a means for pursuing the intuitive clues or hunches identified in the initial engagement. The aim was to solidify these hunches and clues while also leading to further insights. The designing, administering, and time spent waiting for the results of the survey served as opportunities for immersion and incubation.

The survey questions were designed to capture data on learner satisfaction with 3D CG SDL. Factors contributing to a learner's perception of satisfaction such as enjoyment, frustration and confidence, as well as yes/no responses, were captured. The questions were written with specific objectives in mind. The first objective was to identify if 3D CG learners both like SDL resources and perceive them to be beneficial. This objective was first and foremost, as if learners perceived 3D CG SDL resources to be of little value then this research study's approach would need rethinking. The second objective was to identify levels of satisfaction with specific practices and media presently used in 3D CG SDL. Data was required on media preferences and practices so as to begin identifying broad themes. This data would also help identify what was currently perceived as best practice by learners. This data was used to define the interview questions. The third objective was to collect data based on the researcher's hunches, to collect data on learner perception, begin identifying broad themes and define the interview questions. These hunches stemmed from the notion that learners may be dissatisfied with 3D CG SDL and demonstrations and practice may be poorly implemented. The hunches formed in two ways – from the initial engagement and immersion in the literature, and in dwelling on experiences as a 3D CG educator.

The survey was conducted online, hosted via the online survey provider SurveyMonkey.com (2011). This allowed for participants to access the survey at any time for the duration it was open from any computer with internet access. The survey ran for a week during February 2011. During this week 15 responses were collected.

Recruitment for the survey was initialised by emailing CG artists on an animation school's alumni list located in Auckland, animation schools in the Auckland region, and studios in the Auckland region. Auckland was selected as it has the highest concentration of animation schools in New Zealand. Schools, recent graduates, and studio artists were targeted to ensure a diversity of answers. To ensure quality in the data collected, criteria were used to select actual participants from potential participants. The criteria stated that all participants must be aged over 18, so as to legally give their consent, and have completed a 3D CG SDL resource, to ensure they had experienced the phenomenon under investigation directly. Potential survey participants were informed of these criteria through the initial recruitment material and again through an information sheet which preceded the survey (see appendix i and ii).

The validity of the survey was ensured through face and content checks, which occurred before the survey was administered. Face checks are conducted by showing a survey's content to subject matter experts for review. Face checks were conducted first, and consisted of showing the survey to 3D CG artists. Only one issue was raised during the face checks. This issue was whether the professional field was called computer generated imagery (CGI) or CG. This issue proved moot, as the 3D CG artists felt the terms could be used interchangeably, perceiving little difference. Content checks were conducted by the researcher's supervisors and lead to several changes. First, the wording of the questions was revised. Second, questions that were repetitive were removed.

The survey was recorded using SurveyMonkey's (2011) features. Each individual's responses were recorded, in addition to a summary of responses and non-responses to each question. The survey was completely anonymous. Anonymity was maintained by avoiding the recording of data that could be used to identify participants.

5.2 Survey Analysis Procedure

The goal of the analysis was not to draw precise statements from the collected statistics but to merely act as a starting point for the research, to gain orientation on where to start probing and to shape the meaning of the combined results as normative themes. The analysis of the survey served the incubation phase of the study.

The analysis seeks to display the recorded quantitative data from the surveys. This is achieved by first collecting all the numerical data and converting it into percentages. The values are then displayed graphically using bar graphs, recommended by Kent (2001) for displaying data, as they allow for easy comparison of numerical data (see section 5.3).

The graphical representations of the numerical data are used to generate statements by generalising the results to the larger population of 3D CG SDL users. This type of logic is known as inductive reasoning. The results do not require degrees of error to be calculated as the statements are not intended as precise inferred statements (Kent, 2001). Validity comes from the heuristic process, the statements are returned to in the interviews and again through the creation of the proof of concept, each time refined by the addition of new data and a period of indwelling. If this survey's results were to stand alone in isolation then a different process to ensure validity would be needed. The results are utilised to help refine the research questions of the interviews and to act as a point of discussion with interviewees. In this way, the meaning behind the results can be explored in the interviews leading to far deeper insights, which are of more use than statistical values when answering the specific questions in this research.

5.3 Survey Results

From the survey, 15 responses were received during the week the survey was open. Following is a summary of the results. Ten of the questions returned results that displayed a clear trend or highlighted divisions and as such were of use to this research. These results aided the illumination phase of heuristic research. New knowledge was gained and existing knowledge was modified by this process.

The first objective of the survey was to establish if 3D CG learners both like SDL resources and perceive them to be beneficial. Questions 3 and 4 achieved this. Question 3 (Figure 5-1) asked *"In general do you enjoy 3D CG self-directed learning resources?"*, to which 93.3% answered yes and 6.7% answered no. Question 4 (Figure 5-2) asked *"Do you feel that 3D CG self-directed learning resources are an important part of being a 3D CG artist?"*, to which 100% of the respondents answered yes.

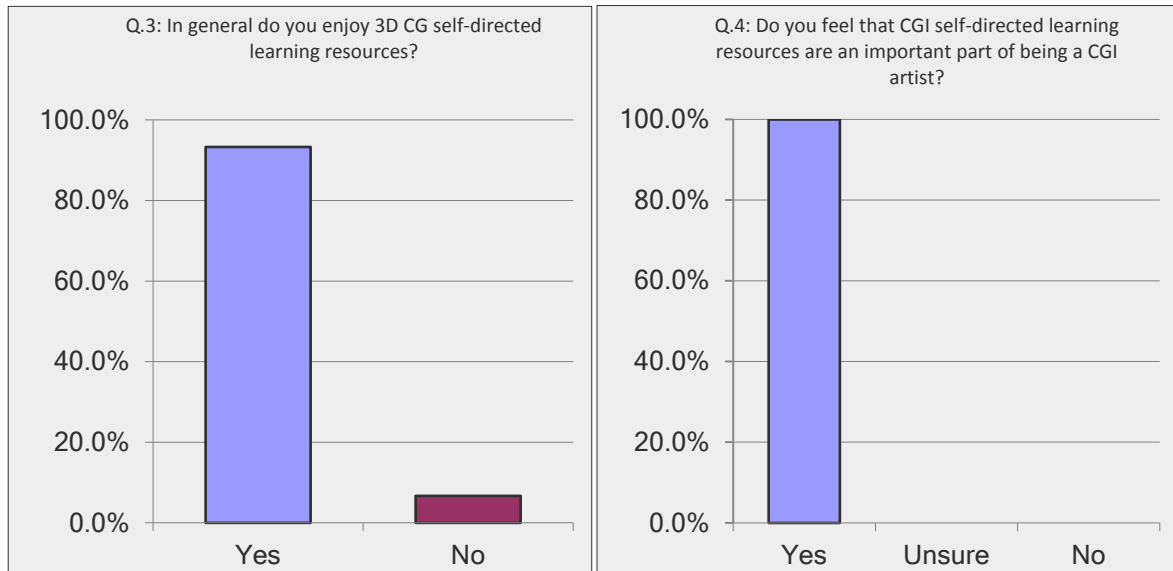


Figure 5-1 (left). Perception of enjoyment of 3D CG SDL.

Figure 5-2 (right). Perception of importance of 3D CG SDL.

Question 7 (Figure 5-3) of the survey asked *"How satisfied are you with self-directed 3D CG learning resources?"*. The question could be answered as: highly satisfied, satisfied, neutral, dissatisfied, or highly dissatisfied. The results were that 53.3% of respondents answered "neutral" and the other 46.7% answered "satisfied". No respondents felt highly satisfied, dissatisfied or highly dissatisfied. These responses show a mean of learners surveyed are neutral to satisfied with 3D CG SDL as a whole.

In Question 10 (Figure 5-4) learners were asked *"Do you ever become frustrated while using 3D CG self-directed learning resources?"*, to which 40% answered yes and 60% no. Learners surveyed therefore have different or divided experiences with frustration when using 3D CG SDL resources.

Question 14 (Figure 5-5) asked *"Do you feel that 3D CG self-directed learning resources could be better than what is presently offered?"*, to which 60% answered no and 40% answered yes. Like question 10, there is a divide on how the surveyed learners perceive 3D CG SDL.

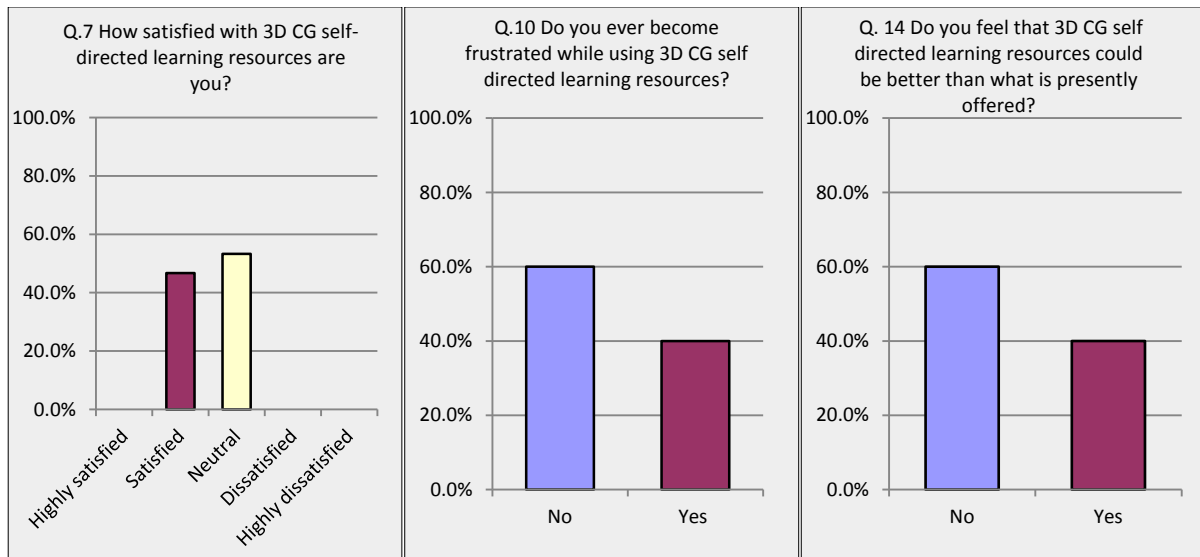


Figure 5-3 (left). Levels of satisfaction with 3D CG SDL.

Figure 5-4 (centre). Perception of frustration with 3D CG SDL.

Figure 5-5 (right). Perception of room for improvement of 3D CG SDL.

Question 6 (Figure 5-6) asked *"Do you feel more confident as a 3D CG artist after completing a 3D CG self-directed learning resource?"*. Participants could answer yes, no, or sometimes. 66.7% of respondents answered to only sometimes feeling more confident, while the remaining 33.3% answered yes.

Question 8 (Figure 5-7) asked *"Do you ever feel overwhelmed by the way information is presented in 3D CG self-directed learning resources?"*. Participants could answer yes, no, or sometimes. 13.3% of respondents felt overwhelmed and 60% of respondents sometimes felt overwhelmed. This shows the majority of respondents have at some point had problems processing the information presented in 3D CG SDL.

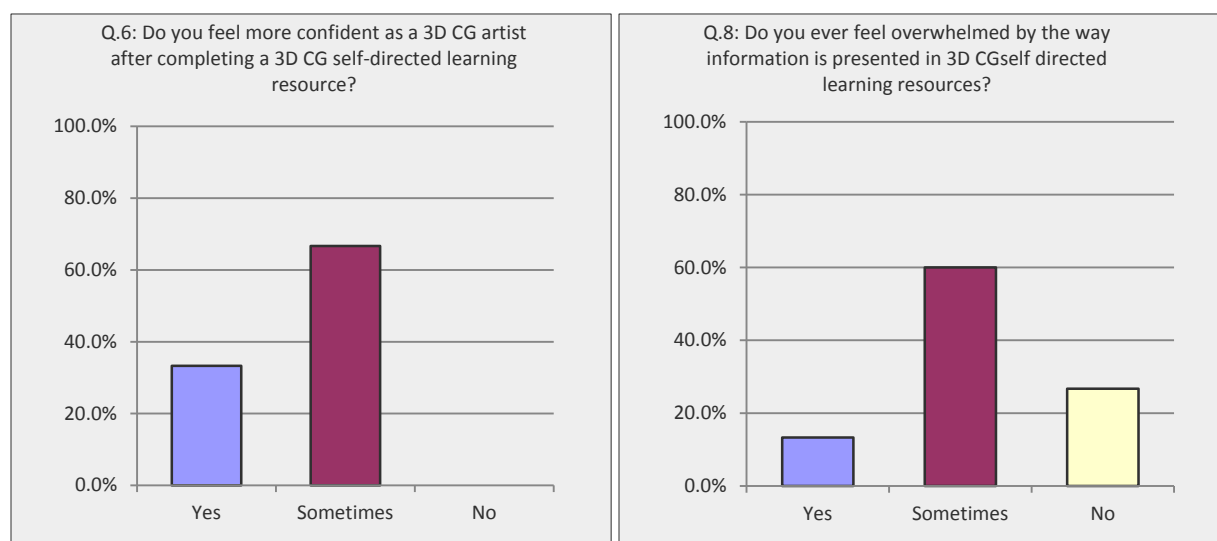


Figure 5-6 (left). Perception of increased confidence on completing 3D CG SDL.

Figure 5-7 (right). Perception of feeling overwhelmed by 3D CG SDL.

Question 9 (Figure 5-8) asked *"Do you feel that the practice exercises included with 3D CG self-directed learning resources are important to learn 3D CG skills?"*. Participants could answer yes, sometimes, or no. 64.3% said yes. This result identifies that the majority of participants perceive practice as important. Question 11 (Figure 5-9) asked *"Do you find instructions for exercises included with self-directed learning resources are clear?"*. Participants could answer yes, sometimes, or no. 40% answered yes and 60% answered only sometimes.

Question 13 (Figure 5-10) asked *"Do you try to follow along, by parroting, screen captured video demonstrations if they do not provide clearly defined exercises?"*. Participants could answer yes, sometimes, or no. 40% of respondents parrot videos to practise if no exercises are included and 46.7% will sometimes do so.

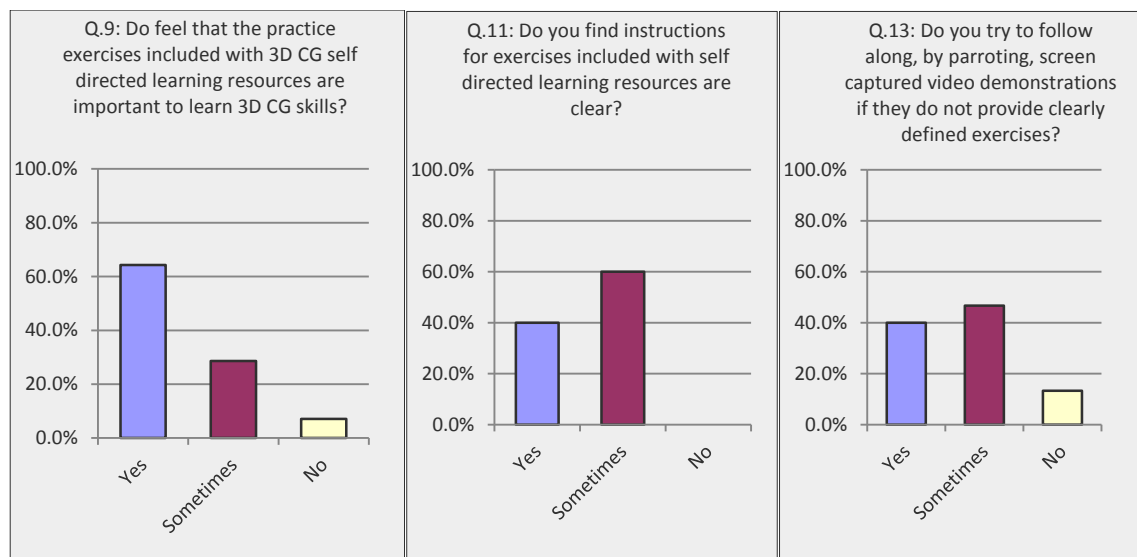


Figure 5-8. Perception of exercises importance within 3D CG SDL.

Figure 5-9. Perception of exercises clarity within 3D CG SDL.

Figure 5-10. Percentages of students that parrot videos to practise.

Question 5 (Figure 5-11) asked learners to identify their preferred medium for 3D CG SDL. Participants could answer written theory-based literature, written examples, video demonstrations, video theory lectures, or other. The option of "other" allowed for a text box for participants to fill out. Participants identified video demonstrations as the favourite media for self-directed learning with 66.7% of learners preferring this media. Written examples followed second at 20%. The "other" option at 6.7% consisted of one participant stating *"Video demonstrations and written examples"*. Therefore learners surveyed prefer video demonstrations.

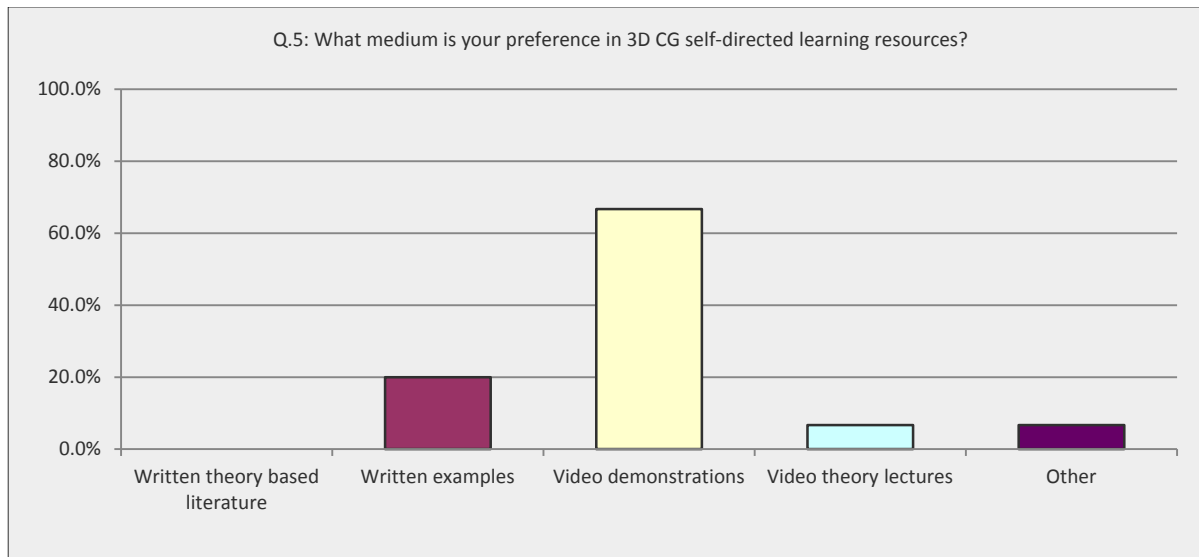


Figure 5-11. Learner preferences of 3D CG SDL mediums.

5.4 Survey Discussion

Following is a discussion of the survey's results. The following discussion is part of the explication phase in heuristic research. The ideas discussed became the starting points for the themes found in section 6.3 of this research study.

Both sets of responses to questions 3 and 4 show that the large majority of 3D CG learners surveyed perceive 3D CG SDL to be an enjoyable experience and of value to 3D CG artistry. Therefore there is a high probability that 3D CG SDL resources are not perceived as being a negative experience by the majority of 3D CG learners.

Question 10 and 14 both show a divide in their results among learners. This divide could potentially be attributed to several causes. The first cause of the divide could be that learners have used different resources and therefore have different experiences. Second, learners may perceive a resource differently; what is a positive experience for one learner may be a frustrating or a negative experience for another. Last, this divide may be a combination of both a learner's different experiences and perceptions of 3D CG SDL. Both sets of data show an area for further investigation. With only limited quantitative data collected at this stage, it is difficult to draw any meaning other than that there are learners who have become frustrated with 3D CG SDL and there are learners who perceive that 3D CG SDL could be improved. One cannot tell the cause of the frustration or offer any solutions from this data. Therefore the interviews to follow should ask questions to probe learners on the causes of their frustration or previously experienced issues with 3D CG SDL as a whole and its constituent factors. They should also probe learner perceptions of improvements that could be made to avoid frustrations.

Question 6's responses highlight an area for further investigation – why some learners feel confident only sometimes is not understood. Understanding this may help illuminate improvements for 3D CG SDL. This can be said as there is a well documented link between learner confidence and successful students (Davis, 2000).

The data collected in question 8 shows there may be a problem with 3D CG SDL; however, it does not illuminate what the problem is. The feeling of being overwhelmed could be attributed to the way information is transferred, the way knowledge is constructed, the level of the materials to be learned, the language used, and the skill level of the learner. As such the interviews should attempt to capture more data on all these factors.

The literature review conducted by this research on common 3D CG SDL teaching methods identified practice as a potential problem area. However, question 9's results show the perception that current practice is important. This may mean that present teaching methods for practice are perceived as being beneficial, or at least some parts of it are. These results highlight an area for further investigation on what factors of practice are working and what are not.

The results of question 13 show that the majority of learners will practise or practise sometimes if no specific instruction is given. This result could be interpreted as learners perceiving there to be an obligation to practice, having a desire to practise, or could be a result of the perceived importance of practice seen in the results of question 9. This result may also explain question 11's results showing that instructions are perceived by learners to sometimes be unclear.

The results of Questions 9, 11 and 13 together describe 3D CG SDL's practice components. The importance of practice seems to be recognised by participants, and the majority of participants will attempt to practise even if no instruction is given to do so. When instruction is given, the majority of learners find it hard to understand or hard to understand sometimes. These results show a mis-match between the importance 3D CG SDL places on practice and learners' perception of practice. These results warrant further investigation into how practice is conducted. As such, the subject of practice should have an important role in the interviews.

Question 5's results show the preference for screencasting by learners using 3D CG SDL resources. It also may identify the importance of worked examples, as the top two choices made by participants are based on this teaching practice. This result will be used to narrow the interviews to examine only screencast media. Not examining improvements for a media that is not preferred will save effort.

5.5 Summary

This research study employed a web-based survey to capture quantitative data on learners' present level of satisfaction with 3D CG SDL. Questions were asked to identify whether 3D CG SDL was perceived positively by learners, to gather levels of satisfaction with current media and practices, and to follow the researcher's hunches. The survey was administered in Auckland, New Zealand and ran for one week during which collected 15 responses were collected. The survey was analysed by converting all the data to percentages and inputting the result into bar graphs. Inductive logic was applied to generalise the results to the larger population of 3D CG SDL users. The results were used to define the interview questions.

The results show that learners generally perceive 3D CG SDL positively and that learners had divided perceptions of frustration and the need for improvement. This could be attributed to varied experiences and/or varied skill level. Learners only sometimes feel more confident after using SDL resources. This

warrants further investigation, as confidence and success have an established link. Some learners felt overwhelmed. This potentially could be attributed to the way information is transferred and/or constructed, the material's level, the language used, and learner skill level. Learners perceived practice as being important. Also evident was a mismatch between the importance 3D CG SDL places on practice and how learners perceive practice. Practice therefore warrants further investigation. Screencasting was identified by learners as the most popular medium for 3D CG SDL. This may also have to do with the use of worked examples, as the top two media choices incorporate this teaching practice.

6 Interviews

This chapter details the methods used to conduct the interviews, the procedures used for data analysis of the interviews, presents the results as nine themes, and discusses the themes.

6.1 Interview Design

Designing and administering the interviews contributed to the immersion, incubation and illumination phases of the heuristic research. The interview technique was selected from Moustakas's (1990) work. This specific interview technique was selected as it is designed to move past surface details of a problem and instead focuses on uncovering the root of a problem, also known as the underlying problem. This technique also aligns with heuristic research practices.

The selected interview technique recommends asking interviewees two broad questions: What have you experienced in terms of the phenomenon? And, what contexts or situations have typically influenced or affected your experiences of the phenomenon? Additional open-ended questions may be asked. Asking questions within these guidelines provided both structural and textual descriptions of interviewee's experiences with 3D CG SDL resources. The phenomena under investigation were specific factors of 3D CG SDL. These specific factors were identified by the survey, literature review, and through a period of indwelling on the researcher's own experiences as a 3D CG educator. This allowed for an incremental increase in knowledge and a return to the emerging themes, undertaken so as to adhere to Moustakas' (1990) description of heuristic research. All the questions used explore the learners' insights and perceptions of 3D CG SDL resources based on their own experiences.

Moustakas's (1990) guidelines for questions result in questions such as:

- What factors have caused problems for you while using 3D CG self-directed learning material?
- In what situation did this problem occur?

Additionally, open-ended questions ask how experiences with the phenomenon could be improved or avoided. An example of such a question is:

- How do you think this problem could be avoided in future?

The interviews were conducted at either the homes of the interviewees or at AUT in a private room. Due to the busy schedule of 3D CG artists, participants were free to select a time and location of their choosing within a two-week period.

The number of participants for the interview, five, is based on small samples suited to qualitative research and is supported by the Nielsen-Landauer formula. This formula was developed for selecting the correct number of participants required for usability testing. The Nielsen-Landauer formula states that 3 to 5 interviewees will encounter between 70% to 90% of usability problems (Nielsen & Landauer, 1993). Once five testers is exceeded, the additional resources and effort needed to yield a comparatively small amount of new data is inefficient and ineffective.

The sample size aims to capture a diversity of answers while minimizing natural repetition of responses. No numerical data was required from the interviews.

Recruitment for the interviews was conducted in a similar way to the recruitment for the preceding surveys. Recruitment began with emailing CG artists on an animation school's alumni list located in Auckland, animation schools in the Auckland region, and studios in the Auckland region. Auckland was selected as it has the highest concentration of animation schools in New Zealand. Schools, recent graduates, and studio artists were targeted to ensure a diversity of answers. To ensure quality in the data collected, criteria were used to select participants from potential participants. The criteria stated all participants must be aged over 18, so as to legally give their consent, and have completed a 3D CG SDL resource, to ensure they had experienced the phenomenon under investigation directly. Potential interview participants were informed of the criteria through the initial recruitment material, through an information sheet provided on interest of participation, and again preceding the interview (see appendix iii, iv and v).

6.2 Interview Analysis Procedure

The qualitative interview data was analysed using stages based on Colaizzi's (1978) methods for analyzing data: 1) Transcribing the interview recordings, 2) listening to and reading the recordings and transcriptions until they are understood, 3) developing a list of significant statements, 4) formulating meanings based on these significant statements, 5) clustering the formulated meanings into themes common to all participants, 6) writing an exhaustive description of each theme from the integrated results, and 7) having the theme descriptions verified by the participants.

Colaizzi's (1978) stages for analysis, although described as a linear process, were not necessarily always linear. For example, while transcribing the recordings the researcher was already engaging with the transcripts. This specific blurring of the stages was unavoidable as the researcher had to engage with the material in order to transcribe it. Additionally, heuristic research requires that a researcher continually return to the data so as to maintain validity.

The first stage of data analysis is to transcribe the collected data. While not made explicit by Colaizzi's (1978) stages, it is implied as researchers are expected to have data that is transcribed from interviews for analysis. The researcher took on the transcribing of recordings as it provided an opportunity for engagement and immersion.

The second stage of this method is outlined in Colaizzi's (1978) method as the first stage; the researcher tries to acquire a sense of each transcript. Moustakas (1990, p. 51) describes that the researcher "*enters into the material in timeless immersion until it is understood.*" He states the researcher may take as much time as necessary to understand the collected data on an interviewee's experience. The immersion is achieved in several ways. First, the interviewer is the researcher. The interaction with the interviewees helps the researcher gain a more personal sense of their experiences. The transcription process is also conducted by the researcher, allowing another opportunity to engage and immerse in the interview. The transcriptions and audio recordings are then read and listened to several more times.

This repetition stops when the researcher feels an understanding of each interviewee's experience is achieved.

Stage three consists of re-reading the transcripts to identify and digitally highlight any normative statements of the interviewee's experiences and perceptions of 3D CG SDL. Colaizzi (1978) suggests that a researcher should highlight and extract significant phrases and statements from the transcribed data that together form the whole meaning of an experience. In the context of this research, this means highlighting all the statements of significance in answering the research questions. The identified statements directly pertained to the interview questions: positive and negative experiences with 3D CG SDL, the context in which this experience had arisen, and how this experience could potentially be improved.

Meanings are then formulated from the significant statements for stage four. In this stage of analysis, Colaizzi (1978) recommends that these are more general restatements or meanings for each significant statement identified in the text. Sanders' (2003) method for this stage is to ask what the meaning of the researched phenomenon is and what it tells about the researched phenomenon. These questions are asked to help formulate meanings and to ensure formulated meanings are in context with the specific concerns of the research. For this research, the significant statements are copied into a table with a free space adjacent to each to allow for meanings to be formulated (Table 6-1). While formulating each meaning the researcher asks: What is the purpose 3D CG SDL? And what does this tell me about 3D CG SDL?

<i>Significant Statements</i>	<i>Formulated Meanings</i>
It's good being able to pause and rewind.	Video controls are perceived as useful.
Usually has verbal explanations on things which you probably wouldn't get written.	The narration accompanying screencasts allows for information to be transferred that wouldn't usually occur in written materials.
Sometimes you'll find a tutorial on something and then you'll realise that it is slightly outdated in the way that process is done.	Tutorials outdated.
If I compare it to live tutoring then self-directed learning has the benefit that you can stop and start when you want to, and take a break whenever you want to which is really good.	Self-directed learning puts the learner in control.
I guess because a lot of the YouTube stuff is home brand style.	YouTube videos are of a low quality.
Actually I find that some of the animation tutorials I did get a bit annoying. Like the guy was kind of joking around a lot and even swearing and stuff like that and I really didn't appreciate that, I just wanted to learn.	Teacher's demeanour not appreciated by learners.

Table 6-1. A sample list of significant statements and their associated formulated meanings.

Once all the formulated meanings have been created, Colaizzi (1978) suggests that the formulated meanings should be arranged and clustered into themes (Table 6-2). This forms stage five. From these theme clusters, themes begin to emerge that encompass all the significant statements.

Example of a theme with its cluster of associated formulated meanings.

Offline media is preferred to online media.

- YouTube videos are perceived negatively by 3D CG learners.
 - Learners prefer offline media's larger resolution as it is easier to understand.
 - Large data size SDL material is problematic to download due to internet speed.
 - Highly compressed video media can become distorted.
 - DVDs allow much larger resolution which is perceived positively by learners.
 - Internet can be unreliable and learner motivation can be affected negatively.
-

Table 6-2. An example of a theme and its associated meanings.

Colaizzi (1978) recommends that a researcher should integrate all the formulated meanings into an exhaustive description of the phenomenon. This is stage six. For this specific research, the exhaustive descriptions were achieved by incorporating all the work thus far, that is the themes that had emerged, and the clusters of formulated meanings and the significant statements into a description containing all elements of the experience. This forms the themes and their descriptions.

The next stage is to return to the participants for an interview to elicit views on the essential structure of the phenomenon to ensure that it represents their experience (Colaizzi, 1978). This however was not practical. Instead, stage seven consists of a practice recommended as a substitute by Holloway & Wheeler (1996), where the exhaustive descriptions are sent back to the participants to examine as to whether they are representative of their experiences. In accordance with Holloway's & Wheeler's (1996) recommendation, this researcher sent the exhaustive description to each participant via email asking whether it was representative of their experiences of 3D CG SDL. Feedback was invited at the participants' discretion. Feedback from two participants was received. Both these participants felt positively about the exhaustive descriptions, and felt there was no need for any corrections.

6.3 Analysis of Interviews

From five verbatim transcripts, 163 significant statements were extracted (see appendix vi). The significant statements had meanings formulated. These formulated meanings were then clustered into themes based on the associated meanings. This process resulted in the following nine themes and their descriptions. Each participant is referred to by the pseudonyms P1, P2, P3, P4, and P5 in order to maintain confidentiality.

6.3.1 Theme 1: Resource Integration

The desire for tighter integration of demonstration and practice with 3D CG SDL resources was expressed by three of the five interviewees. At present, learners are required to integrate learning resources with practice themselves. P4 described this as *"flicking between the software and the tutorial"*, constantly having to *"turn it on, watch part of it, switch it off, do that part, switch it back on see what they've done"* while practice and experimentation is attempted. Interviewee P3 expressed a similar frustration and continued by putting forward a solution *"...actually, instead of like having a video and then going back to Maya and then going back to the video and then going back to Maya, actually, just going into Maya and having more of an interactive learning software so like it tells you do this, you do it and then it tells you to the next thing and you do it and it checks what you're doing."*

The integration of 3D software used for practice and instruction was again echoed by P4: *"It would be cool if it was interactive so that you could spin stuff around and see what's going on"*, suggesting that integrating the 3D software package with the lesson material would be useful. P4 continued *"It's funny because the screen[cast] looks like Maya so I go to move something and I'm like wait! I'm in the wrong screen! Go back to Maya, ha-ha."* In this instance the constant *"flicking"* backwards and forwards between a screencast and the actual software used for practice caused confusion in the interview participants.

Most interviewees stated that they will pause tutorials often and switch to the software to play and experiment with what has been shown in a lesson in order to gain a hands-on perspective. P5 commented *"A lot of the time, I like to play around with the tools"* while talking about *"flicking"* between software and the lesson. P2 said *"sometimes, I want to check the options of something when they say hey just click on this thing and see the settings, I might stop and have a look at what the settings are before continuing"*.

6.3.2 Theme 2: Screencasting

Both the dominance of screencast resources within commercial 3D CG SDL and the results of the survey conducted earlier in this research show screencasting to be a popular choice for SDL among 3D CG artists and publishers. All interviewees agreed it was the best choice for learning: P3 even said *"Actually I have only done that [screencasting] type of learning."*

Three of the participants stated that not only were they visual learners but the majority of 3D CG artists were, and this was the reason for their preference for screencast material. Interestingly, most of the participants compared screencasting to written materials to state their point. P4 said *"most 3D artists are visual people. No one wants to read a book."* P2 said *"Videos are better than reading stuff just*

because I'm a visual video type person and reading is just slower and more difficult". If screencasting is indeed preferred because the majority of 3D CG artists are visual learners it is difficult to say. Learners may perceive they are visual learners for other reasons. Another explanation can be extracted by looking at the comparison made with other learning media such as books. P4 said *"it's [screencasts] a lot easier than like a book would say file>reference>options"*. This response indicates that some 3D CG specific knowledge is easier to transfer visually. This idea is echoed in responses by P3: *"It's [screencasting] easy to compare with what they're doing. All the same UI stuff is there and it's easy to reference."* P2 states *"It's [screencasts] actually literally showing you what to do, as compared to reading what's on a page and translating that to what you need to do."* P5 asserts *"3D is so relevant to the program. That's what I wanna see all the time I don't want to miss a single mouse click."*

When interviewees were asked what features they perceive as beneficial with screencasting, all but one commented on the usefulness of video controls. Three benefits of the controls were identified.

The first benefit identified by interviewees is the ability to pause and resume learning at will. P2 said *"If I compare it [SDL] to live tutoring, then self-directed learning has the benefit that you can stop and start when you want to and take a break whenever you want, which is really good"*. These controls allow the learner to decide when learning takes place. P5 summarised this convenience by saying *"I can wake up at 10 and the lecturer is quietly waiting away on my hard drive."* Additionally, the pause feature was used by the majority of participants to pause the media in order to allow for practice or experimentation with the software being taught. P5 said *"well it's one of the things I like about it, the fact that I can pause and play around with it [the software being taught]"*.

The second benefit is the ability to rewind to repeat part of the lesson that a learner may have missed or be struggling with. P1 stated *"so I can just follow through and if I don't understand I just go back to it again"* and then *"sometimes it's just such a complicated process I just have to go over it again"*. P5 expressed this too while talking about the ability to rewind: *"every now and then, minute seven and 12 seconds, I will find that little thing that he mentioned that will help me"*.

The third benefit of video controls is the ability to skip material. P1 said *"and if I feel I already know this, I can fast forward"*. The other participants hinted at this ability to fast forward and skip too; however, they did not mention it as directly as P1.

As a side note, a couple of interviewees alluded to the usefulness of slides edited into screencasts, showing both examples and non-examples. P4 said *"everything was just a lot more easily explained [by the slides], rather than saying this is how a spot light works and setting it up in Maya."*

6.3.3 Theme 3: Practice

"Practice makes perfect" noted both P4 and P5. Practice was identified as of high importance by all the interviewees when asked. P3 summed it up saying he can only truly have learned something by *"getting in there, getting messy."* The importance of practice in learning any form of artistry is accepted knowledge; however, the interviewees identified two types of practice and why they perceive them as important in the context of 3D CG SDL.

The first is *"copy cat-ing"* as P1 put it. This is where procedural steps are copied step for step in order to learn. This learning by mimicking style of practice dominates 3D CG SDL. P2 notes *"in terms of the 3D stuff the purpose of the self-learning is for you to be able to do it yourself. So the act of you doing is the point when I suppose you are fully understanding or at least creating ability to do it for yourself."* The other participants made similar statements about learning by mimicking and how it grants them the ability to do by one's self. Also mentioned by P2 *"it's more of a positive feeling, you think you've had a sense of achievement in that I've done this now, I am actually learning it and I've applied it"* when talking about learning by mimicking. This statement indicates that this learner has positive emotional responses to learning by mimicking.

All the participants mentioned there was no way to check their practice while learning by mimicking. P5 voiced his concerns on this subject: *"I would say that's a negative about practice. You don't know if what you're practicing is right or wrong, because if you practise the wrong thing too many times can become a bad habit."*

All participants were asked how they attempt to check their work. P3 responded *"You just compare it to the final product you have been shown or told, but you can never fully know if you've done everything precisely the right way."* P4 responded similarly, though emphasizing the severity of the problem: *"Apart from the fact that you know if your stuff doesn't look like the tutors you have probably done something wrong. But there is no real way to check that which I guess is one of the major problems."*

Beyond the lack of ability to check work, feedback on problems was also identified as an issue by P5: *"What I do for self-directed [learning] is rigging so it is very technical based, pretty much if it doesn't work I know that the practice was incorrect. That's the benefit of having a teacher, you can show them and they will be like that is wrong"* In this instance the learner can easily identify there is a problem; however he does not know what this problem is specifically or how he can fix it.

The second form of practice is where learners practise, explore and experiment free of steps or attempt an ill-defined problem. An ill-defined problem is one that addresses complex issues and thus cannot easily be described in a concise, complete manner. This type of practice is sparsely found in 3D CG SDL, which is interesting as the majority of the participants perceived this practice to be the most important. P5 stated *"maybe I'm doing something completely irrelevant to the tutorial, but think one of those tools could apply and I can be like oh maybe this will work... The more you play with it the better you learn it"*. P3 said *"not just copying it, but actually understanding how it worked, and why it worked that way when he did that rather than doing exactly what he just did."* These statements would suggest practicing free of strict steps creates deeper learning. Also, another important factor in ill-defined practice is that it can result in work that can potentially be used on a showreel, essential for gaining employment. P4 vocalised this in two statements *"I mean if I sit there and listen to my tutors do something at the end of it have nothing on my show reel"* and *"If you don't have it [a showreel] you pretty much don't have a job"*.

6.3.4 Theme 4: Help

Learners feel that there is no way to obtain help to solve problems they encounter using 3D CG SDL, yet there are many places to find the type of help learners are seeking. P5 states *"my biggest problem with self-directed learning is if I have a question that can't be answered."* Many of the other interviewees expressed the desire for a help system. However, all the comments made about what learners want in regard to help already exist as fully realised external resources. This perception may stem from the lack integration of these help systems in 3D CG SDL.

Two interviewees commented it would be good to have an online or built-in Q&A where questions could be asked and answered. P1 vocalises this suggesting *"you can have a problem box and everyone can drop their problem in if you can still not solve [a problem] after watching a tutorial, then like once a month someone can go through and pick up those common problems and then add on to a answering or question shooting part of the tutorial"*. These comments are interesting, as forums such as CG Society (www.cgsociety.org) have a frequently asked question forum for just about every discipline within 3D CG artistry committed to this very cause with a very active community of industry veterans to answer new questions. These help systems are rarely mentioned by 3D CG SDL and stand as separate entities. It appears that the help that is available is not availed because of integration problems.

One interviewee stated that he wanted a help system then followed by contradicting himself, pointing out how valuable Maya help is and that it's the very solution he is looking for. *"It was frustrating when you encounter a problem with the software and there's nothing on the tutorial that can help you to deal, because there is so many problems that can crop up with software like Maya, and... just unforeseeable problems"*. He then realises what he has said and comments, laughing *"Except Maya help, ha-ha"*. When asked to elaborate P3 said *"I think I need to use it more. I think I underestimated how helpful it actually is. Because usually help systems are like, pffft [blowing noise] instruction manuals you just kinda blow them off. Like I don't want to be seen using that, or..... Yeah but Maya help is actually very helpful."* Software such as Maya, due to its incredibly complex UI, frequently have comprehensive help files. Additional free to download learning resources and forums are provided by most software authors. P3, when asked about the availability of these resources, replied *"well it's there obviously, it's there for anyone"*.

The lack of perceived benefit in existing help systems may have to do with the perception that teachers cannot be replaced by automated systems. P3 said *"nothing is ever going to replace a tutor"* while talking about feedback when using 3D CG SDL. P5 on the subject said *"they [tutors] actually give feedback relevant to your work and I think that is something self-directed learning can never really do [...] and until we have AI I don't think it may happen any time soon."*

6.3.5 Theme 5: Skill Level

Learners are of different skill levels and learn at different paces and thus have different learning needs. This assumption can be made based on the conflicting statements made by interviewees on the pace both being too fast or too slow. Also the desire for more or less detailed descriptions was noted. P3 thought the pace was too fast and needed more detail, commenting *"generally I would prefer more explanation, but that's just me I like to pull things apart and figure out how they work, why they work"*

that way so that's what I'm always hungry for when watching a tutorial". Whereas P4 thought 3D CG SDL was too slow, commenting "Sometimes they [3D CG SDL resources] are really long and if I all ready know a little bit about it I have to wait, wait, wait, wait for like half an hour".

P2 picked up on the differences in learner skill level:

"One of the tricky balances when teaching would be teaching it at the right level is probably a difficult thing. Don't quite know the answer for that, but you don't want to be going over every basic detail like what does [the keyboard shortcut] w do or something like that, but at the same time you don't want to jump to too many assumptions and then get people lost in the video so I guess that is a tricky thing to deal with sometimes."

This presents a challenge to 3D CG SDL. Obviously, what the keyboard shortcut "w" does needs to be explained at some point. However, because w, which is the move tool, is so commonly used in Maya, learners with even the most basic skills will probably feel the pace slow down as they already know what is being explained. While the simple answer would be to skip forward, because of the nature of the formats used for 3D CG SDL this is not easy to do as P1 explains *"sometimes I already know, but I'm not sure whether anything I don't know will pop-up so I just can't drag [the play head] down to the end [of the lesson]"*. This fear of missing new knowledge in an attempt to skip prior learnt knowledge causes this particular learner to lack confidence in skipping material.

The issue of varied skill also manifested as diversions from the lesson. Three of the interviewees, P1, P3, and P5, perceived that having diversions from a lesson to expand upon and explore similar or alternative applications of concepts or techniques was useful, while P2 did not.

P5 commented when talking about what he perceived as positive with 3D CG SDL that *"There is a lot of people that will even divert off the main course of the tutorial to show you a tool, and be like, well, that's irrelevant but you know you can do this with that tool and then go back to the tutorial, and for me that is real education."* P1 commented *"It would be good if in one tutorial that could show a few different ways of doing things. It's almost like explaining all of the possibilities."* P3 said *"I would probably want to see all the same concepts used on something else. So to make sure I have actually got it, and so I can see it applied on multiple products."*

P2 described these diversions as *"waffling"*, flagging his dissatisfaction with this approach, and went on to say *"Occasionally, people go off on a tangent and tell their life story."* This division in perceived benefit or lack thereof could be attributed back to experience, as P2 is a practicing studio artist, while P1, P3 and P5 are still studying at tertiary level.

6.3.6 Theme 6: Orientation

A number of interviewees signalled that they would like the structure and content of 3D CG SDL to be communicated more clearly in order to gain a better sense of orientation. Suggestions and previously encountered positive experiences were noted on how this could take place.

The first set of suggestions was to have clear introductions for the entire resource. P2 talked about what previous experiences had been helpful on the topic, explaining what was needed is *"to show this is what we going to do today. We are going to do this, this, and this, and here's the details and steps of how to."* P2 continued on to say *"when you're teaching a class of kids it is good to be able to say, hey guys, we are gonna to make this! And they go wow! This is going to be so cool! I get that when I finish"*, suggesting that introductions that illustrate what a learner will be doing can have a strong motivational effect.

The second set of suggestions was for each lesson component to have an introduction. P5 had encountered such introductions: *"When the guy or lecturer will start it [a 3D CG SDL lesson component] he will say in the beginning, maybe for 15 seconds, what he is going to run through which is really nice especially when you have tutorials that are labelled video one, video two, videos three and you can just quickly watch the first 10 seconds of each of them and then know exactly which tutorial you are searching for."* This style of introduction was perceived as having potential to make orientation easier for learners.

Additionally, interviewees flagged the desire for a menu or index of some sort to help gain orientation and select based on their goals. The first was a menu structure, perceived as having potential benefit, suggested by P5: *"It would be cool if you could scan through tutorials, so instead of being like from start to finish, it is kind of like [a] DVD menu. So if you only want to focus on texturing then you'll just be able to click on texturing and go straight to that page or tutorial "*. P1 identified the desire for an index of topics to be included in self-directed learning while talking about a lack of help, signalling this potentially would help learners solve problems *"... and have the tags which is almost like a dictionary so if I don't know what to do I can go straight into that chapter."*

The last set of suggestions was to have smaller, consistent, well-named components that make up the larger lessons. Learners perceived that this would aid location of specific information. P1 said *"If they can break down into chapters it would be more helpful [for] citing. I could go ah, I want to know this or not that. It's more specific"*, followed shortly by *"I really wish they had more sub-topics."* P4 said *"If it's [the structure of SDL] in small stages and it's consistent throughout the entire tutorial you know that you're gonna hear what you're going to be doing next."*

6.3.7 Theme 7: Online and Offline

All participants had strong negative feelings about using the internet for self-directed learning. All those interviewed clearly stated that YouTube and other such online media would not be appropriate for 3D CG SDL. P1 summed it up by saying *"those YouTube ones are really horrible"*. Interviewees perceived that a majority of online 3D CG SDL resources were unhelpful and had many negative implications.

The first notable negative feature was the high compression rate and low resolution required for online media. YouTube and other such online media providers just cannot deliver the resolution required. P1 stated *"YouTube ones are really low res it's not right. Even if you turn up to 480p you still cannot see some of the details."* P2 said *"YouTube videos are a bit too compressed."* P3 said *"the resolution is usually pretty average on the ones [online media] that I've seen and usually it's like, yeah I can't see exactly what he's clicking on up there or,... It's usually pretty poor on the ones I've used."* P4 said *"I don't tend to look*

at you YouTube for tutorials or anything like that for tutorials anymore because they just look bad." The statements of all interviewed illustrate that online media, particularly YouTube, is perceived negatively for its high compression rates and low resolutions.

High compression and low resolution issues can be overcome by having larger media data sizes. However, this too is a problem as P1 points out: *"you don't want them [online media] to be super big. It will just cause problems with the Internet speed"* and *"If you have an Internet cap you would not be able to go through a lot of that."* Other interviews expressed similar concerns citing lag while files load, data caps and stability as problems. These problems were perceived as influencing motivation negatively by learners. P5 said *"The Internet goes off you lose your motivation straight away."*

A better alternative, as perceived by the interviewees, is offline media such as DVD discs with computer playable content on them. P5 compares online media to offline media and ranks them by saying *"They can be put on a scale all the way from YouTube to Gnomon."* P4 had a similar perspective saying *"It's [DVDs] just more reliable. You know if you want it, it's there, you've got it. But yeah the Internet is not so reliable."*

6.3.8 Theme 8: Currency

Learning resources for 3D CG SDL outdated. While the basic theories and concepts remain for the most part unchanged, the software used for 3D CG artistry is a whole different matter. New tools and their associated improved processes, which are rapidly evolving, change how artists work.

P4 expressed this by saying *"I guess 'cause Maya is constantly improving. It's constantly growing every year, well most software is any way. Every year a new level of that software comes out, but the tutorials stay the same and we're still using [Maya] 6 tutorials for like Maya 2011."* P2 said *"sometimes you'll find a tutorial on something and then you'll realise that it's slightly outdated in the way that process is done."*

6.3.9 Theme 9: Teacher

Good artists do not always make for good teachers or, as P4 put it, *"Anyone can pretty much learn 3D but not everyone can teach it."* Interviewees had both complaints and praise for the various teachers found in recorded resources. The two biggest complaints were some teachers had a negative presence and a lack of preparedness or effort.

P3, having only recently consumed a large number of 3D CG SDL resources, had a lot to say about the negative presence of a teacher. *"Actually I find that some of the animation tutorials I did it got a bit annoying. Like the guy was kind of joking around a lot and even swearing and stuff like that and I really didn't appreciate that, I just wanted to learn."* In this case P3 highlights the unprofessional demeanour and language as being negative. P3 discussed another bad teacher found in SDL: *"It kinda sounded like a lot of the time he didn't even want to be doing the tutorial. [The teacher was perceived to have the mind set of] this is something I'm doing on the side you know getting paid but can't really be bothered with this, this is how you do that this is how you do this, blah blah blah blah. But it didn't really feel like he cared that you are getting the right advice or not."* In this experience the learner sees the tutor as anything but inspiring and was left questioning the information imparted.

P3, unlike P4, found a lack of preparedness and refinement to be the biggest problem with teachers. P4 contrasts a good teacher with a bad: *"I like a tutorial where the tutor has obviously written down what he is talking about, he's not just thinking as he goes. It's actually been presented like a presentation, rather than having to sit there for half an hour while someone's going oh wait wrong window, or oh don't know what I'm doing. It's really irritating, I won't keep watching it."* In this case the teacher's preparation or appearance thereof is perceived as a positive quality in a teacher.

Although P3 and P4 saw different problems with the teachers found in recorded SDL resources, they both agreed on what they perceived as positive. Both cited tutorials by Jeremy Birns, a very well-known 3D CG lighting artist, as the best SDL resources they had completed. P3 said about his tutorials *"He always sounds like he is talking like he's taking you by the hand. He understands that you don't know anything, ha-ha, and is very accommodating of that fact and you just feel very comfortable going through his stuff. All of his explanations are really clear."* P2 said while talking about Jeremy Birns *"being a good teacher just makes such a difference, and we noticed that in real life as well with [my class] tutors."*

6.4 Discussion of Interview Results

6.4.1 Resource Integration

The “flicking” between educational resource and software to be learned was perceived negatively by learners. The requirement to continuously shift focus was described by learners as frustrating and confusing.

The problems of shifting focus could be explained by cognitive load theories. The split-attention effect offers one such explanation. This is a negative effect of splitting a learner’s focus, causing extra cognitive load that is not beneficial to learning (Chandler & Sweller, 1992). 3D CG learners at present have their attention constantly split by 3D CG SDL resources as they shift focus from the material to software for practice.

Another explanation offered by cognitive load theory is the theory of working memory. Working memory is used for temporarily holding and manipulating knowledge in active consciousness (Mayer, 2005). Presently, 3D CG SDL transfers large amounts of knowledge rapidly to a learner, which must be consciously stored in working memory until an opportunity to practise arises. The process of holding large amounts of knowledge in working memory causes high amounts of cognitive strain. This is problematic as it reduces the amount of cognitive ability available to manipulate and integrate knowledge, which are essential tasks for learning (Mayer, 2005). The “flicking” described by learners may be a result of trying to reduce the amount of knowledge to be stored in working memory. By “flicking” a learner commits a small amount of knowledge to working memory then shifts to practise with working memory spare to manipulate and integrate knowledge thus increasing cognitive ability to learn.

Integrating demonstration and practice was perceived by learners as being an improvement. This would eliminate the need to flick between the educational resource and the software to be learned. An integrated system would also still allow for the moving between demonstration and practice, noted as a practice undertaken by the majority of those interviewed. This integration would need to happen on both a physical and pedagogical level.

To integrate demonstration and practice on a physical level requires the media used for demonstrations and the tools to be practised on to be integrated. No such media exist at present to support this integration by default. Physical integration could however be achieved by creating a new medium, by modifying an existing medium, or by integrating existing media. How this functions, however, needs to be informed by pedagogical considerations.

To integrate demonstration and practice on a pedagogical level should be the foremost consideration. The result of this will most likely dictate how the physical integration will happen and characterise a 3D CG SDL resource. As highlighted by Renkl’s (2005) examination of integrating worked examples and PBL, integrating demonstration and practice does not result in sound pedagogy. One therefore should not attempt to form a new educational practice based on integrating demonstration and practice without considerable commitment. As such, it would be far more efficient to find an existing educational practice fitting these criteria.

The preferred use in 3D CG SDLs of worked examples and problem-based learning highlight worked-out examples as a good educational practice for integrating demonstration and practice. This practice however has not been researched in the context of 3D CG education. While a concern, this is a common problem applicable to most pedagogy as there is little research on best practice for 3D CG education.

6.4.2 Screencasting

The responses collected from those interviewed would seem to indicate that learners perceive that screencasting is easier to learn from. This is most likely due to the screencasts being easier to comprehend as they relate more directly to the context and presentation of the information being transferred.

The ease of comprehension afforded by screencasting in comparison to other media can be attributed to 3D software's complex and dynamic UIs. The complexity of a 3D software's UI makes it very difficult to describe without references. The dynamic elements of a 3D software's UI mean that not only is it difficult to understand without visual reference, it is also difficult to understand without a time-based medium to capture the ever changing states of a UI. These two factors lead one to require a time-based medium that represents a 3D software's UI. Screencasting is such a medium.

The ease of comprehension could also be attributed to dual coding theory. Screencasting naturally integrates audio narration with moving image, therefore abiding dual coding. The mouse acts as a flashing mechanism in its default state, highlighting areas on screen as the artist demonstrates and narrates.

The controls afforded by screencasts are discussed in section 6.4.5, varied skill levels and orientation.

6.4.3 Practice

Learners felt negatively about how practice is facilitated by 3D CG SDL. All interviewees stated the importance of practice when learning 3D CG artistry, yet felt that practice in SDL resources was not clearly defined or adequately provided for.

Screencast resources often state that practice can be conducted by first watching a video then attempting to mimic the actions in the video. This results in learning by mimicking, noted by many of the interviewees. The problems with this approach as perceived by those interviewed were such things as the flicking outlined in the preceding section and having no way of checking the practice confidently.

The learning by mimicking in 3D CG SDL, while perceived as important, was also perceived to be poorly implemented. The preference shown by both learners and publishers for screencasting may be the root cause of this. Screencasting does not allow for construction of knowledge, therefore will limit the kind of practice that can be administered through it. This is because screencasting, being a form of recorded lecture, operates under the objectivist learning model. Learning by doing, which learning by mimicking is encompassed by, and problem-based learning operate on the pedagogical assumption that learners need to construct knowledge to learn. This pedagogical assumption is not supported by the objectivist learning model. To implement these types of educational practice, media that can support the

constructivist learning model would be more suited. Both learning by doing and problem-based learning also require some form of learner support. Screencasting alone, however, does not allow for this.

Another problem noted by learners who used learning by mimicking was that there is no way of knowing if your practice is correct. Learners perceived several problems with this. First, learners can never be sure that what they have done is correct. Second, learners may be reinforcing knowledge incorrectly through practice. Third, learners may identify problems but have no access to answers. Learners reported these problems caused a lack of confidence in their practice. This is an area of concern, as there is a well-established link between achievement and self confidence in education (Davis, 2000).

Given the link between confidence and achievement and the lack of confidence imparted by the inability to check work, it can be assumed that it would be of benefit to learners to include mechanisms that allow for more confident checking of practice. This would result in greater learner confidence and therefore higher levels of achievement. An interviewee also highlighted a need to not only know if something is wrong, but what is wrong with it and how to remedy the situation. The mechanisms therefore must also provide feedback on incorrect answers. Screencasting does not support these features so its use needs reconsideration as a 3D CG SDL medium.

PBL was perceived by learners as being another important practice when learning 3D CG arts. The question used to initialise PBL can be presented in almost any medium without any serious concern. However, PBL requires learners to be supported, which learners perceive is not happening. This is discussed in detail in the following section.

6.4.4 Help

Learners feel there is a lack of access to help when learning from 3D CG SDL resources. This is interesting as there is plenty of free access help for 3D CG SDL. This perception of a lack of help could be for several reasons. First, as highlighted by the preceding section, there is no way to check practice confidently. Secondly, learners may not be aware of available help resources. Third, learners may not value the various help systems available. Fourth, learners do not embrace help systems as they tend to be external to the learning space.

Learners are sometimes not be aware of the help systems available. This can be assumed because learners voiced the desire for help systems which are already available and completely free. This could also be interpreted as learners' unfamiliarity with help resources.

Another potential reason for desiring more help is that learners do not value the current help systems: as P3 commented, people *"just kinda blow them off"*. The reason for lack of perceived value in the available help systems could be a result of wanting face to face help or being accustomed to face to face help. It is known that the ability of a person to respond is far greater than any SDL resource at present (Gibbons & Fairweather 1998). This may cause learners to undervalue other sources of support and feel unsupported without a teacher.

The key to overcoming both potential reasons for desiring help that already exists is advocacy for the existing help systems. This can be achieved by including in the introduction messages of 3D CG SDL resources the importance, value and functionality of existing help systems. It may also be beneficial to explain that even though this type of help is not as effective as a knowledgeable person, it is still of benefit to learners. Including exercises that require learners to use existing help systems may also be beneficial. Additionally, feedback provided on practice can point learners to help systems for more information. Also, 3D CG SDL resources could include a help area that highlights existing help resources and explains how they can be used.

The lack integration of help systems into the learning space may also contribute to the desire for help. This could be overcome by integrating help into the learning space. This could be done by providing dynamic links to help from the learning space and providing feedback on practice as both help in its own right or through linking to help.

6.4.5 Skill Level and Orientation

The learners interviewed contradicted each other when discussing the pace of learning and the level of detail desired in 3D CG SDL resources. This leads to the assumption that learners have varied skill levels. This can be seen manifested in the desire for greater control in adjusting the level and pacing of materials. This however requires that learners not only have the ability to control their learning but are well informed so as to understand the decisions they are making. These ideas can be seen in the themes of video, varied skill level, and orientation.

Control can be facilitated in a number of ways. Already in prolific use are video navigation controls seen in screencasting. Menus are also commonly used and allow for learners to navigate quickly and precisely. One learner asked for a more detailed menu in the form of an index. Any navigation features such as these will be greatly appreciated by learners as they grant learners control. Such controls would also help support learners because seeking for specific information is made easier, which would aid in referencing for problem solving.

Aside from controls for moving through linear paths, learners can be presented with non-linear learning paths. Bersin (2004) gives one such approach called the core and spoke model. This is where a core educational unit is surrounded by optional educational units. This approach to course design affords learners the ability to choose what they wish to learn within a SDL resource. This also can allow for learners to have as concise or elaborate lessons as they desire. The desire for diversions by some learners would be facilitated by such an approach. With 3D CG artistry's split into specialised fields, the core and spoke model can also be used to help learners to focus on only the specialised knowledge they require for their chosen specialty.

Mechanisms that helps improve a learner's ability to gain orientation should be used. Interviewed learners signalled a desire for this. This is not surprising, as gaining orientation is a crucial first step when a learner seeks to self-manage, as occurs in SDL. Gibbons & Fairweather (1998) explain the steps a learner undergoes as: seeking orientation, evaluating status, forming goals, planning action, executing action, and again seeking orientation. Gibbons & Fairweather (1998) state that orientation can come

from maintaining familiar landmarks, making the instructional strategy as salient as possible, and by clearly stating instructional goals. Orientation can be assisted by including the discussed controls, by providing landmarks, and by making a SDL resource as consistent and therefore predictable as possible.

6.4.6 Online and Offline

Online media is not perceived as appropriate for 3D CG SDL. While online media is proven in other disciplines, in 3D CG SDL it is perceived negatively by learners. This is due to its inability to support a minimum level of visual detail required by learners to comprehend what is happening on screen without lagging. Every learner interviewed felt strongly about this. This problem's root is the speed at which data is delivered over the internet.

Data can only be delivered over the internet at a set rate. If the data rate of a video is larger than the data rate of transfer over the internet, a video will continuously have to stop and buffer. This is commonly referred to as lag. The common solution to video lag is to reduce the amount of data needed by video. Data size of video is directly affected by resolution and compression. Most online media for educational purposes can usually afford to compromise on either resolution or compression to keep their data rates low. 3D software UIs do not allow for low resolutions or compression to be used as it distorts the fine detail found in 3D software's UI beyond a visibly recognizable state. If a learner cannot discern information that is being transferred visually, then it can be assumed they will not learn. As such, until internet data transfer rates increase or video compression is better optimised, online media will not be appropriate for 3D CG SDL.

An alternative recommended by those interviewed may be to use offline media such as DVDs. These can support much greater resolutions with far less compression as they are not limited by the speed at which data can be transferred over the internet. Interviewee's views on offline media are also echoed in the choice of the majority of 3D CG SDL resource providers using off line media too.

6.4.7 Currency

The rapid evolution of 3D CG artistry and the youthful nature of the field result in new practices, techniques and tools being created all the time. This results in educational resources becoming obsolete within a couple of years of their creation. Therefore, if undertaking the designing of a 3D CG SDL resource one must consider how to cope with the speed at which its material will outdate.

Two strategies can be seen in commercial 3D CG SDL resources at present to cope with the short shelf-life. The first strategy is to use cheap media that can be disposed of and replaced with only a small cost. This strategy is applied in 3D CG SDL resources that use screencasting, which are replaced every few years with entirely new screencasts. The second strategy is to make resources that are updatable. Books such as *[digital] Lighting and Rendering* authored by Jeremy Birn, an author mentioned by two of the interviewees, written in year 2000 and updated in year 2006, provides an example of an updatable resource.

6.4.8 Teachers

The difference between a "good" teacher and a "bad" teacher, based on the descriptions collected from learners, can be summarised as depending on a teacher's demeanour and preparedness.

The demeanour of a recorded lecturer can have a negative effect on learners. Foul language can offend and upset. Offended learners do not learn well. Aside from this seemingly obvious point, also brought up was the overuse of humour, or “joking around”. According to Gibbons & Fairweather (1998) using humour can build confidence, attract interest, re-energise learners, and increase student attention. However, overuse of humour or “bad” humour can overpower the educational message, offend learners, and becoming irritating. It is therefore important to keep a professional demeanour when recording lessons.

Preparedness was the other issue brought to attention. A lack of preparedness can see learners waiting for coherent messages. This proves frustrating for learners. This can be easily overcome by having recorded lecturers prepare before their lessons. Gibbons & Fairweather (1998) recommend the use of story boards, scripts and tables for capturing content. As the recordings are capturing live performances, it may also be beneficial to rehearse.

6.5 Summary

This research used interviews to collect qualitative data on learner’s experiences and perceptions of 3D CG SDL. It did so by interviewing five participants and asking them about their experiences of 3D CG SDL, in what context these experiences had arisen, and how the situation could be avoided or improved upon. Five participants were selected, based on the guidelines of the Nielsen-Lauder formula for usability testing, as this would capture a diversity of answers while minimizing repetition of responses.

The interviews were analysed using Colaizzi’s (1978) guidelines for analysis. This saw data transcribed and understood, significant statements highlighted, meanings formulated for each significant statement, formulated meanings clustered into themes, exhaustive descriptions written for each theme, and the exhaustive descriptions verified by the interviewees.

The results provided nine themes which were then discussed. First, the desire for integration of demonstration and practice was identified. Second, learners perceived screencasts as the best medium for 3D CG SDL. Third, practice was perceived as both important to learning 3D CG arts and problematic as there is no way to confidently check work. Fourth, learners desired help systems that already exist. This could be caused by a lack of awareness of the help systems, the perceived lack of value of present systems, or the lack of integration of help into the learning space. Fifth, learners had varied skill levels and therefore had different learning needs. Sixth, learners desired mechanisms for orientation and greater control. Seventh, online material is not appropriate for 3D CG SDL. Eighth, resources outdated therefore 3D CG SDL should be disposable or have the ability to be updated easily. Ninth, teachers can have a negative impact on learners if they are not prepared, use vulgar language, and overuse humour.

7 Recommendations for 3D CG SDL

The following is a list of recommendations based on the results and discussion of the literature and the data from survey and interviews. This list of recommendations is designed to directly apply to 3D CG SDL and will be used as a guide for the practice-based research component of this research. It was produced by taking the results and discussion of the interviews and turning them into actionable points.

Recommendations:

1) Integrate demonstrations and practice.

This needs to happen on both a pedagogical level and physical level.

This requires the integrating of the following factors:

- Objectivist learning model's ability to transfer procedural knowledge efficiently and effectively.
- Constructivist learning model's ability to facilitate much deeper knowledge and develop tacit skills.
- Problem based learning.
- Learning by mimicking.
- Screencasting.

2) Provide several mechanisms to check practice and to provide feedback.

3) Advocate and educate learners on available help systems.

4) Provide learners with controls.

- Video controls.
- Navigational features.
- Provide a non-linear lesson path.

5) Present professionally.

- No vulgar language.
- Offer positive humour and restrain from negative humour.
- Prepare lessons in advance to recording.

6) Provide means for learners' orientation.

- Provide a menu.
- Provide an index.
- Start videos with sign-on messages.
- Provide landmarks.
- Present materials in a consistent fashion.

7) Provide means for both offline and online delivery.

8) Build resources that can be easily updated or replaced at low cost.

8 Conceptual Design

The design of a proof of concept was undertaken to provide an opportunity for creative synthesis, as suggested by heuristic research. This allowed for thought processes to be observed, documented and described while creating the proof of concept. Most importantly, the practice-based component not only tested conceptual ideas but delivered direct insights and knowledge about a functional 3D CG SDL resource that theoretically cannot be fully established.

Conceptual design is typically the first phase undertaken in the creation of products. The common steps in this phase are the creation of ideas, exploring the intentions of these ideas, and representing these ideas and their intentions. Therefore the conceptual design phase was selected as the initial phase for the practice-based research elements of this research project.

For the purpose of this research study, only the creation of ideas and their associated intentions was undertaken by the conceptual design. The representation of the ideas and their associated intentions was left until the construction of the proof of concept has begun. The decision to postpone the representation of ideas and their associated intentions was made because the authoring software's at this point of time were still unknown. The selection of the technology used to create the proof of concept does not occur until after the conceptual design, thus making any representations now mere guess work. To avoid having to guess what the technology may afford now, the representation of ideas happens later, concurrent with the creation of the proof of concept. This allows for more accurate representations, which will enrich this research.

8.1 Ideas and Intentions

Following are the conceptual design ideas and intentions noted for the 3D CG SDL proof of concept.

Of the recommendations made in chapter 7, two provide a starting point for the design of a 3D CG SDL resource. These are 1) the recommendation to integrate demonstration and practice, and 2) the recommendation to provide non-linear lesson paths. Both can be thought of as foundational recommendations as they dictate the structure of the 3D CG SDL resource. Given this, these recommendations will most likely have the most influence on how the 3D CG SDL resource will operate.

The recommendation to integrate demonstration and practice first requires pedagogical integration to be considered, as this will dictate how the integration on the physical level will happen. Integration of worked examples, PBL, and learning by mimicking can be achieved by using worked-out examples. This educational practice allows for both the transfer of knowledge and the construction of knowledge. Worked examples require constant switching from demonstration to practise and back again in steps. These steps are whole sub-procedures in a much larger procedure. This means the switching between demonstration and practice will happen at naturally occurring breaks in the larger process. This is important to this research, as it identifies that demonstration and practice do not need to blend together, just be made to function together.

The first consideration in the physical integration of demonstration and practice is which media will be integrated. With the physical aspects of integration dictated by the need to function together, but not

blend together, it seems meaningful to use two media, one for demonstrations and the other for practice. This decision allows for one medium to be selected that supports an objectivist learning model and another that supports a constructivist learning model. Screencasting, the first medium selected, will be used to transfer knowledge as outlined by the recommendation for integration. Simulations will also be used to provide learners opportunities to construct knowledge while providing learning by mimicking and PBL, as outlined by the recommendation for integration.

Worked-out examples will need adaptation to fit the media chosen to provide demonstrations and practice. This is expected as the pedagogical practice, although developed to teach procedural knowledge, is aimed at teaching mathematics as text supported by images. A stated limitation of the worked-out examples is that not enough research has been done in other domains. It was noted that initial trials were showing success in the field of therapy using recorded discussions (Renkl, 2004). This shows that while not yet applied to 3D CG SDL, one can potentially transfer this educational process to other domains and media.

The adaptation of the worked-out examples to screencasting and simulations needs to maintain the same goals. These are outlined by Renkl (2004): to make salient solution steps and sub-solution steps, to teach in a way that allows understanding of structural features, facilitate self-explanation, provide help systems that support learner self-explanation, integrate elements so as to not divide a student's attention, and, most importantly, use sequences of examples faded into practice.

To make salient the solution steps and sub-solution steps, tasks need to be broken down into small units. Each unit will contain material on a step or sub-solution step needed to complete a larger task. Each unit will be contained within one stand-alone screencast or simulation.

Each solution step unit will contain information, where appropriate, on associated structural features. This requires the principles used in solving or executing a step to be discussed. To facilitate this, diagrams can be edited into screencasts as digital slides. Slides within screencasts were noted as a being a positive experience by learners during the interviews (see section 6.3.2).

By providing sample questions and their solutions, self-explanation is facilitated by worked-out examples' default nature. This teaching practice encourages a learner to try to make sense of step by step demonstrations of problems being solved. Learning is then reinforced by removing solution steps and replacing them with exercises that a learner must complete as the fading progresses. Mechanisms that check answers and provide feedback also provide opportunity for learners to self-explain, as they are encouraged to comprehend and, in some cases, apply corrections. Providing help, as directed by the recommendations, will also aid in self-explanation. Learners with the intention to self-explain may seek information within help systems.

The proposed 3D CG SDL resource will include two menus that act as help and support, aiding learner self-explanation. These menus also allow for control and provide learners means to gain orientation. A traditional menu of the material contained within the 3D CG SDL resource will be provided, with topics listed as they occur. Also an index menu that displays all topics in alphabetical order will feature. The index will dynamically link to all knowledge contained within the 3D CG SDL resource.

Learners will be encouraged to use 3D CG software application-specific help files. These files include details on the procedures for every tool and operation. The information contained is not related to any particular context, so as to provide default and neutral technical explanations. The different viewpoint contained in the help files will help students to self-explain, as they will need to impose their own context on the information to make sense of it. The 3D CG SDL resource will also introduce external resources such as CG society, Creative crash, and The Area. Similarly to help files, these help resources will provide different perspectives, encouraging learners to self-explain as they impose their own context on the information to make sense of it.

Visual and audio elements need to be integrated to avoid the split attention effect. This can be achieved through the use of screencasting. 3D CG SDL screencasts by their default nature promote integration of audio and visual elements. This is because on screen mouse cursors will act as a flashing mechanism. To elaborate, the person driving a 3D CG SDL screencast usually narrates what they are doing while the mouse cursor does it, achieving integration. In the unlikely case integration does not occur naturally, additional flashing mechanisms can be used to draw a learner's attention to integrate visual elements with audio narration.

Integration of elements within simulations for the 3D CG SDL resource cannot be achieved without negative implications. The simulations need to provide practice as learning by mimicking and PBL, as stated in the recommendations. To do this, the simulation must be an accurate representation of the 3D CG software to be learned so as not to introduce incorrect habits as an artefact of the 3D CG SDL resource or display false schema while practicing. Integrating elements within simulations for practice would create falsified experiences. This is due to 3D CG software UIs' dynamic display constantly changing to adapt to varying selections and situations. Integrating elements would need to freeze 3D CG software UIs to integrate elements and therefore display a false schema. For this reason, integration will not be attempted in the simulations.

Perhaps the most important factor of worked-out examples is fading, where instruction moves from supplying worked examples to PBL by gradually replacing solution steps with problems (see Figure 3-1). Worked examples can be achieved using screencasting. Implementing PBL requires a problem, direction, and support to solve it. The problem and direction require no special consideration to be implemented, as simple on-screen text can achieve this. Support is offered through the ideas described in the preceding paragraphs. The faded steps are more complex. They require the physical integration of demonstration and practice to be considered. They also require consideration of how the fading will happen in successive steps while still following the recommended guidelines to provide non-linear lesson paths.

Two ideas were devised for how the integration of demonstration and practice could happen. *First*, two media could be overlaid in a seamless environment. Learners would be presented with a screencast that looks and functions identically to an underlying 3D CG simulation to facilitate demonstrations. Practice would be facilitated by bringing the simulation to the front of the screen, turning control over to a learner. When it is time for another demonstration the screencast could be brought back to the front of the screen, overriding the simulation controls. By matching visually the screencast to the simulation it

would appear to a learner to be one seamless environment that facilitates both demonstration and practice while still using two media. This strategy would have the benefit of appearing to have only one interface. However, this one interface would have to be added to the 3D CG software package being simulated. It would require a time line and significant modification to the existing UI. This would present a false schema and run the risk of developing incorrect habits as an artefact of the 3D CG SDL resource. Also, when learners come to use the actual application being simulated, the absence of the UI additions may be confusing and troubling.

The *second idea* to integrate demonstration and practice would be to switch between the two media, showing that they are separate systems. Demonstrations would be followed by a switch to simulations then back again. This would allow for the two media to be tailored to the type of content and educational practices they contain. Simulations therefore could be kept as accurate as possible. This would avoid imparting false schema, as theorised in the first idea for integration. This strategy would afford an easy approach to construction of the proof of concept as tasks could be broken down into smaller, more manageable, parts. Care would have to be taken, however, as this strategy has potential to suffer the same flicking problem described by learners. This negative implication can be overcome by ensuring demonstrations are short enough to avoid overloading learners' working memory.

The second strategy for physical integration of demonstration and practice offers the most flexibility, and provides simplest approach. Therefore the second strategy aligns more closely with the recommendation that 3D CG SDL resources be easily updated or replaced at low cost. For this, reason the second strategy was selected over the first.

Providing non-linear lessons was stated as desirable in the recommendations. An examination of instructional ordering was conducted as to best understand what non-linear approach would be best suited for this design concept. Bersin (2004) states that there are two approaches to ordering e-learning. These are the program flow model and the core and spoke model. These two approaches should not be thought of as separate as they can be blended to accommodate what learners need.

The program flow model is what learners are most familiar with. It is how most New Zealand high school curricula are structured. In this model the curriculum is step by step and organised chronologically. Each chapter or step builds upon the previous. Learners navigate the material in a linear fashion. The benefits of this approach are: creating deep levels of commitment and thus higher completion rates, enabling progress to be tracked easily, it fits with what students expect, and it is easy to adapt and modify (Bersin, 2004). This ordering does not meet the recommendation for non-linear education; however, as stated earlier this model can be blended to create a non-linear arrangement.

The core and spoke model uses a single training approach surrounded by supporting materials. The supporting materials can be optional or mandatory and can be encountered in almost any order. The benefits of this approach are: it has greater flexibility during design phases, it serves self-motivated students, and the supplementary material can be specialised for learning only what is desired or required by some learners. This model provides a non-linear arrangement of learning materials.

For the proposed 3D CG SDL resource, elements of each model would be beneficial. Identifying these elements and trying to maintain the strength they create will guide how the blending of the models will take place.

- Getting a learner to finish a piece of work is important. This was identified as important through the interviews as it builds self confidence. It additionally has merit as it improves a student's workflow. This requires the application to have the ability to walk a learner from start to finish through a project in a linear fashion like a program flow model.
- Some tools and techniques found in 3D software require that knowledge of other tools and techniques is known first. For example, to extrude a face one must first know how to select a face. The program flow model can provide information that is ordered so as to build upon itself.
- Learners have varied skill levels. Advanced learners may wish to know more about the tools and techniques they are using or skip material if they have prior knowledge of them. This can be facilitated by a core and spoke model.
- Learners may identify they do not need or want some knowledge, as highlighted in the interviews conducted. For example, a set modeller may not want to watch videos on facial modelling and wish to skip this material. A core and spoke model would afford learners this ability.

While there are many more points that could be explored, the four points above allow for a good overview to be extracted on how the blended model for the proof of concept 3D CG SDL resource should function. A linear lesson path of some sort is required. This linear path can be derived from a real world task and turned into a walk-through. Off this core lesson path will be non-linear lesson elements or diversions that allow for extra learning to take place if a learner so desires. These diversions can cover basics that more advanced users may wish to skip, extra material for struggling learners, advanced information, and niche information not required by all learners using the 3D CG SDL resource.

With an overview now established on how the non-linear lesson paths will operate, the adaption of fading required by worked-out examples can be finalised. Renkl's (2004) stated way to conduct fading is to have successive steps that incrementally reduce a series of worked examples demonstrate steps by replacing the steps with problems to be solved. This however presents problems when translated to the proposed 3D CG SDL resource as it appears to conflict with the recommendation for non linear lesson paths.

To overcome the conflict between worked-out examples and non-linear lesson paths, I propose there will be two directions for ordering educational units. First, a linear lesson path will be included. This will provide walk-throughs of tasks, ordered chronologically to a greater task. Second, fading will happen at a tangent to the linear path through non-linear paths accessed through diversion points in the linear path. The tasks to be faded will be sub-procedures rather than complete tasks. As a welcome side effect, this approach will benefit learners with prior knowledge, as they can skip the initial steps of the fading and move directly onto the more advanced ones without disrupting the flow of the lessons.

8.2 Summary

Conceptual design is introduced and defined through creating ideas, exploring the intentions of these ideas, and representing these ideas and their intentions. As the technology that will be used to create the proof of concept has not been selected at this stage, the representation of ideas can not be undertaken with confidence.

The conceptual design identifies the recommendations to integrate demonstration and practice and provide non-linear lesson paths as key to establishing the foundation of the proposed 3D CG SDL resource. Worked-out examples are identified as a means to integrate demonstrations and practice on a pedagogical level. Screencasting and simulations are selected as the media for demonstrations and practice. Physical integration is identified as possible by switching between screencasts and simulations. Blending linear and non-linear learning paths results in a hybrid model of linear lesson paths with non-linear diversions.

9 Technological Considerations

This chapter translates the recommendations and conceptual design into the technologies that produce a functional learning resource. This phase in the research helps achieve the explication and creative synthesis phases of heuristic research. This chapter discusses the proof of concept, tools selected to achieve the proof of concept, and the trials of the selected tools.

9.1 3D CG SDL Resource: Proof of Concept

A 3D CG SDL resource proof of concept is attempted by this study so as to conduct practice-based research, aligning with heuristic research's suggestion for creative synthesis. A proof of concept was chosen over a prototype or the construction of a full working 3D CG SDL resource. The intent of practice-based research within this study is to illuminate and answer the outlined research questions – in particular, how the improvements will translate into the technology used for SDL. All that is required to achieve illumination and answers is a proof of concept.

The conceptual design asks for screencasts and simulations to be integrated. No software at present can offer these two media with the level of customization required to achieve the proof of concept. Three ideas were theorised to overcome the lack of customization. First, a new software package could be purposefully created. Second, a single software package could be modified. Third, two software packages, one for screencasts and one for simulations, could be modified to work together. The third choice was selected as it provides the simplest approach, aligning it with the recommendation to build resources that can be easily updated or replaced at low cost.

Using two software packages raises the issue of how integrate them and how to provide navigation. In order to resolve this issue, a "container" for these media will be used. This container will encapsulate both media and also facilitate the ability to navigate the two media. CBI was selected as the container as it can contain most digital media and affords linear and non-linear lesson paths.

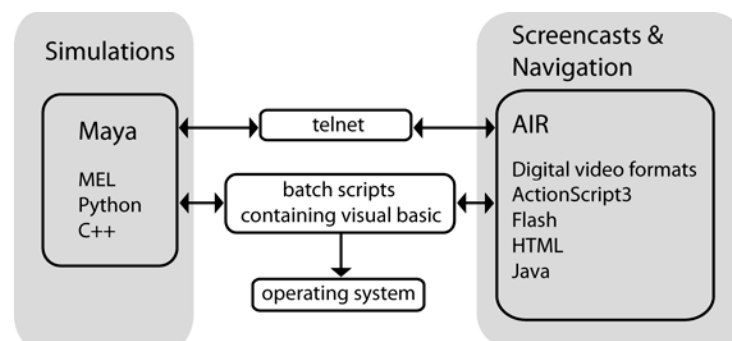


Figure 9-1. Schematic of selected tools and how they will integrate.

9.2 Tool Selection

The tools selected will have a significant impact on the design of the proof of concept. This can be said as it has been identified in the conceptual design phase that the simulations will be kept as close as possible to the software they simulate. Therefore, certain factors such as UI elements will be inherited from the software to be simulated.

The first software selected is the one that will facilitate simulations. Implementation of simulations comes first as they are the most technologically complex element to be used in the proposed 3D CG SDL resource. The most practical way to create simulations is to use an available 3D CG tool, rather than build a new 3D CG software that mimics an already existing tool. Autodesk Maya is one such existing tool, and will be used as the simulation software. Maya is commonly used in industry and also affords a high level of customization. Maya allows most features to be changed through the use of its own internal language, MEL, or through the use of Python (CGsociety, 2011). All features that cannot be changed by MEL or Python can be changed through the Maya API in C++. As all the tools for practicing 3D CG are available to a learner in Maya, creating simulations only requires UI additions that allow for direction and feedback, and additional scripts to load and configure exercises.

The second software package needs to accommodate screencasts and CBI's interactive components such as navigation features, and have the ability to communicate with Maya. The software also needs to communicate with the local operating system (OS) so as to facilitate switching between the two separate softwares so they can work together. Adobe AIR was selected to accomplish these tasks. The AIR runtime enables developers to use HTML, JavaScript, Adobe Flash, and ActionScript 3 to build stand-alone client applications. AIR is one of Flash's runtime environments, with the ability to install as an executable to allow for greater system access. The system access afforded by AIR will be used to switch between itself and Maya. AIR also allows for the hosting of telnet sessions, which will be used to communicate with Maya.

Telnet is a communication protocol commonly used for accessing remote computers. For the purpose of this study the telnet communication is simply one program talking to another on an isolated machine. The decision to have the software communicate via telnet was one of flexibility and ease of implementation. This protocol has the power to feed commands in each program's native language to each other without any modification to either software. As an added bonus it can very easily be used to allow separate computers to communicate or have a host machine communicate to a learning management system (LMS). This opens a range of options to further this research in the future. The decision to use telnet also further reinforces the decision to use two separate softwares to achieve integration of demonstration and practice.

Batch scripts will be used to execute visual basic commands to switch between AIR and Maya. A batch script is a text document containing a list of commands for a computer to follow. The commands contained are visual basic commands, a language used to communicate with Microsoft Windows. This is the simplest and most stable way to facilitate the switching. As this is a proof-of-concept, it was not critical to accommodate other platforms at this point in time.

Techsmith Camtasia will be used for creation of the presentation and demonstration materials. This tool was chosen for its ease of use and power. Creating screencasts and editing them is very simple. Camtasia has the ability to add text bubbles, flashing mechanisms and slides. It can export a range of formats too, such as .flv, .f4v, .mp4, .mov, .avi.

9.2.1 Tool Trials

To ensure the tools selected would both function as expected and work together, two small trials were conducted. First, the tools were used to create elements expected to be seen in the proof of concept in isolation. The tools were then tested to see if they could be integrated in a rudimentary fashion. Similarly, Adobe Captivate can output to swf and provides API hooks to customise your output respectively and integrate it with other Flash-based environments such as AIR.

The first test, designed to test each element in isolation, proved no problem with the exception of the batch scripts. The batch scripts problem stemmed from not being able to execute a command to switch Microsoft Windows focus between programs. A solution was found by including visual basic commands in the batch script. The solution proved very simple and effective.

The second test aimed to achieve rudimentary integration, to ensure the tools could function together. The conceptual design and tools selected show that screencasting, the interactive features of AIR, the 3D abilities of Maya, and a mechanism to switch between AIR and Maya, will need to communicate with each other. This small test verified that the authoring tools were appropriate and could be purposed to the proposed 3D CG SDL resource. The test allowed for consideration of the most difficult technological aspect of integrating the selected tools.

The second test occurred as follows. A screencast was recorded. The screencast was then taken into AIR and given video controls so AIR could control the screencast. Event markers were added to the screencast to allow the time line of the screencast to control AIR. Both the event marker and a button in AIR were then purposed to execute a command to open a Maya file and execute global procedures within Maya. Lastly, both Maya and AIR had a button purposed for executing a batch script containing visual basic commands that switched Microsoft Windows' window focus between the two programs. No problems that could not be overcome were encountered. Therefore this test showed that all the tools could be integrated. It was noted that AIR and Maya were noticeably separate software packages though.

9.3 Summary

This chapter details the technological considerations undertaken so as to translate the recommendations and conceptual design into the technology to be used to create the proposed 3D CG SDL resource. The proof of concept will use two softwares integrated by CBI to provide screencasts and simulations. Simulations will be provided by Maya. AIR will afford CBI and navigational features. Telnet will be used to communicate between Maya and AIR. Batch scripts will be used to change Windows' window focus to provide the switch between demonstration and practice. Camtasia will be used to record the screencasts. Rudimentary integration of the tools was attempted and it was found the tools could be made to communicate together.

10 Proof of Concept

This chapter presents a strategy for CBI authoring, the documentation created from following the strategy for CBI creation, and details of what the proof of concept covered within the strategy for CBI creation. The process is then reflected upon and discussed, followed by a chapter summary.

10.1 CBI Design

The creation of a 3D CG SDL resource proof of concept was undertaken to illuminate and answer the research questions of this study; in particular how the improvements would translate into the technology used for SDL. The proof of concept uses the recommendations proposed for 3D CG SDL (see chapter 7), the conceptual design (see chapter 8), and knowledge from the technological translation (see chapter 9) to guide its creation. This practice-based research aids the creative synthesis of this research study.

CBI is identified in the technological concept chapter as appropriate for containing the demonstrations and simulations required. As CBI acts as the "glue" holding the proposed 3D CG SDL proof of concept together, a CBI authoring strategy will be used for the proof of concept creation.

Gibbons & Fairweather (1998) offer a strategy for CBI creation. The strategy is designed free from media preference and pedagogical stances so as to allow an author the ability to use what is best for a specific task. This strategy is therefore appropriate for this research as it accommodates the media, conceptual design, and technological concepts required by the proposed 3D CG SDL resource.

The strategy offered by Gibbons and Fairweather (1998) is one that has been refined over many years of producing CBI. This process has been modified slightly for use in this research, eliminating reviews by subject matter experts and pilot testing on students as they were not achievable in the given time frame for this thesis. The modified process has 14 phases:

- 1) Select an appropriate instructional strategy.
- 2) Subdivide the strategy into blocks.
- 3) Divide the strategy into content-related blocks.
- 4) Shuffle the content blocks into instructional order.
- 5) Create content tables.
- 6) Add auxiliary features.
- 7) Design the creative overlay.
- 8) Diagram logic blocks.
- 9) Create message tables.
- 10) Channelize messages, specify continuity blocks, and design screens.
- 11) Create production sheets.
- 12) Add production sheet details during production.
- 13) The production stage.
- 14) Test and debug.

These 14 phases overlap in part with the conceptual design in its earlier phases. As such, phases 1 and 2 have had much of their work already completed.

The 14 phases were carried out so that the building of the proof of concept happened parallel to planning of it. This strategy was borrowed from the idea of concurrent engineering, where planning and designing happen parallel to the prototyping of a product (Clausing, 1994). This approach saw the phases not always conducted as linear steps. While this made planning more difficult, it allowed the proof of concept to be built faster and more reliably. Also, this approach allowed the technology used to create the proof of concept to inform the representation of the conceptual design. This was seen as crucial, as the constraints and affordances of the tools to create the proof of concept were not fully tested in the context of this research project.

The 14 phases resulted in materials being generated outside the scope of the research questions. This, however, was deemed necessary to show that due process of a proven method for CBI creation had been followed. This also helped identify which insights needed to be drawn from the proof of concept, and what could be explained in theoretical discourse. For example, it is known that a login page is of benefit to learners to track progress (Gibbons & Fairweather, 1998) and help maintain orientation. This style of login page can be seen commonly in SDL resources. Therefore, building such a page that would be identical in purpose and function for the proof of concept 3D CG SDL resource would not provide new knowledge in the domain of 3D CG SDL. However, the login page would have to be considered first in order to know that it would be identical in purpose and function. Only after could it be concluded that the login page was not required by the proof of concept. This example shows that the proposed 3D CG SDL resource needed to be planned in its entirety to reveal what the proof of concept should attempt.

10.2 CBI Design Documentation

Following is the documentation written while undertaking the 14 phases of CBI creation.

10.2.1 Select an Appropriate Instructional Strategy

The instructional strategy used is discussed in detail in the conceptual design section of this research paper (see chapter 8). To summarise, worked-out examples are used to integrate demonstration and practice. Linear lesson paths are provided with non-linear diversions branching off.

10.2.2 Subdivide the Strategy into Blocks, Divide the Strategy into Content Related Blocks, Design Screens and Add Auxiliary Features

The instructional strategy was broken down into strategy blocks or units. These blocks are facilitators of demonstration (and presentation) and practice. These blocks were then further broken down based on the content they would be accommodating. This was for three reasons. The first is any decisions about functionality and construction relies heavily on the content (Gibbons & Fairweather, 1998). The second was to allow for the planning of any special considerations that needed to be made for the communication between Maya and AIR to integrate demonstration and practice. Third, it allowed for the integration to be planned more thoroughly on a pedagogical level.

While the content-related blocks were being defined, auxiliary features were also being thought through. This was due to the communication that needed to take place between AIR and Maya influencing how the blocks would function. Take, for example, the switching from AIR to Maya. In which block would this switch take place? At the end of a demonstration? Did it require an additional block? To answer these, and similar questions, the auxiliary features had to be considered while constructing the blocks. Also, the auxiliary features were found to play a role in instructional ordering. Therefore, the auxiliary features had to be defined before step 4, shuffling the blocks into instructional order.

Designing the screens was part of step 10. However, it is more meaningful to present the diagrams of the screens and their intentions in this section, where the reader can associate the theoretical discourse of the screens with their associated renderings. The interface elements in each screen are very minimal with the exception of the 3D blocks. The design of most screens was kept simple. Two basic guiding rules were followed when designing the screens. The first was to maintain orientation by positioning interface elements consistently, providing continuity blocks and consistent landmarks. Second, Fitts' law stated the size and distance of an interface element will dictate how quickly it can be accessed (Tognazzini, 1992). Interface elements, such as controls, had to be kept to the edge of each screen to allow room for content. Therefore buttons were made large so as to be easily accessed. The 3D block design was inherited from Maya. The foremost design concern with Maya was to keep added content as far out of the way as possible while practicing to avoid imparting false schema.

The blocks were created as either one-off screens or as template screens. The one-off screens only occur at one point in the proposed 3D CG SDL resource. Every time a learner accesses a one-off screen the contained information remains mostly unchanged. The template screens are designed to follow a predictable pattern, though they have changing content.

The blocks derived from considering strategy, content, screen design and auxiliary features can be summarised as fitting under the following categories.

10.2.2.1 Welcome Blocks

These blocks will be used to initialise the software and welcome learners. One will function as a splash screen and the others will instruct students on pre-learning tasks that must be completed before learning can take place.

There will be four types of welcome blocks:

- A splash screen.
- A welcome note, which is needed as Maya needs to be initialised before continuing. It presents learners with the option to navigate to a login screen or to a first-time user's screen.
- A student login that allows users to register, login, and keeps data on learner progress.
- A first-time users screen with information on setup, use, and how to use help.

Splash Screen

A simple screen will let users know that the software is loading. It will include the software's name, a mechanism to notify users that the software is loading such as a progress bar, a version number, the publisher, and a graphic of 3D CG artwork to inspire learners. The splash screen is important as the software may take a while to load and as such needs a device to notify users that the computer has not frozen (Tognazzini, 1992). Further, this is a chance to include elements of showmanship, as having a well-designed splash that includes impressive 3D CG art work can be used to motivate learners and set a professional tone as outlined in the recommendations. This will be like any other CG software's splash screen. Autodesk Maya 6, 7, and 8 provide good examples of similar splash screens. This screen will only occur once, when the software is first initialised. It cannot be navigated back to.

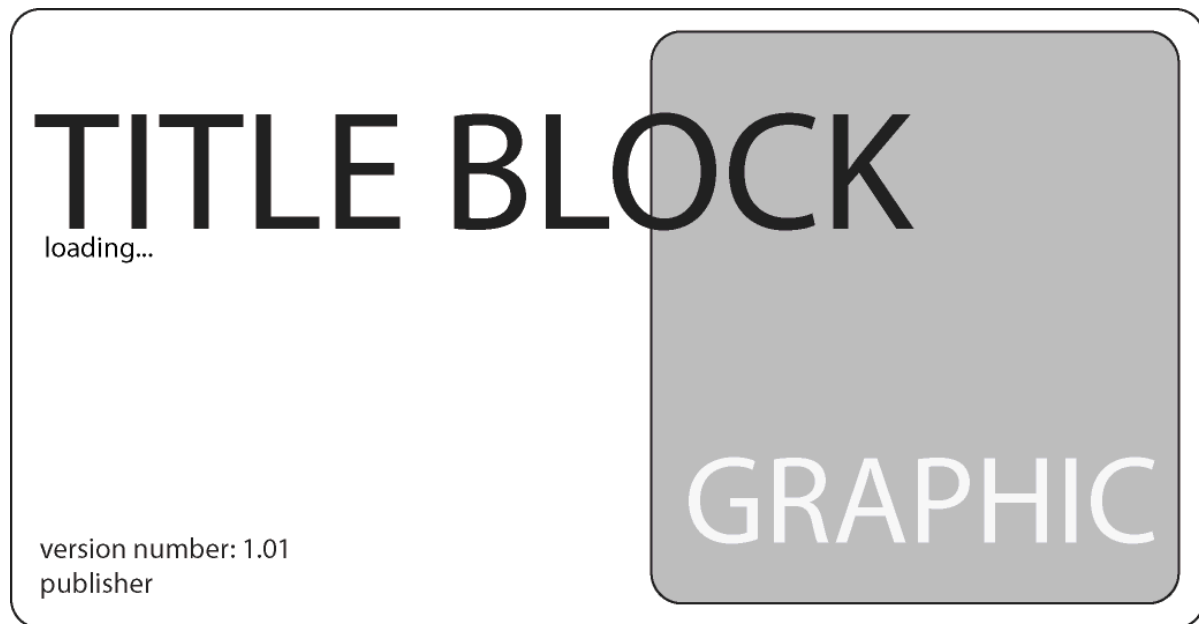


Figure 10-1. Diagram of the splash screen

Welcome Screen

This screen is the starting point of the 3D CG SDL resource. The welcome note serves to remind learners that Maya must be running and any scenes open in Maya will need to be saved. This is due to the software, AIR, linking into Maya and communicating via a telnet session. If Maya is not running when AIR tries linking to Maya then the software will not function correctly and will need to be restarted. A welcome side effect of this screen is that it makes learners aware they are using Maya, so they can be confident that their practice and exploration are relevant.

The starting of Maya could be carried out autonomously, and initially was implemented in this way in the proof of concept. However, this would potentially open multiple instances of Maya, which is a known cause of system instability. Also, if a scene was open in Maya and the proposed 3D CG SDL resource proceeded, there would be the chance of losing unsaved data. Further, it drives home the point to learners that AIR and Maya are separate programs working together. This is important as Maya can become unstable and crash. If a learner knows the software is separate, when a Maya crash happens, learners will be more informed of what is happening and be better prepared to rectify the situation.

The welcome screen's left bottom half works to guide new students to a page that explains setup procedures for the proposed 3D CG SDL resource and how to use the resource. This is important as Maya will need scripts manually placed into a learner's user preferences to function. This task could have been automated when installing the software. However, having a learner manually complete this task presents two advantages. The first is, if there are custom scripts running or that need to be added later, learners know where the code is located and know not to overwrite it. Second, it affords a unique learning opportunity about user preferences, which are essential for Maya artists to know if they are to be effective 3D CG artists. In the case of returning learners, the bottom right of the page is a button to guide them to a login page. This screen is not a template and only occurs once. It can be navigated back to from the student login screen.

Welcome to CGI training

Please ensure that Maya is running. If you have a document open, please save it now and create a new scene. When ready select one of the options below.

First time user

Select if it is the first time you are using this learning tool.

Student login

Select if you are a returning student.

Figure 10-2. Diagram of the welcome screen.

Student Login

This screen enables students to login in order to keep track of their progress. It will have the ability to navigate back to the welcome screen, create new users, allow existing users to select their account, delete existing accounts, export existing accounts, and import accounts. These options will allow multiple users to track progress separately. Having a student login affords tracking of learner progress, which helps learners to form goals and maintain orientation between sessions (Gibbons & Fairweather, 1998). This is especially important as it is not likely that a learner will complete the whole 3D CG SDL resource in one sitting. This screen was included as per the recommendation for orientation. The data recorded on a learner's progress will be displayed visually through the main menu. It is when a student reaches this page that AIR will attempt to establish a telnet session with Maya. This will happen invisibly in the background. This screen is not a template and only occurs once. It can be navigated back to from the menu block.

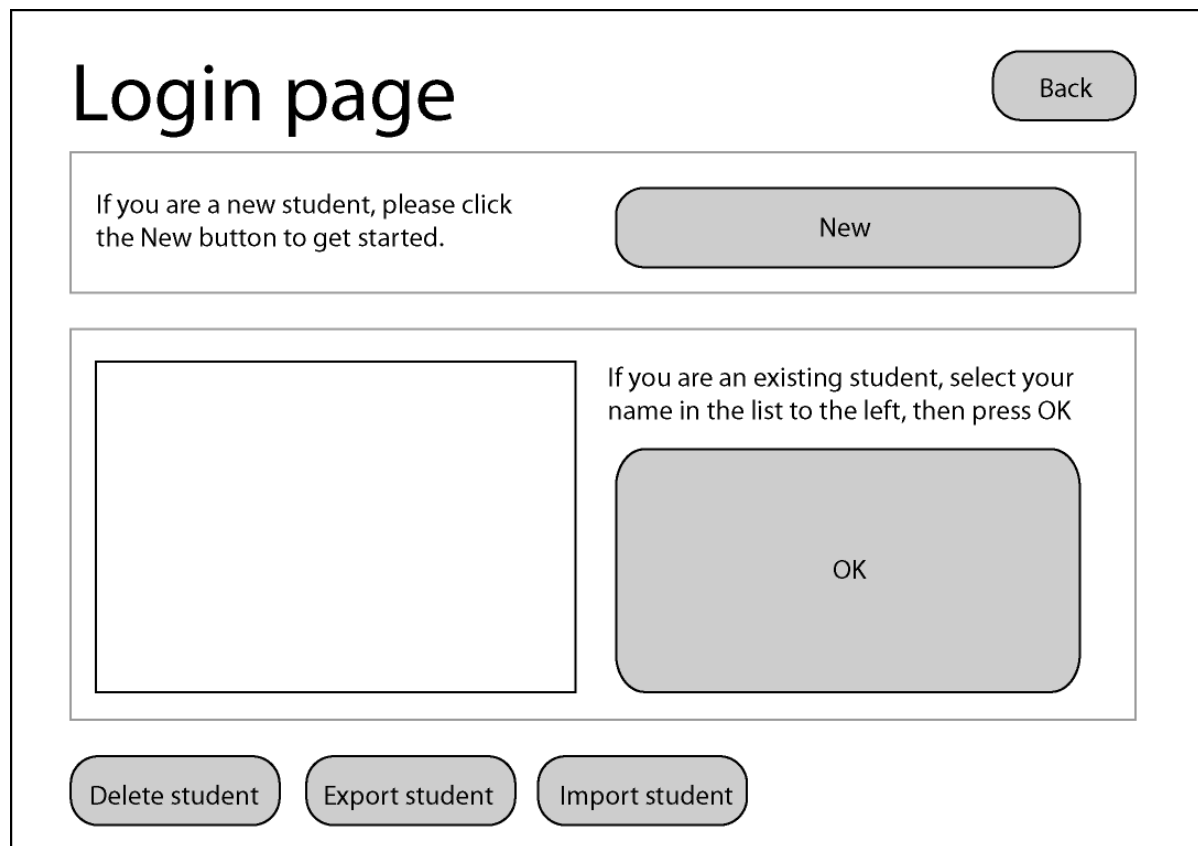


Figure 10-3. Diagram of the Login screen.

First Time Users Screen

This screen will contain two videos. The first will be on how to set up and configure the software correctly after it is installed. It will direct students to where they need to place a script to ensure the communication of AIR with Maya can take place. The opportunity is also taken to explain Maya preferences and script folders as the first lesson. The second video will be a short introduction on how the software works covering the most important points of navigation, the instructional strategies, and how the switching between Maya and Air works. This is of importance as it will inform learners how to take charge of their own education (Gibbons & Fairweather, 1998). Additionally, the instruction included in this video will include a brief introduction to how to use both integrated and external help resources and explain their benefits as advised by the recommendation. This screen also has a back button to navigate to the welcome screen. This screen is not a template and only occurs once. It can be navigated to from the welcome screen.

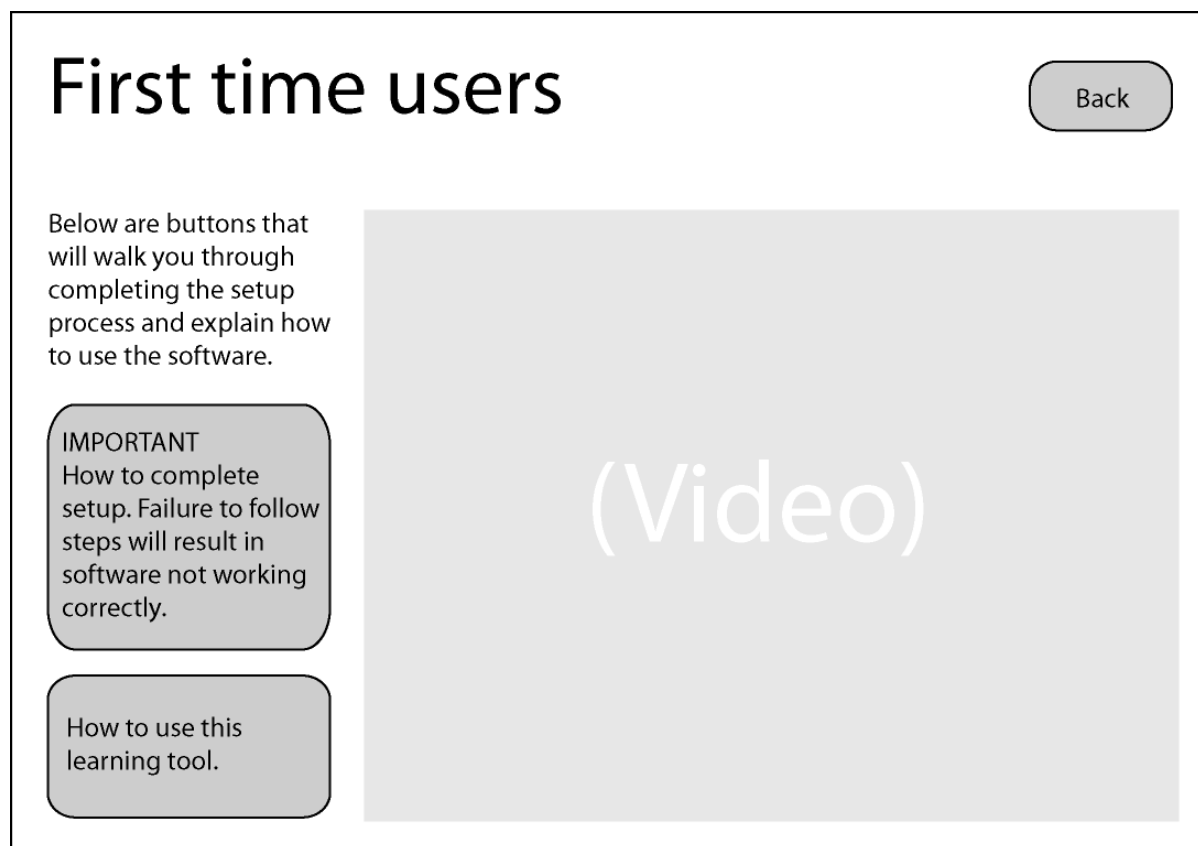


Figure 10-4. Diagram of the first time users screen.

10.2.2.2 Navigation/Menu Blocks

These blocks provide information on each presentation, demonstration, and 3D blocks. Also, they provide information on learning completeness, provide a roadmap of the blocks detailing how and when they can be encountered, and provide a help menu. The navigation blocks therefore service the recommendations to provide a means for orientation and advocate help. These menus also provide learner support, as required by worked-out examples.

There will be two types of navigation/menu blocks.

- The main menu. Data will be presented as a map of all the educational blocks.
- An index menu.

Main Menu

The main menu displays the instructional strategy used, as recommended by Gibbons & Fairweather (1998). This helps learners to orient themselves. All the blocks, and how they can be encountered by following pre-set lesson plans, are presented like a road map. Learners can follow the strategy set by the lesson plans or follow their own learning pathway by clicking only on topics of interest. This menu system provides learners with control. By hovering the cursor over a block icon in the menu, a learner can activate a description for that block. Left clicking will take a learner to that lesson block. The blocks are represented by icons: one type for presentation and demonstration blocks, another for 3D blocks, and lastly one for macro blocks. The icons are dynamic and will change per block once a student has completed it. The icons will use colour and shape to represent their purpose and completion. There will be buttons to allow a user to navigate to the index or to navigate back to the student login screen. This screen can also be navigated to from every block within a lesson path. This screen is not a template and only occurs once. It is automatically navigated to once a student logs in.

Menu

[Back to student login](#)

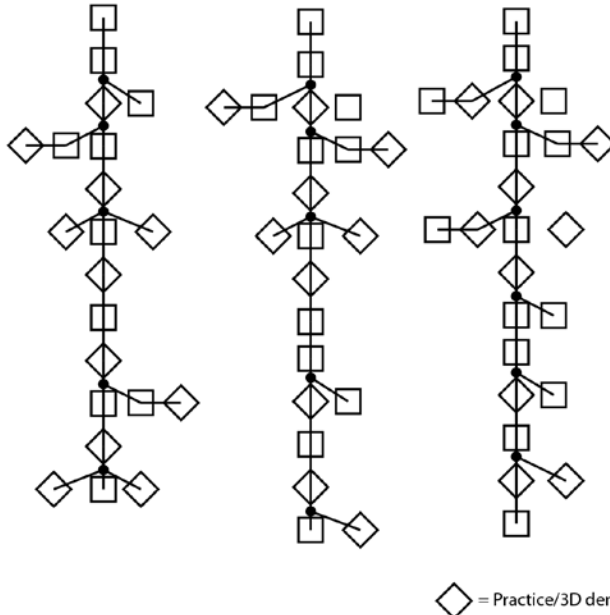
[Topic index](#)

START

Lesson plan 1

Lesson plan 2

Lesson plan 3



END

(This area will provide an explanation of the blocks represented by squares and diamonds when the mouse hovers over them. It will also summarise the entire lesson plan if the lesson plan blocks are hovered over.)

□ = Presentation/Demonstration

◇ = Practice/3D demonstration ● = Alternative path decision point

Figure 10-5. Diagram of the main menu.

Index Menu

The index menu provides a subject list view in alphabetical order of the material contained within the proposed 3D CG SDL resource. It is designed to provide quick access to materials within the resource. It will separate out demonstrations and presentations from simulations by using icons. The inclusion of the index is advised by the recommendation for orientation. Also, this menu provides support for learners, as suggested by worked-out examples. Clicking on either the text or associated icon will take a user directly to that material. It includes a button that will take users back to the menu. This screen is not a template and only occurs once. It can only be navigated to through the main menu.

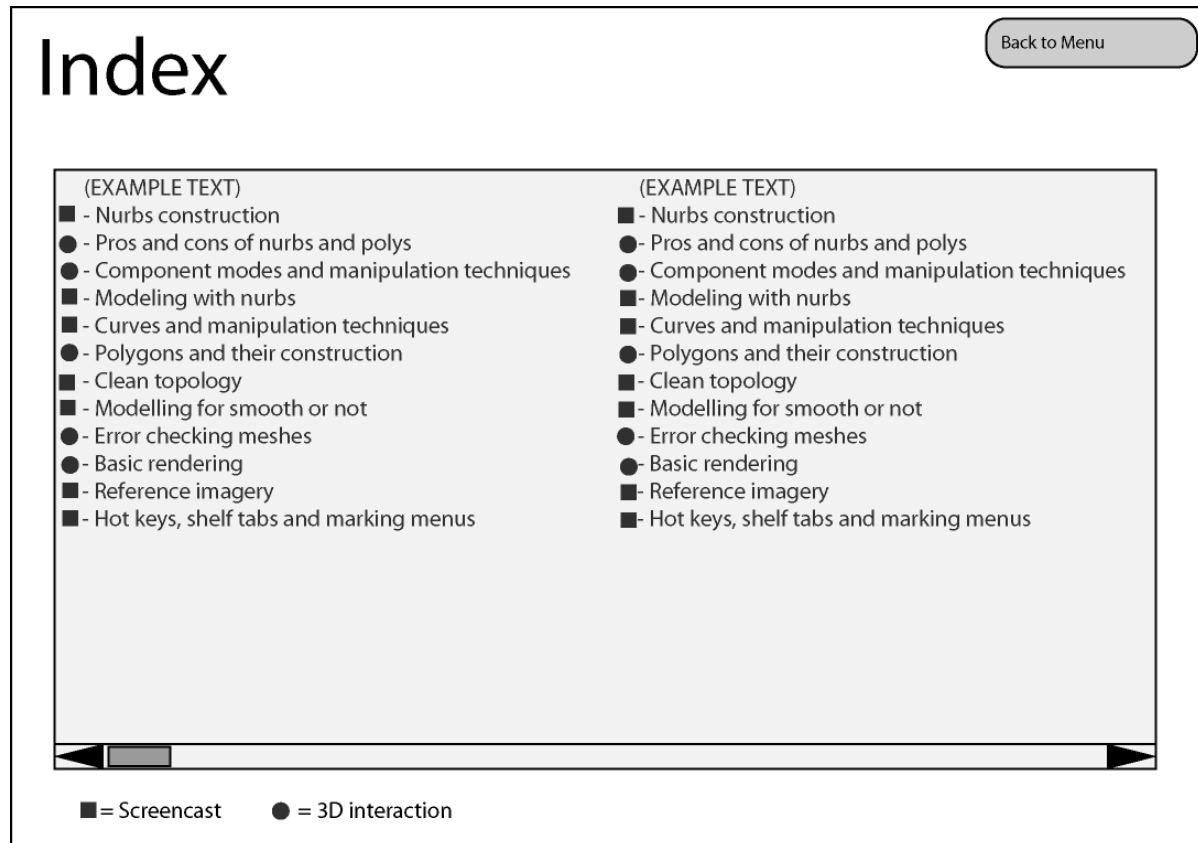


Figure 10-6. Diagram of the index.

10.2.2.3 Demonstration and Presentation Screen

Screencasting, videos, and slides will be used for the purpose of presenting and demonstrating learning material. All material will occur as videos of the same format to maintain consistency throughout the 3D CG SDL resource.

There is one type of demonstration and presentation block. It will be designed to contain the following multimedia content with no change to its structure:

- Screencasts created through Camtasia.
- Slide presentations created through Camtasia.
- Video and audio media of educational merit.

This block for demonstration and presentation may include any of the following: graphics, video, audio, and the use of screencasting. This block provides a platform for screencasts and includes video controls, which are perceived to be beneficial by learners (see section 6.3.2). This block will allow for presentations and demonstrations as videos. The videos will have a time line that will allow a learner to play and pause, as well as seek, by dragging a play head through the timeline. It also includes a volume control. The controls will appear as a water mark over the bottom of the content. This is so students can clearly identify that the controls are only for the video content and will not navigate them through blocks. The videos will fill the screen with the exclusion of a navigation bar off to the right side. This will contain a menu button for navigating back to the menu, a next button. The next and back button will navigate learners through the blocks. These will grey out where appropriate. The bottom right of the screen will contain a display telling users what lesson pathway they are on, what block they are on, and how many there are in total for any given lesson pathway (see Figure 10.5). This provides a lesson landmark that can be used to help assess both completion and how much more there is left to complete of a particular lesson path, helping learners maintain orientation. In the case of supplementary material this land mark will inform users that there is no lesson path. This screen is a template and will occur many times containing varied content.

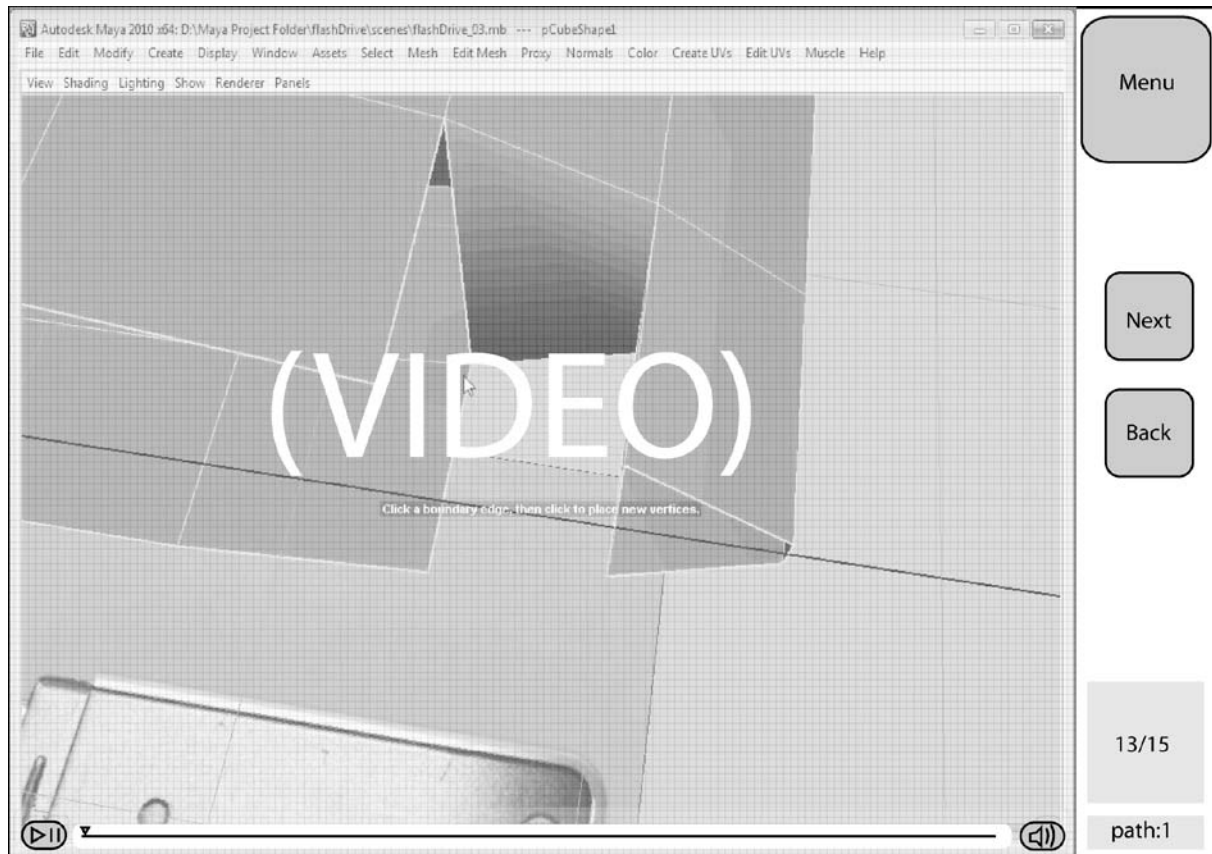


Figure 10-7. Diagram of the presentation and demonstration screen.

10.2.2.4 Switch Screen

The switch screen facilitates the switch between AIR and Maya so as to allow for integration of demonstration and practice as suggested by the recommendations. Originally, this switch was automatic in the prototype. This automatic switch however had potential to confuse learners as the screen changed dramatically, erasing all familiar landmarks. This automatic switching therefore ignores the recommendation on orientation. It also failed to stress that a learner was actually using Maya. By creating a manual switch and a separate screen to contain it, learners are alerted that they are about to switch to Maya and can maintain their orientation. The screen to facilitate the switch is identical in look and function to the presentation and demonstration screens so as to maintain familiar landmarks. The only change is that where video and its associated controls would appear, there is now text explaining the switch and a button to initiate the switch. The navigation bar on the right of the screen will maintain the same functionality as in the demonstration and presentation block. This screen is a template and will occur many times.

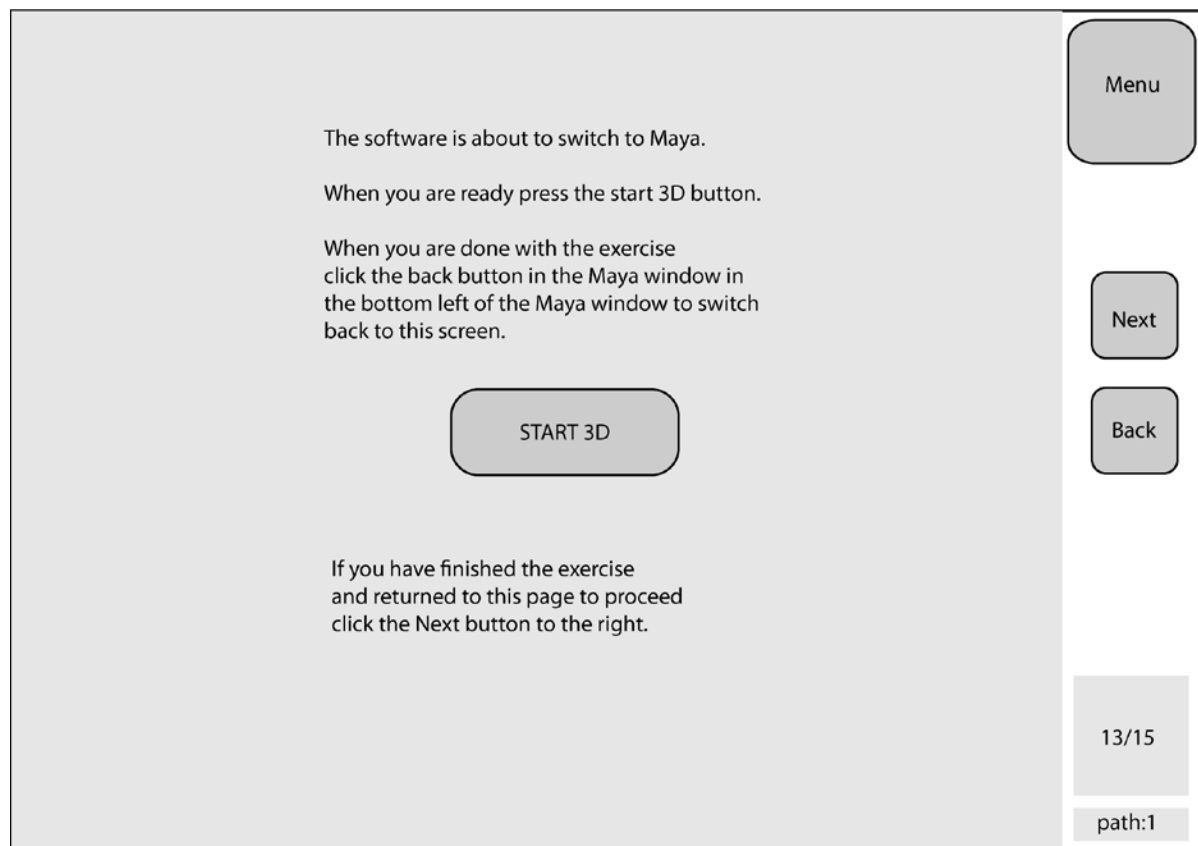


Figure 10-8. Diagram of the switch screen.

10.2.2.5 3D Blocks

The 3D block provides simulations in Maya. It displays objects in 3D space with manipulation tools, affords practice of 3D procedures with feedback, affords practice with a comparison model, and allows practice without feedback.

There will be one type of 3D block. This block will have one interchangeable pane that will allow for functionality specific to a simulation's content. There will be four variations of the pane.

- › A pane that facilitates the demonstration objects in 3D space.
- › A pane that can check actions have been performed correctly and provide feedback on exercises.
- › A pane that will open an example answer for students to compare work without feedback.
- › A pane that can facilitate multiple choice answers with feedback.

The 3D blocks take advantage of Maya's default work space. Exercise or demonstration files are automatically loaded and the UI automatically configured. This block aims to provide practice as learning by mimicking and PBL, as suggested by the recommendations. These two forms of practice are used to conduct the practice suggested by worked-out examples faded steps. The only difference between using Maya normally and the simulation is that there will be an extra free-floating window available. This window will have the facility to be minimised or moved. It will be divided into three sections. The first section contains a written recap of what is expected of a learner. The second facilitates error checking, reveals example answers, or provides multiple choice options. In the case of providing an example file that requires no user input as a demonstration, this section will be left blank. The third section will have a button to facilitate the switch back to AIR for when learners wish to proceed. The proof of concept originally provided this block by integrating it into the existing workspace. This however resulted in a falsified experience and presented false schema. This window will serve as a template for all 3D exercises and demonstrations.

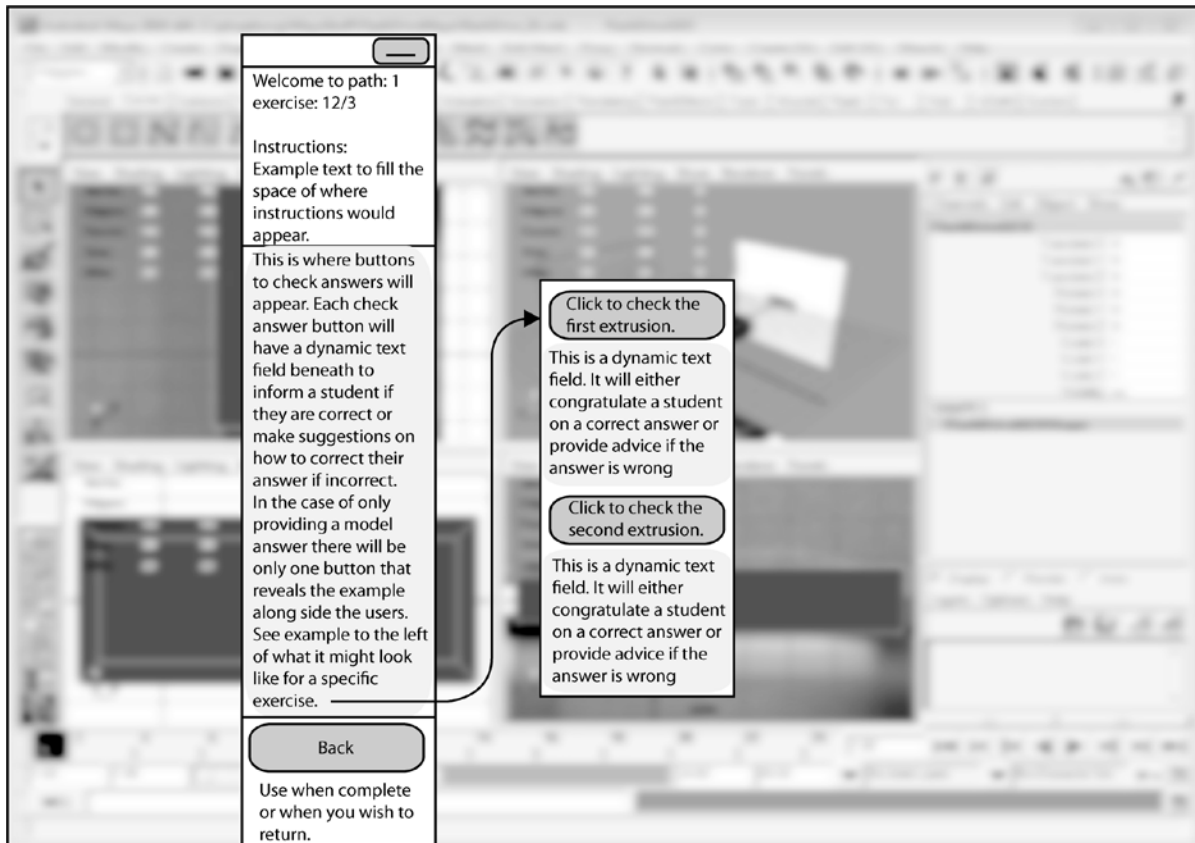


Figure 10-9. Illustration of the 3D block's screen.

10.2.2.6 Macro Screen

There is only one type of macro block, which will facilitate the following:

- › Navigation and selection of learning pathways.
- › Allow for prerequisites to be stated.
- › Offer supplementary, niche, novice, and advanced lesson topics to a learner.

As the name suggests, this screen allows for out-of-lesson decisions about how learning will occur. It provides learners control to navigate through material. Macro screens accommodate learners' varied skill, as they act as diversion points from a lesson path to provide non-linear learning. They inform prerequisites of the lesson path, allow novice learners to detour into extra lessons, allow advanced learners the ability to explore more complex ideas, allow more advanced learners the ability to confidently skip lessons, and can be used to provide niche information that all learners may not require. Macro screens maintain the landmark of the menu bar to the right of the screen, found in the presentation and demonstration blocks. A continue button is provided to move a learner to the next block. There are also buttons that allow learners to select diversion paths. Information on each diversion option available is provided so learners may orient themselves. This is a template and can be navigated to via the menu and from 3D blocks and demonstration and presentation blocks.

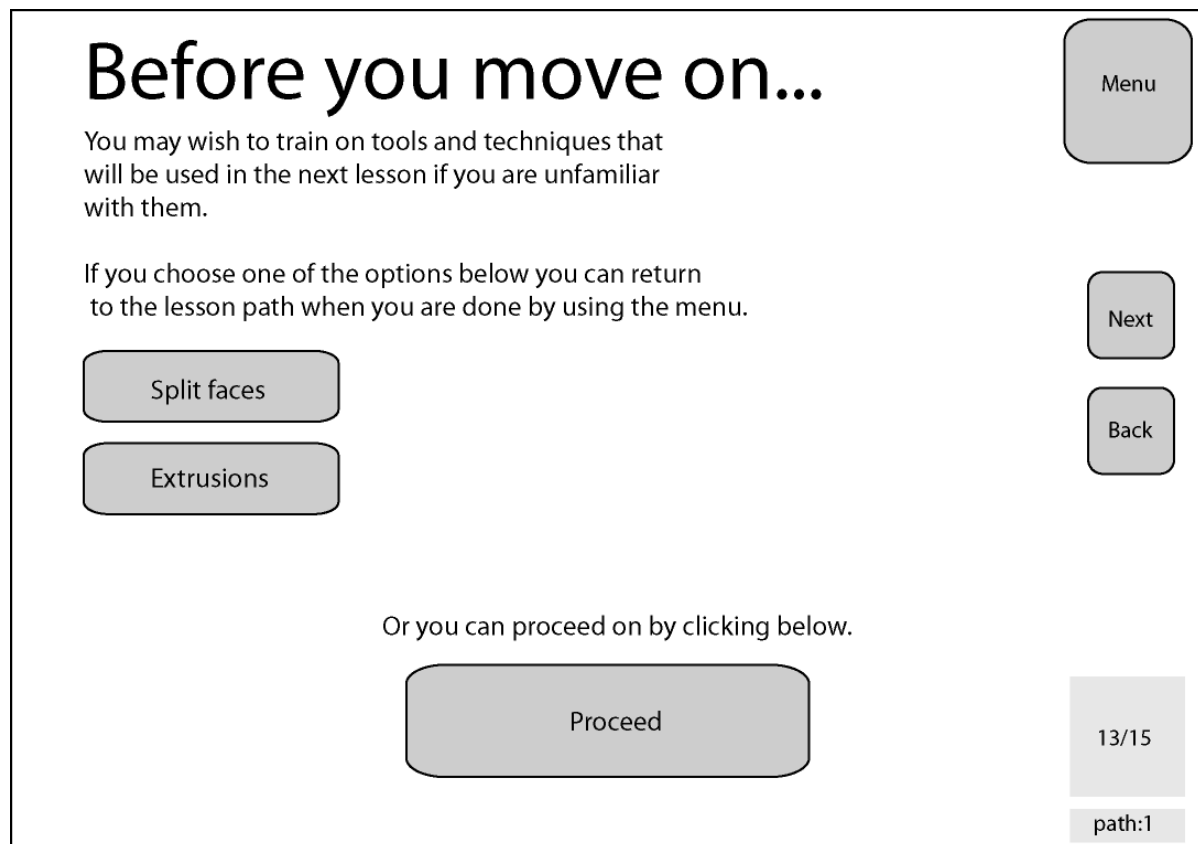


Figure 10-10. Diagram of the macro screen.

10.2.3 Shuffle Content Blocks into Instructional Order

The instructional ordering of the blocks applies the instructional strategy outlined in the conceptual design to the content blocks. The instructional strategy selected for use is worked-out examples. Breaking down an entire 3D exercise into sub-procedures required by worked-out examples results in many sub-procedures. Fading these sub-procedures one, two or even three at a time would require many linear lessons one after the other to shift a learner completely from worked example to problem based learning. This would see learners moving slowly through very repetitive lessons. Instead, the fading works by recognizing the sub-procedures and fading them over two to four blocks across separate learning paths. This means the fading does not require large amounts of sequential lessons.

As described in the conceptual design chapter, there will be lesson paths that provide a linear lesson for achieving a greater task. Throughout the linear lesson path will be points where learners can make decisions about what materials they want to learn. These decision points provide diversions from the lesson and form non-linear lesson paths. These can be used for supplementary educational materials. Additionally they can be used for the basic explanations of procedures and tools. This way advanced learners can skip past novice materials, while novice learners have access to the education they need.

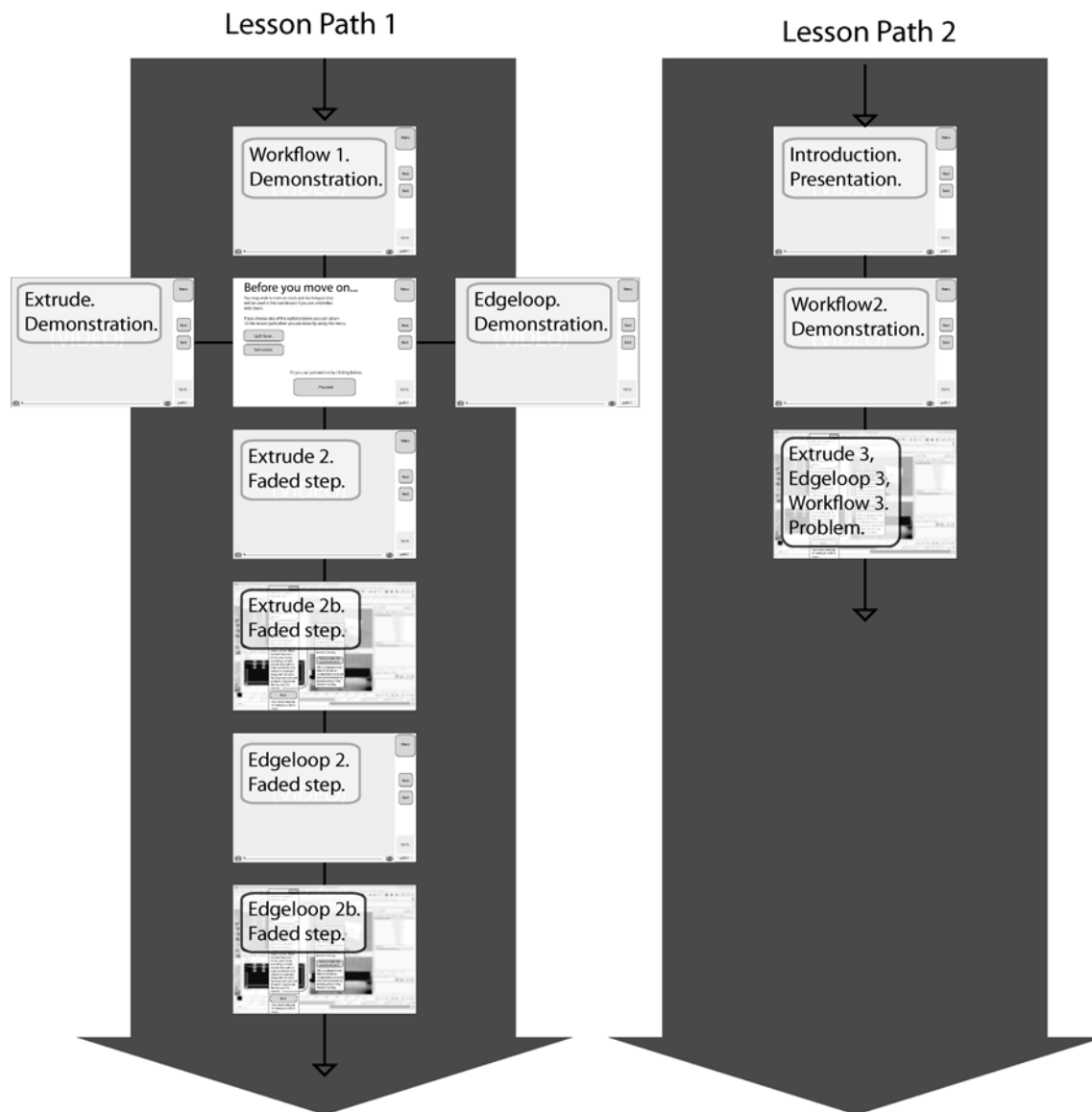


Figure 10-11. Diagram of the lesson paths and worked-out examples.

10.2.4 Creating Content Tables.

To capture content, Gibbons & Fairweather (1998) recommend the use of tables. Content tables can be used for evaluating the clarity, precision and completeness of content. The checking of content is important before authoring material, as CBI is not an intelligent system able to recognise mistakes or gaps in knowledge within its own instruction and amend them. For example, in a classroom situation, teachers can easily correct learners if there are errors in material or missed knowledge. CBI however does not have this function. If knowledge is not complete within CBI, learners will be forced to struggle on with no means for correction. This has potential to derail a 3D CG SDL resource, as it may reinforce bad habits or interfere with learner motivation when learners cannot achieve. Content tables also ensure teachers are well prepared to present professionally. Content tables are influenced by the type of performance being taught, therefore they inherit their structure from the nature of the content to be captured. Two content tables will be used for the gathering and refining of content for the proposed 3D CG SDL resource. These are the procedure-using content table and the concept-using content table.

The procedure-using content table takes advantage of the fact that most procedures are made up of steps that are common among most procedures. What constitutes a step within a procedure can be deconstructed and documented. As 3D CG arts require many procedures, these table will capture most of the content required for the proposed 3D CG SDL resource.

Category	Content
Step 1	
Step Name	This cell contains the name of the step.
When	What the initiation cue is that alerts a user that a step can or must be performed.
What	Information on the action that is performed in this step.
Where	Used to locate the appropriate controls or feedback.
Why	Rationale and intended outcome of the step.
See, Hear, Feel	Clues or evidence which will occur as a result of the step alerting one to step effectiveness or success, secondary indications that are a result of step action but not a sign of success, and non-associated indicators.
Meaning	An overview of what is happening as a result of the step action.
Warning	An overview of actions that will lead to adverse effects.
Technique	Mannerisms that are required to perform the step.
Emphasis	Highlight the importance of the step or procedure.

Table 10-1. Gibbons & Fairweather's table for capturing procedure content. In the place of the column entitled "content" is "rationale" for each category.

Category	Content
Step 1	
Step Name	Prepare for extrusion.
When	When you are modelling with polygons.
What	Follow the procedure for selection of a component or components to select a face. Ensure the viewport camera is at an angle that allows for easy viewing of the extrusion when it comes time to extrude the face out.
Where	In the viewport.
Why	When you require more geometry or topology.
See, Hear, Feel	If a face is correctly selected it will be highlighted.
Meaning	We are selecting a face for extrusion.
Warning	Sometimes when selecting faces, you may select faces on the opposite side of the mesh. Doing so will result in unwanted geometry.
Technique	N/A
Emphasis	Ensure that the right faces are selected. Incorrect face selection can result in extra geometry that will require you to undo the whole procedure and start again, or if missed may be quite difficult to remove at later stages of modelling.
Step 2.	

Step Name/Number	Ensure the state of the option keeps faces together.
When	Before executing the extrude operation.
What	Either check or uncheck the option for keep faces together on or off depending on whether you wish to extrude multiple faces as if they were one face or if they were separate faces.
Where	The option keep faces together is found in the modelling menu set under the edit mesh drop down menu.
Why	Depending on the results desired you must ensure the keep faces option is set to what you require.
See, Hear, Feel	When keep faces together is selected will see a tick next to the keep faces together option and the edit mesh menu.
Meaning	Before executing an extrusion, Maya needs to know how it will extrude faces.
Warning	Having this option wrongly set will result in extra unwanted geometry. This can be hard to spot as the extra geometry usually occurs inside a mesh.
Technique	N/A.
Emphasis	This option must be set correctly as the extra geometry or lack of it may be extremely difficult and time-consuming to fix if not spotted early. As a reminder for beginners it can pay to ensure the keep faces together option is always checked on as the majority of extrusions will require this setting. In the rare event that a beginner will need this option checked off they can tear away the entire edit mesh menu to remind them that keep faces together is checked off. At the end of the procedure they can check the option back on then close the edit mesh window.
Step 3.	
Step Name/Number	Initiate the extrude.
When	You have the correct face/s selected.
What	Select extrude from the polygon marking menu or from the edit mesh menu.
Where	The polygon marking menu that contains extrude can be accessed through the viewport by holding down right click and pressing shift, then to access extrude move the mouse down over the extrude option then release the mouse click. This menu will only be available when a polygon face or faces is selected. Alternatively one can select the extrude option from the modelling menu set under the drop down menu edit mesh.
Why	This will create new polygons from existing faces.
See, Hear, Feel	On entering the extrude tool one will see a manipulator and the viewport that is a combination of the move tool and scale tool.
Meaning	New geometry has been created and is ready to be manipulated.
Warning	Do not stop here. At the moment the new geometry created has zero area in 3D space and is not visible. The extruded face needs to be manipulated in the next step. It is important to move onto the next step, as the leaving faces with zero face area can cause huge problems that can be both costly and time-consuming to fix. Spotting faces is virtually impossible through sight.
Technique	Upon executing the extrude command move on to the next step as quickly as possible so as not to leave faces with zero face area.
Emphasis	N/A
Step 4.	
Step Name/Number	Manipulate the new geometry.
When	Immediately.
What	Use the extrude tool manipulator or the standard move, rotate, and scale tools to transform and reshape the new polygons.
Where	The face or faces highlighted in the viewport.
Why	To both ensure you do not leave faces with zero face area and to ensure the shape of your model is correct.
See, Hear, Feel	N/A
Meaning	N/A
Warning	As mentioned in step 3, ensure the face is moved so as not to cause faces with zero face area. If at this point you notice the extrude had the wrong option selected for keep faces together you can hold down control shift and right click and choose toggle keep faces together from the resulting marking menu in the viewport.
Technique	N /A
Emphasis	This is the last step. You are finished.

Table 10-2. An example of the procedure table used to describe how to extrude a polygon face.

A concept-using content table captures information on concepts and structural features. It includes an area for description of a concept and a table that defines examples and non-examples. Concept-using content tables were used to think through presentations. Presentations occurred predominantly as slides with narration defining examples and non-examples within presentation and demonstration screens.

Concept definition	Provide a definition for the concept.
Example 1 Describe example: Here you describe the example intended for use. It can be anything from an image to an abstract concept.	Non-example 1 Describe non-example: Here you describe the non-example intended for use. It can be anything from an image to an abstract concept.
Non-Defining attributes: List of attributes that differ from example to example that do not affect the concept but may likely be confused too.	Describe missing attributes: List the attributes missing from the non-example that prevent it from being an example.

Table 10-3. An example of a concept-using content table with rationale for each category.

Concept definition	Working in passes. Where workflow in 3D follows progressive steps, or passes, in achieving a similar standard across the whole task at each pass. This maintains a consistent level of detail across a piece of work as it is built up. This speeds up later stages of a task, ensures work is in balance, and minimises wasted effort.
Example 1 Describe example: A sequence of images showing progress of a basic drawing from start to finish. The level of detail increases at a uniform rate across the whole picture.	Non-example 1 Describe non-example: A sequence of images showing a basic drawing where working in passes has not been followed to contrast example 1.
Non-Defining attributes: The amount of steps. The specific steps taken in creation of that drawing.	Describe missing attributes: Levels of detail in areas of the drawing progress at different rates rather than uniformly.
Example 2 Describe example: A sequence of images showing the progression of a model from start to finish.	Non-example 2 Describe non-example: A sequence of images showing the progression of a model from start to finish that has not been modelled in passes
Non-Defining attributes: The amount of steps. The amount of faces or verts.	Describe missing attributes: Levels of detail in areas of the model progress at different rates rather than uniformly.

Table 10-4. An example of a concept-using content table describing working in passes.

10.2.5 Design Creative Overlay

Designing the look of the software presents a chance to inspire, motivate, and present professionally. The aesthetic design of this project was by no means a priority. However, it was felt that this is a phase in the creation of a CBI resource so should be undertaken so as to understand its importance. On reflection, little was uncovered in this step that advances the field of 3D CG SDL and it did little to enrich this research. This step is included in this thesis to show that the CBI creation strategy was followed.

It is important to keep the design of the interface muted when not demanding attention so it does not distract from the instructional content. The aesthetic considerations are therefore kept to a minimum to

allow the content to be predominant. Colours, a theme, and font were decided upon then overlaid on the visual descriptions of each block to create the aesthetic look of the proof of concept.

First, a colour scheme was chosen that would tie all elements together. It was decided to use a palette of black, white, and red. These colours relate to 3D CG arts as they are commonly used in 3D CG paraphernalia such as Maya's and CG Society's visuals. Black and white are used as the standard interface colours. Red acts as a highlight, used to draw attention to the interface when required. The black and white in reality are roughly a grey 15% and a grey 80%. This reduces contrast and pushes the interface into the background. Red is used as a rollover colour to highlight clickable items and make them more discernable. This palette is also visible to the colour blind.

These colours were used to replicate a carbon fibre look. This look has a low brow appeal frequently seen in amateur 3D CG work. Background empty space is filled with a carbon fibre texture with an extremely muted black gradient overlay to mute the contrast more. All buttons consist of this same carbon fibre texture. To make them stand out they have a gloss effect added over the top to feign the appearance of clear coat and height. The aesthetics of all buttons throughout the proposed 3D CG SDL resource follow this design so as to be recognisable through consistency.

Type face is consistent throughout the resource, using three point sizes occurring as two fonts. A single sized, high impact, bold, futuristic font is used for the titles. The bodies of the text use two sizes of Myriad Pro. This increases readability. The stylised title font draws attention to important core information. Less important bodies of text will use a plainer, sans serif font with all emphasis on readability. The bodies of text use two point sizes to allow headings and text needing emphasis to be set apart. If the carbon fibre theme which the text is set against is too overpowering, a black tinted background can be used to provide more contrast between the font and textures.

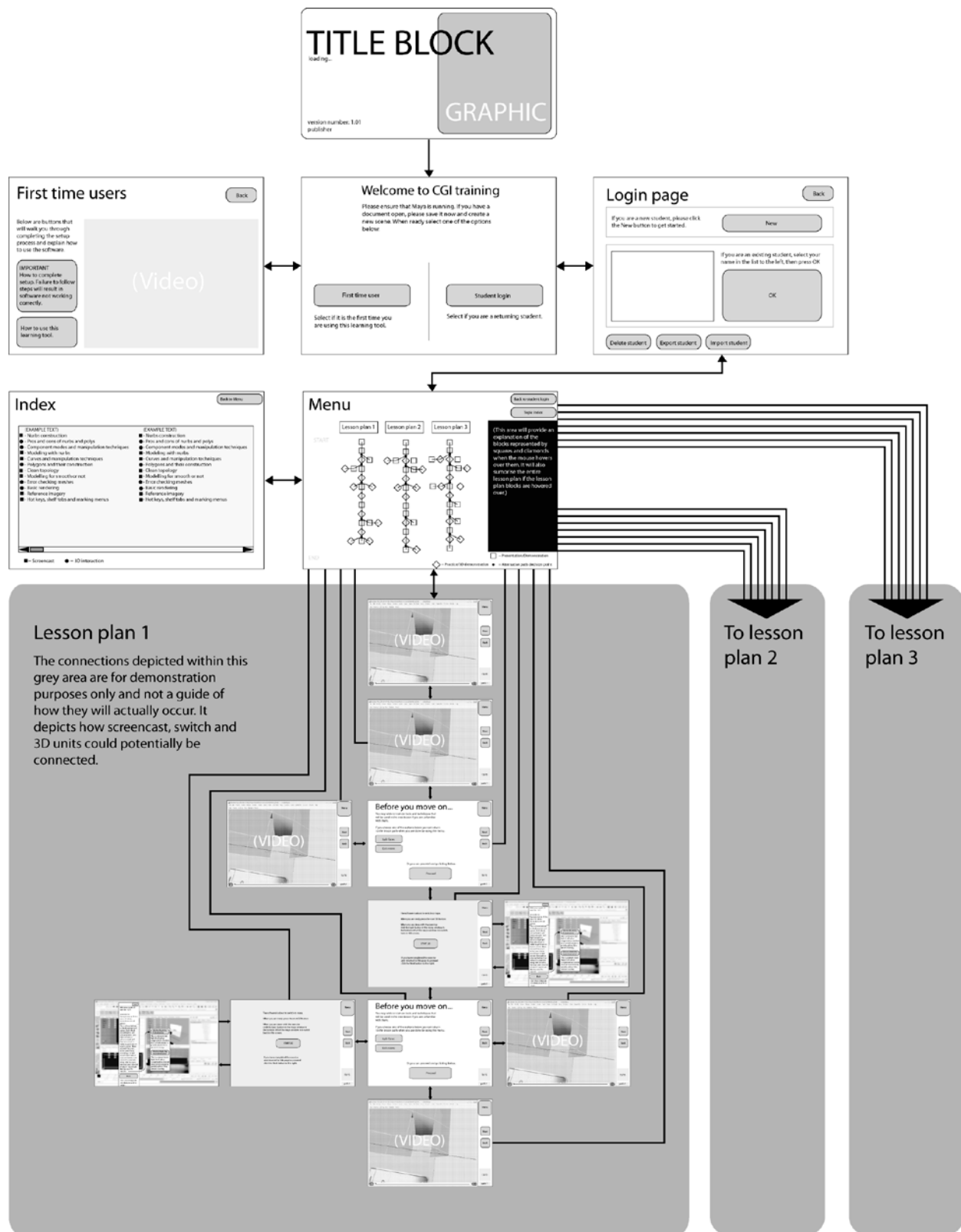
The aesthetic design of each screen follows how they are visually described earlier in the diagrams in this chapter with the exception of the 3D blocks and splash screen. The 3D blocks, scripted in MEL, offer very little flexibility for visual design. While everything was constructed consciously, the majority of the visual elements are inherited from Maya and cannot easily be changed. Therefore, designing any aesthetics that deviate from Maya's default look would go against the recommendation to build resources that can be easily updated or replaced at low cost. The splash has full aesthetic freedom other than keeping within the size constraints and palette. The splash provides opportunity to design motivational and inspirational 3D CG art.

10.2.6 Diagram Logic Blocks

The logic of the features within the proposed 3D CG SDL resource need to be diagrammed to provide a plan for the programming that would be required. Despite how large the proposed 3D CG SDL resource is, there is a comparatively small amount of logic diagramming required. This can be attributed to most of the interaction's logic being simple enough not to warrant diagramming. For example, the next button's program logic did not need to be diagrammed. By clicking next you simply move forward one block, so diagramming this provides little new insight.

Logic diagrams were created for the following: how each block can be encountered, the 3D blocks containing practice with feedback, the 3D blocks containing practice with a model answer, the 3D blocks containing demonstrations in 3D space, the 3D blocks containing multi-choice answers, and the student login logic.

The logic of how each block is connected and is encountered was diagrammed. The first attempt to diagram this logic revealed features past the login are navigational. The proposed 3D CG SDL resource had become a slightly more labour-intensive slide presentation or an exercise in learners digitally turning pages. Bersin (2004) warns of this effect, as learners will go into auto-pilot or become bored and unfocused. This problem was solved by including frequent and significant interaction, achieved by including 3D blocks approximately seven minutes apart from each other where possible. Also, macro screens are used to provide learners with decision points that break the feeling of page-turning. Additionally, the menu allows users to navigate how they choose through the material rather than reading from front to back like a digital book.



The 3D blocks need to be created in Maya, a tool not intended for authoring learning activities. The logic had to be carefully considered in terms of achievability. MEL was evaluated and chosen as the programming language to conduct exercises. MEL affords the ability to easily examine the construction history of objects in Maya. Construction history refers to Maya's architecture creating nodes for every tool and procedure executed. This creates an incredibly detailed account of how an object is created that can be called upon by simple MEL commands. The construction history is used to check learner input by using conditional statements. This technique allows all attributes not only to be checked, but checked within a tolerance. The inclusion of MEL programming in the proposed 3D CG SDL resource meant that the 3D blocks could not be replaced at low cost so would therefore have to be easily updatable, so as to adhere to the recommendations. All programming was subsequently written in a modular fashion so as to be reusable. A welcome side effect of this is that this code has the potential be turned into a tool and provided to 3D CG SDL authors who cannot program; however this was not attempted.

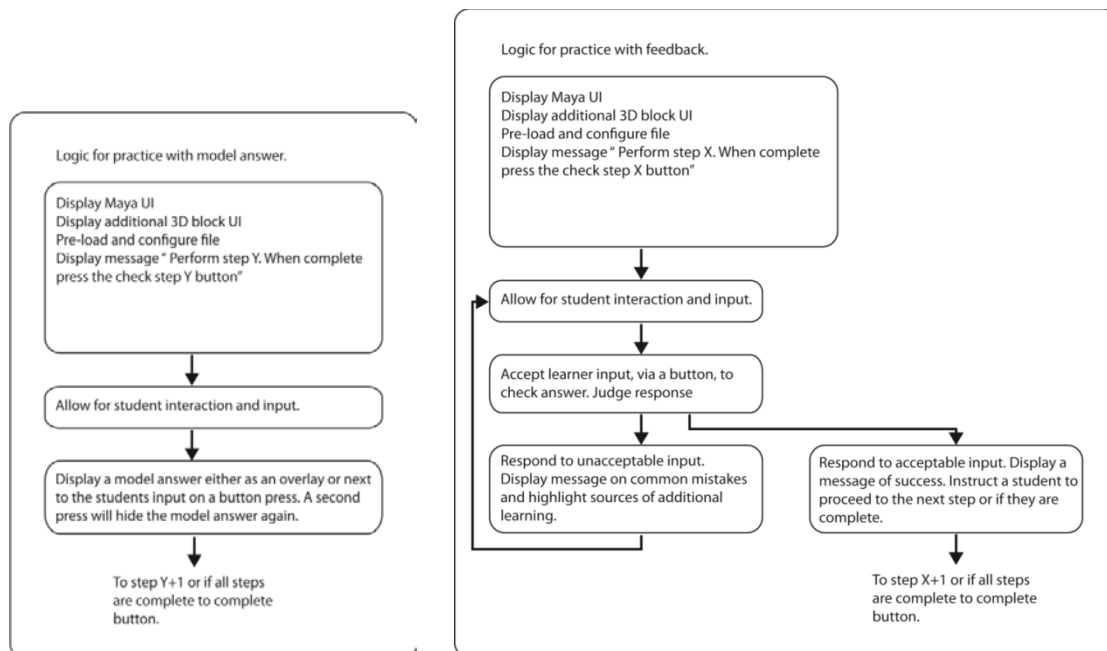


Figure 10-13 (left). Logic for practice with model answer.

Figure 10-14 (right). Logic for practice with feedback.

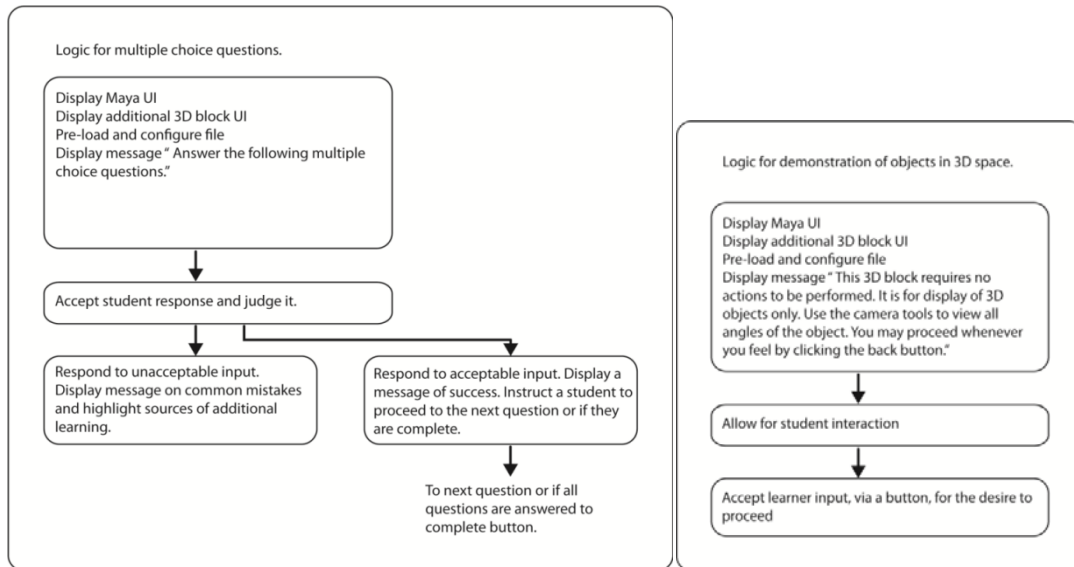


Figure 10-15 (left). Logic for multiple choice questions.

Figure 10-16 (right). Logic for demonstrations in 3D space.

The login logic diagram was simple to accomplish because login pages are common-place in computer-mediated SDL. The logic was diagrammed based on what can currently be seen in educational resources.

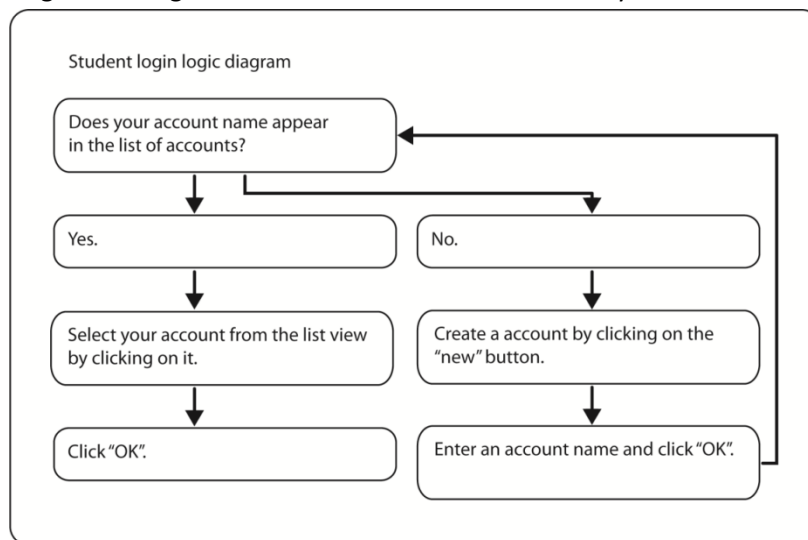


Figure 10-17. Logic for student login.

10.2.7 Message Tables and Channelize Messages

Message tables are used to plan and describe the lesson path structures, step descriptions, feedback messages, imagery, and audio. This requires taking all the content and thinking how to transform it into instructional messages. This information was used to plan the proposed 3D CG SDL resource. As a welcome side effect, this information helps teachers prepare lessons before making recordings, helping to present professionally. There are two types of message tables.

The first type of message table contains details on the lesson and auxiliary paths. It includes a description of the lesson path accompanied by the list of blocks comprising the path. These message tables allow for the content structure of the proposed 3D CG SDL resource to be planned. The descriptions of each lesson path will be used in the menu screen for learners. The list of blocks helps identify each block's role within a lesson path.

Lesson Path: 1.Flash Drive	
Description of path: This lesson when followed will model a complete polygon flash drive. The basics needed for hard surface modelling are covered and is ideal if you are new to modelling. This lesson includes; workflow, basic description of what polygons are, the basic tools needed by a modeller, some basic operations, and polygon manipulation.	List of blocks comprising this path: 1.1) Introduction – Presentation 1.2) Working in passes – Presentation 1.3) Polygon basics - Auxiliary lesson decision point. 1.4) Poly primitives and manipulation – Demonstration 1.5) Basic extrude – Demonstration 1.6) Basic extrude – Practice

Table 10-5. An example of a message table created to describe a lesson path.

Auxiliary lesson: A1. Creating polygons	
Description of auxiliary learning:	List of blocks comprising the auxiliary learning:
To cover the basics of polygons, their creation and explore some basic polygon facts.	A1.1 Polygons – Presentation/demonstration A1.2 Polygons – Practice

Table 10-6. An example of a message table created to describe an auxiliary path.

The second type of message table records the message elements required for each block. These tables are numbered and named as they occur in the lesson paths and auxiliary paths message tables.

The message tables for presentations and demonstrations are not fully scripted. The key points are listed to ensure the lesson covers what is required. Full scripts were used at first; however these produced very stiff and monotone performances. Trying to adhere to a rigid script, it would seem, was a distraction to the teacher when performing for screencasts. Reducing the message to a list of key narration and visual points appears to free the teacher to give a better performance. It was also noticed that attempting a take as a rehearsal first before recording material provided performances that appeared more natural and flowed.

The 3D blocks, not being a performance but a programmed interaction, need much more detail in their message tables. Every written element has to be included – it has to be detailed as well providing a description of how the 3D space will be set up.

The message tables for the macro blocks record the messages advising of auxiliary paths.

1.2 Working in passes – Presentation	
Message Category	Message
Video presentation: A presentation that covers working in passes and why this practice is important.	<p>1) Visual: A sequence of images showing progress of a basic drawing from start to finish. The level of detail increases at a uniform rate across the whole picture.</p> <p>1) Verbal: An introduction message. Explain what working in passes means and how it works using the visual as a reference. Explain progressively increasing levels of detail. Stress how much time this workflow can save, especially when new to art. Describe the non defining attributes: The number of steps and the specific steps taken in creation of that drawing.</p> <p>2) Visual: A sequence of images showing a basic drawing where working in passes has not been followed to contrast example 1.</p> <p>2) Verbal: Describe missing attributes: Levels of detail in areas of the drawing progress at different rates rather than uniformly.</p> <p>3) Visual: A sequence of images showing the progression of a model from start to finish correctly.</p> <p>3) Verbal: Describe why this is working in passes. Describe non-defining attributes: The number of steps or the number of faces and verts.</p> <p>4) Visual: A sequence of images showing the progression of a model from start to finish that has not been modelled in passes</p>

4) Verbal:
Describe missing attributes: Levels of detail in areas of the model progress at different rates rather than uniformly.
Recap what working passes is.

Table 10-7. An example of a message table used to describe a presentation.

1.4 Poly primitives and manipulation – Demonstration	
Message Category	Message
Video demonstration: The basics of polygon creation and basic manipulation of polygon components are explored.	<p>Visual: A screencast capturing the Maya UI and all that happens within said UI. The artist will create a poly cube using first the menu set then the marking menu being sure to show the resulting menus. Hot keys for marking menus will be displayed as an on-screen graphic.</p> <p>Verbal: Artist will mirror actions with explanations as actions occur. Points to discuss are: The speed differences in using menus and marking menus. The physical strain differences in using menus and marking menus. How marking menus changed based on active selections and how to predict these changes.</p> <p>Visual: Graphic of the hot keys for manipulation tools. Moving, rotating and scaling in the viewport using manipulator handles.</p> <p>Verbal: Artist will mirror actions with explanations as actions occur. Points to discuss are: Why to use hot keys over tool box. How to change manipulator sizes. Moving in planes.</p>

Table 10-8. An example of a message table used to describe a demonstration.

1.6 Basic extrude - Practice	
Message Content	Message
Practice: The opportunity to practice extruding with feedback is provided.	
Initialization of Maya.	<p>Visual: Maya will load with a default main window with the perspective cam in the viewport showing a model ready for extrusion. The additional 3D block window will open containing 3 distinct areas. It contains an explanation of the exercise, buttons to be used for checking the extrusions, each with feedback fields, and an area to navigate back to the AIR application.</p>
Explanation field.	<p>Visual: Will be comprised of a text box.</p> <p>Verbal: (text field) Lesson path one: 5/15 As stated in the proceeding video you are required to perform two extrusions on the provided model. These two extrusions are to form the basic form of the usb plug on the front end of the model. Use the provided reference material as a guide. For more information watch the proceeding video.</p>

Check field	Visual: Will contain a text box and two buttons labelled “check first extrusion” and “check second extrusion”. Beneath each button will be a dynamic text field. Verbal: The first dynamic text field will have three states: Default: This will be left blank Correct learner input: Correct, well done! Please move on to the second extrusion.
	Incorrect learner input: The extrusion is not detected! Please ensure you use the extrude tool to extrude out the form of the usb plug. For more information watch the proceeding video (1.5). Additionally you can find more help by watching extra demonstrations (A2.1) found in this software or check the Maya help documentation. The second dynamic text field will have three states: Default: This will be left blank Correct learner input: Correct, well done! You have completed the exercise. Use the back button below when you wish to proceed. Incorrect learner input: The extrusion is not detected! Please ensure you use the extrude tool to extrude out the form of the usb plug. For more information watch the proceeding video (1.5). Additionally you can find more help by watching extra demonstrations (A2.1) found in this software or check the Maya help documentation.
Return field	Visual: Will contain a text field and a button Verbal: Button reads “Back RETURN” Text field reads “Use this button when you are finished or wish to return.”

Table 10-9. An example of a message table used to describe a 3D practice.

Channelizing a message is where a message is deconstructed and the resulting pieces are assigned to media channels. This is step 10 and was conducted at the same time as step 9. This was because the message tables cannot be complete until the media channels are decided upon, and vice versa. Therefore the channelization was incorporated into the message tables to allow each to be considered in parallel.

10.2.8 Specify Continuity Blocks

Continuity blocks are areas that remain unchanged over screens so as to maintain familiar landmarks as a learner progresses through materials. As the recommendations advised providing mechanisms for orientation, this was considered and documented during the creation of the various screens and blocks that provide learning spaces. The use of a navigational side bar to the right of the learning space appears as a consistent navigational tool. Therefore, as learners navigate materials the screen will appear to change only in part, helping learners maintain orientation.

10.2.9 Production Sheets and Their Detailing

A production sheet is a platform for listing all graphic, audio, video and text specifications. It is used to organise teams by listing all assets and changes from block to block. In context of this project, this would mean taking all the information in the message tables and placing them in the area of their appropriate block and listing all the asset locations.

Production sheets, however, created a "cart before the horse" scenario as the each screen was revisited and revised numerous times as the abilities and constraints of the technologies were uncovered. As a consequence of this, production sheets could not be created until the proposed 3D CG SDL resource's screens were created. To know how the screens would function, the screens needed to be created. To create the screens, production sheets were needed. It was realised that this dilemma could not be solved until the CBI creation process was complete. Production sheets and their detailing therefore had little meaning for this research, as they would have to be created after the fact. Instead, the process was carried out directly by taking the message tables and applying them directly to the screens. This afforded greater flexibility, as the creation of the proposed 3D CG SDL resource could be more fluid, adapting as the need arose. The only disadvantage to this strategy was a lack of records on asset locations. To solve this problem, a set of project folders with appropriately named sub-folders and files were created. This organisational strategy is common in 3D CG production pipeline.

10.2.10 Production Stage

The production stage sees the creation of the software. In the context of this research this meant the creation of the proof of concept. In essence, this is taking all the message elements, all the educational assets, creating the screens, and combining them. This step, although appearing as one of the last, actually started with the first step and continued throughout the planning of the proposed 3D CG SDL resource so as to plan and build it concurrently. The result of conducting the production step concurrently sees the work and decisions made spread throughout this chapter. This section will therefore not cover every decision made. Instead, this section notes the basic guides that were established to aid in production.

- Create all the blocks first and ensure they work correctly without the content. These can become templates that the content can be placed within. This saves time and effort while maintaining consistency. The templates can be used in the future to update materials.
- Use incremental saving in Maya while recording the screencasts to create all the scene files needed. This saves authoring time rebuilding files for the exercises. The incremental saves can be cleaned, renamed, and inserted into the resource. The Maya project folders containing the saves also have potential use in the future for updating lesson elements as existing working files can be added to.
- Write all the MEL scripts in a reusable way. The easiest way found was to create separate global procedures to configure the Main Maya window UI, create the 3D block window UI, fill the 3D block's UI window, and load files. The code can then be recycled by changing variables or copying and pasting with substituted file names. This saves time on the hardest and most time- consuming task in creating the resource.
- Write all the ActionScript 3 components (required by AIR) in a similar way to the MEL scripts. The most complex code is establishing the telnet sessions and navigational features. This code occurs on most frames so is written to be reusable.
- Use global procedures with short names. The telnet sessions work on ASCII (American Standard Code for Information Interchange). When flushing ASCII commands from AIR to Maya the longer

strings appear more unstable. Given this, instead of feeding long MEL commands from AIR to Maya, global procedures with short names can be created and used to execute much longer or multiple lines of code. This saves time as both AIR and Maya are more comfortable with this setup. This approach is also easier to debug.

- Reuse assets where possible. Buttons can be constructed and then reused again and again. All images and graphics are created at a higher than necessary resolution or as a vector so they may be scaled and repurposed with comfort.

10.2.11 Test and Debug

Testing and debugging was the final stage of the process in creating the proof of concept. While more testing work would need to be done, for example reviews by subject matter experts and trials on learners, it falls outside the scope of this master's thesis. Therefore, the testing and debugging phase needed careful attention to capture most of the problems.

- The first step was to create the tutorial in a way that reused code as much as possible. When code is reused it is easy to pick up errors in it as the opportunity for problems to present is greater. Additionally, once fixed one can be assured that the rest of the application is functioning correctly.
- The second step was to use the debugging aids built into Flash. ActionScript 3 must be written in a precise way that allows for automatic error checks even before code is executed or compiled. This ability was somewhat limited by the inclusion of commands to execute batch scripts. Executables, such as batch scripts, cannot be accessed until after the code is compiled.
- The code also had built-in error check aids. Trace statements were added so values could be viewed and evaluated during testing.
- As a backup MEL commands had checking mechanisms before their execution to check if the following command would cause errors. In the event of errors the software can attempt to amend potential problems before they happen.
- Code was kept as modular and separate as possible. Chunks of code were created as smaller separate procedures to accomplish larger tasks. This allowed errors in code to be found quickly as they are isolated within small procedures.

10.3 Clarification of the Proof of Concepts Role

This research study only required the undertaking of a proof of concept to illuminate and answer the research questions. As such, not all ideas seen in the CBI design documentation were attempted, as not all the ideas needed proving. Only the ideas that advanced knowledge in the domain of 3D CG SDL were attempted. This section outlines what was attempted and the rationale for attempting it.

The presentation and demonstration blocks were undertaken by the proof of concept. The creation of these blocks proves the navigational features, proves that the high resolution screencasts can be supported by AIR, and proves that AIR is an acceptable runtime for 3D CG SDL.

High resolution, low compression screencasts were made. This was to ensure AIR could support video of this nature and also that OpenGL (Open Graphics Library) could function while having the combination

of Maya, AIR, and high resolution video media running simultaneously on a midrange consumer graphics card (Nvidia 8800GT). Consumer graphics cards, unlike professional workstation graphics cards such as the Nvidia Quadro series, only support one instance of OpenGL at any one point. These cards have to juggle OpenGL applications when there is more than one window using OpenGL. In some cases this can cause system instability, even more so with Maya.

The navigational side bar that would maintain a familiar landmark common to the presentation and demonstration screens, the switch screens, and the macro screens was created. This tested if visual consistency through screen changes could be maintained. It also helped give a sense of how a fully functioning resource built using the conceptual design would feel, as this would be the main source of navigation when in the learning space.

Socket-based communication (telnet) from AIR to Maya was undertaken by the proof of concept. This helped understand what socket-based communication could do and any constraints that may be present.

Batch scripts acting as the mechanism for the OS switch were undertaken by the proof of concept. This clarified if and how the switch could happen, and what it would look and feel like.

AIR and Maya were made to execute batch scripts. This ensured Windows' window focus could be switched so as to integrate demonstrations with simulations.

Building the 3D blocks and all they contained was undertaken in order to understand the abilities and constraints of Maya as a simulation tool. This involved programming the free floating 3D block window, preloading files, defining the interface, including messages, building error checks, and providing feedback.

All these elements attempted by the proof of concept were used to create a lesson path that modelled a flash drive from start to finish. This aimed to give a sense of how learning a task would feel using this type of 3D CG SDL resource. This also provided an opportunity for understanding how the navigation functions would work. Demonstrations were followed by simulations of the same step. This allowed for each sub-procedure needed to complete the lesson to be built as both a screencast and as a simulation. This doubling up was to ensure that all steps could exist as both demonstration and practice.

10.4 Technological Affordances and Constraints Discussion

The recommendations for improvement and conceptual design were achieved by the theoretical discourse and proof of concept. This showed present technology can support the ideas generated in the aim of improving 3D CG SDL. However, some ideas proved more challenging than others to achieve. Discussed are the constraints and affordances encountered.

10.4.1 Integrating Demonstration and Practice

Integrating demonstrations and practice on a physical level proved the most challenging technological hurdle to overcome. Using worked-out examples as a blueprint, this research project integrated units of demonstration with units of practice. Worked-out examples allow for the integration of demonstration

and practice while keeping each separate from the other. This proved beneficial from a technological perspective as it allowed the integration to be facilitated by switching between demonstration and practice, rather than overlapping and blending the two which would have been technologically more difficult to achieve.

The configuration of switching between two media does have its drawbacks. When the switch happens, separate software is presented to a learner, causing difficulties with maintaining visual consistency or familiar landmarks. This is of concern as landmarks help learners both maintain and gain orientation. This problem was overcome by matching the view port of Maya to the view port seen in the screencasts by matching camera angles and models. However, this became ineffective when the addition of the switch block was included in the proof of concept. While this mechanism improved the ability to maintain orientation, as learners are informed and in control of the switch, it does interrupt the viewport landmark. This, in theory, could be overcome by inserting the last frame of a screencast into the background of its associated switch block. This would have to be greyed out to indicate the screencast is no longer active.

The communication protocol used to allow AIR and Maya to communicate was telnet. AIR flushed ASCII to Maya over a local open port (127.0.0.1:6000). The communication in the proof of concept was only achieved in one direction. In theory there is no restriction for Maya to communicate back to AIR. This would allow for greater tracking of student completeness and competency in AIR. Furthermore there is no reason this communication could not happen over great distances between a learning management system and a learner's console.

Using socket-based communication does open computers to potential security risks. As Maya has a port opened for the communication to take place, there is potential for someone to hijack the communication and gain control of Maya. This is incredibly unlikely as the communication has to be from a local host address, meaning an attack on Maya would have to come from within the same computer.

10.4.2 Simulations

Maya's UI proved a constraint to the execution of the proof of concept. Maya's options for building windows and modifying the existing UI are very limited compared to the options and ease of use afforded by AIR. Attempting interface design beyond default in Maya is a very slow process. For example, specifying text attributes, such as size and position, can require a couple of lines of code per instance of text. The 3D blocks were designed to be updatable templates with cheaply replaceable content. To enable cheaply replaceable content, Maya's default design aesthetics could not be altered beyond its default styles.

Another constraint was that the more the UI was modified, the less like Maya the simulations became. Simulations that provide a false representation can lead to imparting false schema and learning bad habits as an artefact of the simulation. This led to compromises between providing features to aid in learning and providing an accurate representation of Maya. While limiting, this was not necessarily a

negative implication as the awareness of the compromises lead to the creation of a very authentic simulation.

The 3D blocks afforded the ability to check learners' work. This was achieved using construction history. By creating scripts to check for the creation of certain types of nodes and attributes, almost any task carried out by a learner could be checked. This checking method is open to potential problems though. If a learner deletes the construction history of an object, all the nodes used for checking a learner's work are deleted and therefore the work cannot be checked. This can be overcome by telling learners not to delete their construction history. However, it is good practice in 3D CG arts to periodically delete construction history. Telling learners not to delete construction history may lead to bad habits as a result of the simulations. A potential way to overcome this could be to include a script that records the construction history of objects in a second location for error checking.

The checking of a learner's work within Maya could be conducted with varying degrees of accuracy. This leads one to question what the scope of the checks should be and within what tolerance practice is considered to be correct. To elaborate, one of the exercises included in the proof of concept was to extrude twice to create a protrusion from a polygon cube, extrude once in and then once again out. The scope of the checks can be thought of as what is checked in this exercise. Does the check examine if two extrusions have taken place? Are the positions of the resulting vertex from the extrusion checked? Are there checks for potential learner mistakes, such as faces with zero area and edges with zero length? Are there checks for anything other than the two extrusions asked for? The tolerance of the checks can be thought of as the accuracy. Take, for example, the checking of a vertex position resulting from an extrude. Does the vertex's position in space have to be accurate to within eight decimal points (Maya's decimal limit) or within a range of a couple of Maya units? Having checks that are too accurate would see almost all answers marked as incorrect, while having a check's range too wide might lead to learners thinking inaccurate placement is acceptable. The answer to what scope and tolerance are appropriate for 3D CG SDL simulations was not found by the proof of concept. As a side note, the more accurate both the scope and tolerance are, the more time needs to be spent programming.

Learner feedback also raised questions about scope. It was questioned whether feedback should be specific to problems found in a learner's practice, or a generic feedback message. This question was unanswered by the proof of concept.

10.4.3 CBI

The use of AIR as a CBI platform afforded enough control for executing all the recommendations and the conceptual design. There were no points during the proof of concept where plans had to be changed or scaled back to match the AIR's capabilities. This shows AIR is an appropriate runtime for producing 3D CG SDL resources.

AIR was expected to be an appropriate runtime as Flash is by far the most prolifically used authoring tool for e-learning applications. This proved useful as plenty of examples of the ideas represented in the theoretical discourse for CBI creation can be seen in other learning applications. This reduced the

amount of work needed for the proof of concept as the ideas represented had already been proven by other developers.

Orientation and control features proved easy to create in AIR. It was felt, however, on completing the proof of concept that the menus could have pushed the technology further. An example of this would be to replace the text descriptors of each block in the main menu with the first 15 seconds of each screencast in the case of presentation and demonstration blocks. The first 15 seconds of the screencasts included a sign on providing a description of itself. This was not attempted, as the researcher feared that if the technology was pushed too hard, the proof of concept may not have worked.

One affordance of AIR that was not explored was using it as a medium for content. AIR was only used to contain all the educational material and provide navigation. This was for two reasons. First, the proof of concept only covered modelling. Providing 3D space similar to Maya's would be difficult and meaningless as Maya provides this space by default. Second, quizzes and other such educational activities by AIR and Flash can be seen in the majority of e-learning applications available already, so providing these in the proof of concept would do little to advance 3D CG SDL's shared knowledge. In hindsight, it may have proven beneficial to explore the potential of the interactions AIR can afford in the context of 3D CG SDL.

10.4.4 Disposable and Updatable

Perhaps the most challenging aspect in producing the proof of concept is the recommendation to create a 3D CG SDL resource that can be easily updated or replaced at low cost. Most aspects of the proof of concept and theoretical discourse were created with this recommendation in mind. At first, this recommendation seemed to contradict the other recommendations. Many ideas did not make it out of the "sketch book" because of this recommendation, proving a constant frustration to the researcher. By not complicating the proof of concept as much as possible, and focusing on providing just the key attributes of the recommendations and conceptual design ideas, everything began to fit together. It was also discovered that rather than making the whole resource either cheap and disposable or updatable, it was far easier to break down its components and decide in isolation whether each component should be cheap and disposable or updatable. For example, the AIR applications structure is designed to be updatable, while the screencasts contained within AIR are cheap and disposable.

10.4.5 Technological Toy

One unexpected finding of the proof of concept was a continuous tendency to overcomplicate technological aspects. An example of this can be seen in the building of the 3D blocks. Initially Maya's UI was hacked and offered a completely reconfigured UI, thought to be at the time more suited to learner's needs. This hacked UI, while an achievement from a programmer's perspective, provided learners with a false schema of Maya's UI. A far simpler option of having a free floating window housed within Maya was more appropriate as it provided a more accurate representation of Maya. Another example was having an auto switching mechanism that automatically engaged switching between Maya and AIR. This however felt confusing as all familiar land marks would be wiped without warning. As such, a "low tech" switching block was created and required human input to initiate the switch. This felt more natural and

helped to maintain orientation when switching between AIR and Maya. Both examples highlighted that what feels refined as a programmer may not be in a learner's best interest.

This finding was unexpected, as upon entering the technological translation it was feared that a large commitment of resource would be needed to wrangle the technology to do what was required. This fear had the proof of concept run the risk of becoming a technological toy, rather than an educational resource with learner's needs in mind. Much time could have been saved by creating a more robust system, such as flash cards with each screen on them, for trialling how the system would feel. This would have lead to the same realisations without needing to program the software, therefore saving time and effort.

10.5 Summary

A strategy for CBI authoring was selected to conduct the practice-based research elements of this study. This strategy involved 14 steps. These steps were carried out in a theoretical discourse to describe and document the process. Parallel to this, a proof of concept was built. This aimed to create the simulations, high resolution screencasts, AIR learning environment, navigational features, switching mechanisms, and a mock lesson. This process revealed that integration is achievable, Maya can be used to create educational simulations, AIR is a suitable runtime for 3D CG SDL, and lessons can be achieved using the blueprint outlined in the theoretical discourse.

11 Conclusion

This chapter will briefly summarise the research and findings. Then the limitations of this research study are discussed followed by implications and suggestions for further research on enhancing 3D CG SDL resources.

11.1 Summary of the Research

This research study sought to address the following research questions, *What are the problems with 3D CG SDL resources perceived by learners? Using the knowledge gained on problems with 3D CG SDL, can improvements be made? How will these improvements function in practical application?* The findings of this research study answered each of these questions in succession.

Using the survey and interviews allowed for problems, as perceived by learners, to be uncovered and explicated. Many small and specific problems were clustered into nine themes, encompassing all the problems recorded. These were issues with the lack of integration of demonstration and practice, the media used, the lack of sound practice, the perception that there was no help, not accounting for learners' varied skill, not providing full means for gaining orientation, the speed at which resources outdate, and some recorded teachers' unprofessional demeanours. These problems appear to either stem from a lack of sound educational practice or a lack of refinement in 3D CG SDL.

Unearthing and explicating the problems with 3D CG SDL also helped in finding areas for improvement, answering the second research question of finding improvements for 3D CG SDL. In the interviews, having learners describe problems also provided an opportunity for recording improvements learners perceived to be potentially beneficial. The perceived problems and improvements were then discussed and distilled down to a list of recommendations for 3D CG SDL. This list of recommendations showed that 3D CG SDL could indeed be improved and detailed how.

The research then continued to attempt a proof of concept based on the knowledge gained. This allowed for the recommendations for improvements to be physically manifested, examined, and verified that they could be achieved. All the recommendations were attempted, documented, and achieved. As a result of this process, a blueprint for an improved 3D CG SDL resource was created. This also allowed for the creation of an ad hoc proof of concept 3D CG SDL resource, which appears to be the first produced as a result of an empirical study. The proof of concept demonstrates that 3D CG SDL's present common practice can be improved upon and provides working evidence.

11.2 Summary of the Findings

This research has three sets of findings, representing the survey, interviews, and practice-based research. The summation of the research shows that 3D CG SDL has problems, that these resources can be improved, and through practical application both proves this and demonstrates how this can be done.

The surveys collected data on learner perceptions of 3D CG SDL. It was found that the majority of learners perceive 3D CG SDL resources as enjoyable and important. Learners are neutral to satisfied with present 3D CG SDL resources. Learners have become frustrated with 3D CG SDL and perceive there to be

room for improvement. The majority of learners feel only sometimes more confident after completing a 3D CG SDL resource. Learners sometimes feel overwhelmed by these resources. Learners perceive practice as important, and will attempt to practise if no instruction is given. Learners only sometimes find exercise directions clear. Last, learners prefer screencasting over written instructional material.

The interviews uncovered nine themes. Learners perceived the lack of demonstration and practice integration as problematic, and that integration would be beneficial. Learners perceive screencasting to be an easy medium to learn 3D CG arts from. Practice is important and needs mechanisms to allow learners to check their work. Learners desire help systems that already exist, highlighting a need for promotion of present help systems and their integration into learning space. Learners have varied skill levels, manifested through a desire for control over how elaborate or precise learning material is. Learners want mechanisms for gaining orientation and control. Online media will not be appropriate for 3D CG SDL until the internet can deliver content reliably. 3D CG SDL resources outdate quickly. Last, a teacher's presence in recorded materials can be a positive or negative experience depending on their demeanour and preparedness.

The literature review, results of the survey and results of the interviews were used to generate a list of recommendations for 3D CG SDL. This list was then tested by physically manifesting the recommendations in a proof of concept 3D CG SDL resource. Integration was achieved pedagogically by using worked-out examples. Integration was achieved physically by using AIR to provide screencasts as demonstrations and Maya to provide practice as simulations then having the two media communicate to work together using telnet. The simulations afforded the ability to check work by using Maya's construction history. Help systems were not conducted by the proof, but were planned in the theoretical discourse. Help was advocated by including messages throughout the resource stating its importance, then reinforcing this idea by integrating help into the learning space through menus and feedback on learner practice. Controls were provided by including video controls and navigation controls. Control was also offered by providing the macro screens that allowed learners to choose diversions from the lesson to explore or skip materials in a non-linear fashion. Presenting professionally was achieved by planning instructional performances for screencasts thoroughly and rehearsing. Menus and consistent landmarks were provided through the use of the navigational side bar. This landmark displayed completeness and menu access in the learning space. Offline media was avoided. Building the proof of concept to be easily updated or replaced at low cost proved challenging. This challenge was overcome by creating an updatable shell to host disposable content. All the recommendations were achieved by the proof of concept, therefore proving they are possible and demonstrating how.

11.3 Limitations

While this study may be one of the first examining 3D CG SDL in order to improve upon it, the research study's results need to be considered with some caution. Following are the limitations noted while conducting this study.

The first limitation is the level at which the results may be generalised. The perceptions of those surveyed and interviewed may not be representative of all 3D CG SDL learners as the participants were

only sampled from within Auckland, New Zealand. Learners' experiences outside this area may be varied due to their specific location or cultural context.

The review by subject matter experts and pilot testing phases in the CBI creation process were removed due to time constraints. While the proof of concept proves that the recommendations for improvement can be conducted and explicates how, the efficiency and effectiveness of these improvements will remain unknown until pilot testing is conducted.

Worked-out examples were modified to match the mediums used by the proof of concept. While the modification process was conducted to adhere to the guides for worked-out examples as well as possible, the 3D CG simulations conducted in Maya could not meet the guideline to integrate information, as this would impart a false schema of Maya. This deviation from the guidelines for worked-out examples was deemed necessary; however, the effectiveness of the modified worked-out examples are unknown for the simulation faded steps.

The worked-out examples principle states a limitation that the application of worked-out examples to domains outside of mathematics education has not been studied. The effectiveness of this educational practice, while promising, is therefore unknown in context of 3D CG education.

The proof of concept only dealt with modelling tasks. As the proof of concept was a limited test, covering full pipeline was not an option. Modelling was selected as from Maya's perspective it involved the most areas. Modelling uses 3D space, tools, operations and a wide range of nodes. It also is less precise than other areas of pipeline, making the checks more difficult or execute as there are varying degrees of correctness. Testing modelling provides promise for other areas of pipeline; however caution is advised when generalising the results to these other areas.

11.4 Implications of the Research

Based on the findings of this research study, what suggestions can be made to the domain of 3D CG SDL beyond the recommendations already made through executing the various methods applied in this study? Above all, that 3D CG SDL can be improved. Authors of 3D CG SDL may wish to use this research to improve how they create their resources. They may do this by using the problems identified to create their own improvements or use the improvements generated by this research study. They may also choose to use the proposed 3D CG SDL resource blueprint and proof of concept as a model.

11.5 Recommendations for Further Research

A lack of studies on the effectiveness and efficiency of different media and educational practices in the context of 3D CG SDL hindered this research project. For future research, studying the efficiency and effectiveness of various media and educational practices applied to 3D CG education in terms of knowledge gains by learners would be beneficial. Due to the lack of this knowledge, this research project relied on user perceptions of best practice. Knowledge about the best media and educational practices as measured by knowledge gains in the context of 3D CG learning would have enriched this research study, and would no doubt prove useful for studies involving 3D CG education to come.

A future study may involve pilot testing the proof of concept in a finished or prototype form. The efficiency and effectiveness of learning measured by knowledge gains would allow for the 3D CG SDL resources designed by this research to be measured by a more accurate scale and compared to current practice.

The simulations created by this research project proved powerful, but because of the scope of this research study this power was never fully explored or refined. An example of this was a question raised during the research study on how accurate the error checks should be within the simulations. This question was left unanswered. It would be beneficial to further examine simulations for 3D CG education to better understand how these simulations would best operate and better understand their affordances and constraints.

The telnet communication setup used by the proof of concept has far greater capabilities than is shown in this research. Communication took place only from AIR to Maya and only on an isolated machine. The potential to have Maya communicate back to AIR and what this could afford was not explored. This may be an area for further research. Also, communication between different computers could potentially provide some interesting outcomes, yet this was not attempted. One idea that was generated, outside the scope of this research, would be to have a mobile device such as an iPad run an application akin to how AIR functioned in the proof of concept. This would afford the ability to host the presentations and demonstrations on a separate device. This would also allow for the window that was added to Maya to be shifted to the mobile device thereby creating a more accurate simulation of Maya. Most exciting about this idea, though, would be to have, as a video progresses on the mobile device, the commands executed in the video fed to Maya allowing for learners to interact with the content as it is built in the demonstration.

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Appendix

Appendix I: Survey Participant Information Sheet

Participant Information Sheet



12 January 2011

Project Title

Creating self-directed training resources for the purpose of learning 3D animation skills.

An Invitation

I, Matthew Guinibert, invite you to participate in a survey, results of which will be used for a masters thesis in the field of creative technology. Participation is completely voluntary and if you do so wish to participate you can withdraw from the study at any time without any consequences.

What is the purpose of this research?

The purpose of this research is to collect information about a users perception of comfort while using CGI self-directed learning resources.

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

You have been identified as being part of the 3D community either through an e-mail list of known artists and studios or you have followed a link from a websites 3D community board. To take part in the survey you must have completed at least one self-directed learning resource for the purpose of learning computer animation or computer graphics.

What will happen in this research?

You will be asked a series of questions through a web-based survey. Some questions will be about your experiences while using CGI self-directed learning resources. Others will be about what you think could be done to improve CGI self-directed learning resources.

What are the discomforts and risks?

The questions asked will be on your experiences with CGI self directed learning resources and your thoughts on possible improvements. Additionally you will be asked your skill level with CGI software. If these questions have potential to cause you embarrassment or emotional stress, please do not participate.

How will these discomforts and risks be alleviated?

The questions have been written as to not cause discomfort as best possible. If however you find yourself uncomfortable with answering a question you can elect to skip it with no consequences. Additionally you can withdraw from the survey at any time with no consequences.

What are the benefits?

This is a chance for you to talk about your feelings and views on CGI self directed tutorial resources and voice your opinion on how these resources can be improved.

How will my privacy be protected?

At no point during the survey will you be asked to supply details that can be used to identify you. In this way all your answers will be anonymous. Only the researcher and his supervisors will have access to the raw responses. The published results will maintain anonymity with no information published that could be used to identify you.

What are the costs of participating in this research?

Approximately 15 minutes of your time.

What opportunity do I have to consider this invitation?

Participants are chosen on a first come first serve basis. You will be 1 of 15 respondents if you so choose to complete this survey.

How do I agree to participate in this research?

Go to the following link and follow the prompts. The first page will ask if you wish to participate stating the terms outlined in this information sheet.

Will I receive feedback on the results of this research?

If you wish to receive the results of this study please email the researcher (details below) asking to be included in a mailing list that will publish the results when complete.

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, Charles Walker, charles.walker@aut.co.nz, 921 9999 ext 9409

Concerns regarding the conduct of the research should be notified to the Executive Secretary, AUTC, Madeline Banda, madeline.banda@aut.ac.nz, 921 9999 ext 8044.

Whom do I contact for further information about this research?

Researcher Contact Details:

Matthew Guinibert, matgui98@aut.ac.nz, ph 021 187 5170

Project Supervisor Contact Details:


Charles Walker, charles.walker@aut.ac.nz, 921 9999 ext 9409

Approved by the Auckland University of Technology Ethics Committee on 23rd of February 2011, AUTC Reference number 10/307.

Appendix II: Online Survey Screens

[Exit this survey](#)

Consent Form



AUT
UNIVERSITY
TE WĀNANGA ARDNUI O TAMAKI MAKAU RAU

Click the next button at the bottom of the page if you have read and agreed to the following:

I am aged 18 years or older.

I have completed a self-directed learning resource on any subject in the field of computer generated imagery (CGI) or 3D animation.

I have read and understood the information provided about this research project in the Information Sheet dated 12/01/2011.

I have had an opportunity to ask questions and to have them answered.

I understand that I may withdraw myself or any information that I have provided for this project at any time prior to completion of data collection, without being disadvantaged in any way.

I understand that I may withdraw myself or any information that I have provided for this project at any time prior to completion of data collection, without being disadvantaged in any way.

If I wish to receive a copy of the report from the research I can do so by expressing my interest by emailing the researcher on matgui98@aut.ac.nz

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[Exit this survey](#)

1. What is your current skill level in the following software packages?

	none	familiar	proficient	expert
Maya	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3ds Max	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Softimage	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Blender	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Houdini	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Modo	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cinema 4D	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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Next

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1. In general do you enjoy CGI self-directed learning resources?

- ☐ Yes
- ☐ No

2. Do you feel that CGI self-directed learning resources are an important part of being a CGI artist?

- ☐ Yes
- ☐ Unsure
- ☐ No

3. What medium is your preference in CGI self-directed learning resources?

- ☐ Written theory based literature
- ☐ Written examples
- ☐ Video demonstrations
- ☐ Video theory lectures
- ☐ Other (please specify)

4. Do you feel more confident as a CGI artist after completing a CGI self-directed learning resource?

- ☐ Yes
- ☐ Sometimes
- ☐ No

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Next

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1. How satisfied with CGI self-directed learning resources are you?

- ☐ Highly satisfied
- ☐ Satisfied
- ☐ Neutral
- ☐ Dissatisfied
- ☐ Highly Dissatisfied

2. Do you ever feel overwhelmed by the way information is presented in CGI self directed learning resources?

- ☐ Yes
- ☐ Sometimes
- ☐ No

3. Do feel that the practice exercises included with CGI self directed learning resources are important to learn CGI skills?

- ☐ Yes
- ☐ Sometimes
- ☐ No

4. Do you ever become frustrated while using CGI self directed learning resources?

- ☐ no
- ☐ Yes (please specify)

Next

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1. Do you find instructions for exercises included with self directed learning resources are clear?

- ☐ Yes
- ☐ Sometimes
- ☐ No

2. How, in general, do you feel about the number of steps needed to complete exercises?

- ☐ There are too many
- ☐ There is the right amount
- ☐ There are too few

3. Do you try to follow along, by parroting, screen captured video demonstrations if they do not provide clearly defined exercises?

- ☐ Yes
- ☐ Sometimes
- ☐ No

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Next

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[Exit this survey](#)

1. Do you feel that CGI self directed learning resources could be better than what is presently offered?

- ☐ No
- ☐ Yes (please specify)

Prev

Next

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Create your own [free online survey](#) now!

[Exit this survey](#)

The survey is complete!

Thank you for your help with this research.

Please let us know whether you would be interested in receiving any summaries of the research once it is completed by emailing Matthew Guinibert on: matgui98@aut.ac.nz

If you would like to register your interest in participating in an interview on the same topic as this survey please do so by emailing Matthew Guinibert on: matgui98@aut.ac.nz

Prev

Done

Powered by **SurveyMonkey**
Create your own [free online survey](#) now!

Participant Information Sheet



12 January 2011

Project Title

Creating self-directed training resources for the purpose of learning 3D animation skills.

An Invitation

I, Matthew Guinibert, invite you to participate in a Interview, the results of which will be used for a masters thesis in the field of creative technology. Participation is completely voluntary and if you do so wish to participate you can withdraw from the study at any time without any consequences.

What is the purpose of this research?

The purpose of this research is to collect information about a user's perception of comfort while using CGI self-directed learning resources.

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

You have been identified as being part of the 3D community either through an e-mail list of known artists and studios or you have followed a link from a websites 3D community board. To take part in the Interview you must have completed at least one self-directed learning resource for the purpose of learning computer animation or computer graphics.

What will happen in this research?

You will be asked a series of questions by an interviewer. Some questions will be about your experiences while using CGI self-directed learning resources. Others will be about what you think could be done to improve CGI self-directed learning resources

What are the discomforts and risks?

The questions asked will be on your experiences with CGI self directed learning resources and your thoughts on possible improvements. Additionally you will be asked your skill level with CGI software. If these questions have potential to cause you embarrassment or emotional stress, please do not participate.

The researcher will be audio recording the interview as so not to have to take so many notes. If the recording of your voice will cause you discomfort please do not participate.

How will these discomforts and risks be alleviated?

The questions have been written as to not cause discomfort as best possible. If however you find yourself uncomfortable with answering a question you can elect to skip it with no consequences. Additionally you can withdraw from the survey at any time with no consequences.

What are the benefits?

This is a chance for you to talk about your feelings and views on CGI self directed tutorial resources and voice your opinion on how these resources can be improved. Additionally if you are chosen as an interviewee you will receive a \$15 petrol voucher.

How will my privacy be protected?

Your responses to interview questions will be kept confidential. Only the researcher and his supervisors will have access to the raw data collected. Your responses will be used in a masters thesis. You will only be referred to as a number (i.e. participant 03) in this thesis paper. The information gained from this survey may also be published in peer reviewed journals and conference presentations. No research participant will be identifiable from any publications.

What are the costs of participating in this research?

The interview will take approximately 30 minutes.

What opportunity do I have to consider this invitation?

Participants are chosen on a first come first serve basis. You will be 1 of 4 interviewees if you so choose to complete this survey.

How do I agree to participate in this research?

Contact the researcher to express interest in participating. The researchers details can be found below.

Will I receive feedback on the results of this research?

If you wish to receive the results of this study please email the researcher (details below) or ask in the interview to be included in a mailing list that will publish the results when complete.

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, Charles Walker, charles.walker@aut.co.nz, 921 9999 ext 9409

Concerns regarding the conduct of the research should be notified to the Executive Secretary, AUTECH, Madeline Banda, madeline.banda@aut.ac.nz, 921 9999 ext 8044.

Whom do I contact for further information about this research?

Researcher Contact Details:

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Approved by the Auckland University of Technology Ethics Committee on 23rd of February 2011, AUTECH Reference number 10/307.



Consent Form

Project title: Creating self-directed training resources for the purpose of learning 3D animation skills.

Project Supervisor: **Charles Walker**

Researcher: **Matthew Guinibert**

- ☐ I have read and understood the information provided about this research project in the Information Sheet dated 12/01/2011.
- ☐ I have had an opportunity to ask questions and to have them answered.
- ☐ I understand that notes will be taken during the interviews and that they will also be audio-taped and transcribed.
- ☐ I understand that I may withdraw myself or any information that I have provided for this project at any time prior to completion of data collection, without being disadvantaged in any way.
- ☐ If I withdraw, I understand that all relevant information including tapes and transcripts, or parts thereof, will be destroyed.
- ☐ I wish to receive a copy of the report from the research (please tick one): Yes ☐ No ☐

Participant's signature:

Participant's name:

Participant's Contact Details (if appropriate):

.....
.....
.....
.....

Date:

Approved by the Auckland University of Technology Ethics Committee on 23rd of February 2011, AUTEK Reference number 10/307.

Note: The Participant should retain a copy of this form.

Appendix V: Interview Questions

- 1.a What factors have you enjoyed about any of the 3D CG self directed learning material you have completed?
- 1.b In what situation does this enjoyment happen?
- 1.c Why do you think you enjoy this?
- 1.d How do you think this could be expanded upon?

- 2.a What factors have caused problems for you while using 3D CG self directed learning material?
- 2.b In what situation did this problem occur?
- 2.c Why is this a problem?
- 2.d How do you think this problem could be avoided in future?

- 3.a Do you find yourself repeating a task while using 3D CG self directed learning materials?
- 3.b In what situation does this arise?
- 3.c Why do you think you need to do this?
- 3.d What could be done to avoid repeating this task?

- 4.a Would you like to see anything added in purpose of bettering 3D CG self directed learning resources?
- 4.b What exactly does it do?
- 4.c Why do you feel this could be beneficial?

5. A survey found screencasting is preferred for 3D CG demonstrations in self directed learning. Why do you think this is?
- 5.b What factors do you feel positively about when it comes to screencasts?
- 5.c What factors do you feel negatively about when it comes to screencasts?

6. A survey found practice is thought of as important to learning 3D CG when using self directed learning resources. Why do think this is?
- b. What factors do you feel positively about when it comes to practice?
- c. What factors do you feel negatively about when it comes to practice?

7. How do you check that your practice is correct?
- 7.b In your experience how often is feedback given on errors you have made while learning?

8. How do you feel about the length of explanations in demonstrations?

9. Do you find yourself wanting to rotate and tumble 3D objects demonstrated in pictures or video to better understand them?

10. Do you feel that images in books and videos are of an adequate resolution to comprehend?

11. Do you find when repeating material for revision purposes, you just want the essentials communicated but are unable to do so?

12. Do you find yourself pausing video tutorials to work on the software package being taught?

13. Do you find there is extra work often when following exercises that do not help you learn but is required to progress with the exercise?
14. How do you feel when you have to copy information from videos or books into the application you are learning when following exercises or explanations?
15. How do you feel about the way that topics are introduced in self directed learning resources?
16. How engaged do you feel by self directed learning?
17. How do you feel about the production quality of 3d CG SDL?
18. How do you feel about the structure of 3D CG SDL?

Appendix VI: Significant Statements

Participant P1's Significant Statements

Well a good thing is, if it's a tutorial you can always go back to it.
So I can just follow through, and I don't understand, I just go back to it again and if I feel, oh, I already know this I can fast forward.
All the tutorials are about how to teach you for something new, but there's hardly any tutorial about troubleshooting.
English is not my first language, so yeah.
You can see another way of doing the same thing.
Wow we have so many ways to model like character. We can do the topology like this, like that, there is no right or wrong, just different choices.
Sometimes ha-ha they are so long. Something I already know so: but I'm not sure whether anything I don't know pop-up so I just can't drag down to the end will go to the next chapter. Sometimes they are really long and if I really know a little bit about it I have to wait, wait, wait, wait, for like half an hour
If they can break down into chapters and then have like the tag on each chapter that would be more helpful citing go ah I want to know this or not about that. It's more specific.
Sometimes I have to do a tutorial two or three times before I remember it because I'm not very good at, like, doing it once and remembering it.
Sometimes it's just such a complicated process I just have to go over it again
and have the tags which are almost like a dictionary, so if I don't know what to do I can go straight into that chapter.
It would be good if in one tutorial they could show a few different ways of doing things. It's almost like explaining all of the possibilities.
But sometimes is really hard to find to find things in Maya, such a complicated user, ah, user interface.
Sometimes if you say, like, shelf people don't even know things called shelf.
another thing is, like, most of us a visual learners.
if it's in text you can go back to certain points faster.
If you have an Internet cap you would not be able to go through a lot of that.

During practice you can also explore more.
And it's More fun too.
Sometimes you may get into problems you cannot solve and then you're stuck there.
He just remembers like a robot, just repeat what you see in the tutorial.
But a lot of tutorials don't, they just tell you step 1, 2, 3, and if you follow-through you'll get the result, but they don't tell you what error is popping up.
The thing is, if I have some error and it's not saying that in the tutorial what kind of an error I am making and how to fix it properly, just go back to the beginning of the tutorial to see if am I following through 100% up to the tutorial or did I do anything different that caused the error.
It's hard sometimes they have their render settings different than yours, and they didn't say if you don't have this render setting you won't get the same result, but yeah that would be hard for me to understand what's going wrong.
They will rotate the object and show you but sometimes you do want to, aah, I want to click on that.
Yeah sometimes they have a dynamic effect, you do start to think, how about if I change this to that, um, what would it look like, or how does it look from a different view, or with different light settings.
Those YouTube ones are really horrible, you can't even see the tabs.
Not the online ones, because the YouTube ones are really low res it's not right. And that also have some friends and they get them transferred from their computer to my hard drive, those ones are all right.
Because those YouTube ones, even if you turn up to 480p, you still cannot see some of the details.
If you want to download tutorials you don't want them to be super big It will just cause problems with the Internet speed.
They just stopped the tutorial occasionally and then typing scripting. It would be better if you could have like to version of the tutorial. One is the follow-through version, one is the text. So if you want to use text, then you can just go and copy and paste ha-ha. But on the other hand, maybe it may make you remember this by typing it all by hand, because you are not copy and pasting. Nobody would be able to remember anything at all afterwards.
I really wish they had more sub subtopics, yeah just divided into subtopics.
That way it gives the viewer their own freedom to make their own combination. Make those two things

together, or how about tried this and that together.
You can have a problem box and everyone can drop their problem in you can still not solved after watching a tutorial, then, like once a month someone can go through and pick up those common problems and then add on to a answering or question shooting part of the tutorial.
I tried to Google tutorials and most the time the results are a little bit disappointing because I just couldn't find what I want.

Participant P2's Significant Statements

It's good being able to pause and rewind.
Videos are better than reading stuff just because I'm a visual, video, type person and reading is just slower and more difficult.
Usually has verbal explanations on things which you probably wouldn't get written.
Videos are ones that, aah, have a little life in them as well, the slightly entertaining ones. But that said, you don't want them to be non-educational, but sort of the really monotone boring stuff becomes more boring. If you can keep it alive [...] as a live person makes it more enjoyable to learn I guess which is a good thing.
One of the tricky balances perhaps, is when teaching things, would be teaching it at the right level is probably a difficult thing, don't quite know the answer for that. But you don't want to be going over every basic detail like what does W do something like that, but at the same time you don't want to jump to too many assumptions and then get people lost in the video. So I guess that is a tricky thing to deal with sometimes.
Sometimes you'll find a tutorial on something and then you'll realise that it slightly outdated in the way that process is done.
If I compare it to live tutoring, then self-directed learning has the benefits that you can stop and start when you want to, and take a break whenever you want to which is really good, and find specifically what you want without having to sit through the other stuff.
It beats reading things I guess because text books are textbooks and eventually they become a little bit mind numbing I guess.
I guess most people in that industry probably are more visual perhaps. So having visual, audio, kinda things are maybe easier to follow along with.
Also its actually literally showing you what to do, as compared to reading what's on a page and

translating that to what you need to do.
If you are just hearing someone saying something, you may not remember it, or even if you're paying attention what said you may remember it, but actually doing it for yourself and translating what is being told to you and into the result, then you actually understanding it.
in terms of the 3D stuff the purpose of the self learning is for you to be able to do it yourself, so the act of you doing is the point when, I suppose, you are fully understanding or it least creating ability to do it for yourself.
It's more of a positive feeling if you think you've had a sense of achievement in that, I've done this now, I am actually learning it and I've applied it.
and they bypass a step that is assumed you know, then that creates another point you then have to go and research that particular tool how to make that gap.
there would be more tutorials that would have people waffling than tutoring that have it too brief. So I guess if in doubt, if I were making a video, I veer on the side of making it slightly briefer.
Occasionally people go off on a tangent and tell their life story, when they're trying to run a tutorial that becomes a distraction at times.
YouTube videos are a bit too compressed.
Things like Digital Tutors and Gnomon are designed to be large enough to see.
Well, not just easy to follow perhaps, but the most in-depth and useful as well. Some are easy to follow, but they bypass the actual understanding of it. They just do this is the steps click, click, click, click, and it's done, but don't tell you why or how.
Ahh yes, well if it's a short video like a five-minute one often I'll do a quick watch through the whole thing and then go, oh yeah I get a rough idea of that, then open Maya file and have a go at it or open and just rough model or something and test it.
But definitely pausing is a go because sometimes, you know, I want to check the options of something when they say, hey just click on this thing and see settings. I might stop and have a look at what the settings are before continuing or something.
This might not be the right answer to the question, but they can be sometimes... they don't have enough of the explanation of the understanding of something if it breaks. If you are trying to do it and they just say, click here, click here, and you've checked it multiple times and you know that's what you've done, that can be quite frustrating. Whereas, if at least they have explained the why of this then at least you have something to Google to figure out why it broke when you did it or something.
It's good copying stuff. I wouldn't wanna make an entire project out of just copy cating what's out there because then it's not your work, and to try and say to people, hay I made this, is not really... Well I

wouldn't feel that's right myself because I know I fully didn't do it.
Sometimes there is something that says to do and you know oh, I'm not really going to use that again, but hey you know I'll keep the video and then when I need to do that step just do it and then move on, kinda thing. Like things, I think of like orienting joints and stuff in rigging work.
Videos that do a quick, just a quick overview at the start is quite good.
To show this is what we going to do today. We are going to do this and this, and here's the details steps of how to. And that's quite good, because, like, when you're teaching a class kids is good to be able to say, hay guys we are gonna to make this, and they go, wow this is going to be so cool, I get that when I finish, as compared to just saying you just do this and you just do this and they can't think why and what is the result we are going to get.
Wow I never really thought you could use that tool to create that, then that's cool because that's giving ideas and inspiration beyond what it specifically teaching you directly.
I guess because a lot of the YouTube stuff is home Brand style.
Having people who know how to teach and how to convey information is important. If there is some whizbang guy that knows what to do but can't explain it properly then it is kinda not so useful.
And then there is where the people have nice exciting and inspiring examples.
In terms of following a step-by-step thing, it's faster than doing a textbook step-by-step because you have to read it, and look at your screen, and then apply it, then go back and check it. There's a lot of chances for things to go wrong because Maya is such a complex program. Yeah that can be a problem.

Participant P3's Significant Statements

...is just whether or not I can fully rely on the advice on being given, whether this actually is the best advice, and being able to rely on the experience of the person teaching.
Actually I find that some of the animation tutorials I did it got a bit annoying. Like the guy was kind of joking around a lot and even, like, swearing and stuff like that and I really didn't appreciate that, I just wanted to learn.
What I've always thought would be really cool, there might be things like this out there, but to actually instead of like having a video, and then going back to Maya, and then going back to the video, and then going back to Maya, actually just going into Maya and having more of an interactive learning software. So like it tells you do this, you do it and then it, tells you to the next thing and you do it and it checks what you're doing and checks off what you're doing as you go through and then if you don't fully understand you go to a video, like little video pop-up thing can come up. Just so it's not so much of a look here okay remember that, then come over here, it will actually guide you through it like is the

teacher sitting there with you.
Because it easy to compare with what they're doing, all the same UI stuff is there and it's easy to reference.
Well I guess I am a visual learner so if I can see it being done then it easier to get in there.
Before I can fully learn something I have to understand why it works this way and why this happens when I do this and the only way I'm going to know that is by actually doing it for myself, getting in there, getting messy.
It was frustrating when you encounter a problem with the software and there's nothing on the tutorial that can help you to deal, because there is so many problems that can crop up with software like Maya, and..... Just unforeseeable problems.
Well I haven't come across any self-directed learning program that has all the knowledge on like how to solve this and how to solve that.
You just compare it to the final product you have been shown or told, but you can never fully know if you've done everything precisely the right way.
Generally I would prefer more explanation, but that's just me. I like to pull things apart and figure out how they work, why they work that way so that's what I'm always hungry for when watching a tutorial.
I can make a better comparison between what I'm supposed to be doing and what I'm actually doing and the only way you are going to be able to do that in a 3D program is to be able to see it in 3D.
The resolution is usually pretty average on the ones that I've seen and usually it's like yeah I can't see exactly what he's clicking on up there or... It is usually pretty poor on the ones I've used.
I would probably want to see all the same concepts used on something else. um. So to make sure I have actually got it, and so I can see it applied on multiple products then it kind that helps me triangulate.
I need to understand the why, or else I don't understand full stop.
Not just copying it, but actually understanding how it worked and why it works. That way I understand when he did that rather than doing exactly what he just did.
He always sounds like he is talking like he's taking you by the hand. He understands that you don't know anything and is very accommodating of that fact and you just feel very comfortable going through his stuff. All of his explanations are really clear.
It kinda sounded like a lot of the time he didn't even want to be doing the tutorial, this is kinda... This is something I'm doing on the side you know getting paid but can't really be bothered with this, this is how you do that this is how you do this, blah, blah, blah, blah, but it didn't really feel like he cared that you

are getting the right advice or not,

And I like that structure, being given the foundation thoroughly and then step-by-step, baby steps, and every single step being explained crystal clear.

Participant P4's Significant Statements

Stopping and starting freely. Sometimes tutors talk too quickly, so it's nice to be able to stop and start.

Being able to reference.

I hate flicking between the software and the tutorial, it drives me nuts.

I like a tutorial where the tutor has obviously written down what he is talking about, he's not just thinking as he goes, its actually been presented like a presentation, rather than having to sit there for half an hour while someone's going oh wait wrong window, or oh don't know what I'm doing, its really irritating, I wont keep watching it.

Anyone can pretty much learn 3D but not everyone can teach it.

You expect it in a classroom 'cause natural things happen, but on a recording you can comp those things out, be nice if people took a little more time to do that.

Sort of power point like presentation type scenarios, showing light bouncing of surfaces, using arrows and everything was just a lot more easily explained, rather than saying this is how a spot light works and setting it up in Maya, he shows you this is what a in real life what a spot light does and this is how light penetrates and its this kind of light and everything and that was a lot more helpful than just having Maya and someone talking.

Think most 3D artist are visual learners, most creative people are visual and I guess that's why books don't come in helpful, just a bunch of theory unless you're doing scripting or something that needs to have a lot of explanation in that respect, but when it comes to visual stuff, visual people don't want to be sitting there reading a bunch of jargon.

But yeah I think its defiantly easier to learn something, for myself, through a tutorial rather than being in a class environment because you are able to control how much is being spoken at a time, and you're not getting washed away with all the extra information and missing out on information because you are able to control when you can, you know stop and stuff.

I get really annoyed if there's not a tutorial that already has geometry setup for you and things like that, especially cause I do lighting and its annoying having to light something that's indoor when I don't have an indoor setting and if there's certain windows and stuff in the room then you have to make sure

they're in the same place or you're just not going to get the same results.
I guess cause Maya is constantly improving, its constantly growing every year, well most software any way. Every year a new level of that software comes out, but the tutorials stay the same and we're still using 06 tutorials for like Maya 2011
like I was saying before, its more than just having Maya visual aid but also having, yeah, being able to have examples of what you are doing, so instead of just unit set up a spotlight 40° behind the camera, saying we do this because of this and really explaining it.
Most 3D artists are visual people. No one wants to read a book.
It's a lot easier than like a book would say file>reference>options.
Nothing is ever going to replace a tutor.
I don't think you have to go to a 3D college in order to learn 3D.
It's like anything, you have to practice. Practice makes perfect.
I mean if I sit there and listen to my tutors do something, at the end of it have nothing on my show real.
If you don't have it you pretty much don't have a job.
And you make mistakes when you practice which is the best thing, if he only sees something then you don't see the mistakes that can be made through doing it. When you actually do it and you are stuck with a problem and your going, ah how would he do it, and you have to work it out, you figure out how it is supposed to be done, do it properly.
Before we start a new shot or scene with completely different lighting we re-light, like, five different real-life scenes that are completely separate from that but have similar lighting in order to make sure we've got it before we start the shot.
Apart from the fact that you know if your stuff doesn't look like the tutors you have probably done something wrong. But there is no real way to check that which I guess is one of the major problems.
There are some like 3D render.com. It is an exercise and a competition to be able to enter those. But at the same time if you win you get critique from some of the top lighters. Same with 11 seconds. If you win 11 seconds you get, your prize, is feedback. Which is cools the fact that the feedback is incredibly important, in the industry. But there are other ways that people have gone about doing that way I guess if you can incorporate that, if you can make it social. Competitions I guess are the best way to go about it, where offer you offer feedback. But then you want to be able to access feedback without having to win anything.
If it is drawn out I want to throw the computer out the window ha-ha-ha. I'm not very patient, I like to

be able to watch a tutorial. This is why we do this, here it is applied, done, move on.
It's funny because the screen looks like Maya so I go to move some thing and I'm like, wait! I'm in the wrong screen, go back to Maya ha-ha. It would be cool if it was interactive that you could spin stuff around and see what's going on.
I think it's probably better to for you work out the problem yourself, which I find is the good thing about self-directed learning as you are forced, you're not spoon fed, you're forced to find the problem.
Yeah I don't tend to look at you YouTube for tutorials or anything like that for tutorials any more because they just looked bad.
The stuff you buy, the DVDs and stuff, are quite good especially concept art. They tend to be quite good.
The only problem is that with students, students don't have the money, so students tend to go online.
Well it depends because the online media is dependent on the Internet capabilities of where ever you're at, and where we're at the Internet goes on and off all the time so use it to do something and the Internet goes off you lose your motivation straight away. At least for the DVD you can sit at home and watch on TV, watch on your computer, its just more reliable you know if you want it, it's there, you've got. But yeah the Internet is not so reliable
I think it comes back to those visual aids again. Like, this is done for this purpose and this is how you execute it. Rather than you're doing it and while you are doing it in Maya you're showing someone how to do it in Maya, you're explaining to them why you're doing it, its too much information in one go.
If it's in stages and its consistent throughout the entire tutorial. You know that you're gonna hear what you're going to be doing next
If you don't you're amazing, ha-ha because I don't know how people do it.
I am impatient so I like to have it there, turn it on, watch part of it, switch it off, do that part, switch it back on see what they've done.
like sometimes the computer doesn't accept the file or something goes down, you just want to be there, switch it on, sweet, do it. But that never happens, not with Maya anyway.
Good old Maya ha-ha.
And it would be cool if you could scan through tutorials. So instead of being, like, from start to finish, kind of like DVD menus we can click on each area you want to do. So if you only want to focus on texturing then you'll just be able to click on texturing and go straight to that page or tutorial.
The biggest problem is just the fact that people are wily nily throwing out tutorials and they have no teaching ability and it's a waste of time.

Being a good teacher just makes such a difference, and we noticed that in real life as well with tutors, if they come in and are good at doing something and they can't teach, it is of absolutely no worth to students because they can't communicate.

Participant P5's Significant Statements

First and foremost I can go at my own pace. There is no rush and also if I want to go ahead I can just skip through it.

Tutorials that are worth anything are usually done by pro, unless you are on YouTube.

It's also a nice close-up of the viewport in Maya, where in a classroom you would have to do it by ear or you be sitting in the back and you can't see the thing.

I have watched where people giving tutorials are very good at what they do, but they're not very good at communicating what they do.

There is a lot of people that will take for granted that you just know what they're doing and they don't explain it.

Then there are tutorials that a step-by-step on how to achieve a goal and then there are tutorials to explain why each thing is done. Those tutorials in the latter are much better.

Um, there is of course sometimes the mic, which the person giving the tutorial isn't the greatest, so it's either very soft or scratchy

People don't speak loud enough sometimes.

Tutorials from Maya five are not relevant at all.

Perhaps the people who give the tutorials are somewhat charismatic [...] my presumption, that a lot of people probably just, like, make a tutorial for us and they are not very social.

Pausing the tutorial, a lot of the time. While I don't really blame it, well it's one of the things I like about it, the fact that I can pause and play around with it.

I would say that pausing is something that I do, not the majority of people would do, just because that's the way I learn.

My biggest problem with self-directed learning is if I have a question that can't be answered.

I'm not too sure how to combat that, maybe a Q&A? They could be at the end of the tutorial like a commonly asked question type of thing which would have to be developed through some sort of feedback.

Because it cuts to the chase, hands down. For me personally I prefer those as well. I don't want to see the guys face when he is talking, I'm not really interested, I'm here to do 3D.
You get to see everything that is relevant.
3D is so relevant to the program, that's what I want to see all the time. I don't want to miss a single mouse click because that could just mess up everything, and, in a lot of tutorials I have done if you lose any part of it then it is kaput. I would say it is a convenience thing and cuts to the chase.
Practice makes perfect.
It's one thing to watch a tutorial or something that self-directed based, but you need to put it into practice and do it at least once or twice, which is why I mentioned earlier I like the pause thing so I can play around with each tool as part of the element the whole tutorial is teaching me and play around with it at my own pace and work it out.
Maybe I'm doing something completely irrelevant to the tutorial but one of those tools I can apply and be like oh maybe this will work.
The more you play with it the better you learn it.
The better I get at something faster I do it, which means my pay cheque will be bigger at the end of the day because I will be more qualified to do what people pay me to do.
...modeler specialist and he said to us you can model something that looks beautiful but if it took to 6 months no one is going to want you because it's all about doing it well and doing fast.
I would say finding motivation is probably the hardest thing.
What I do for self-directed is rigging, so it is very technical based. So pretty much if it doesn't work I know that the practice was incorrect.
I would say that's a negative about practice, you don't know what you're practicing is right or wrong, because if you practice the wrong thing too many times it can become a bad habit.
They actually give back feedback relevant to your work and I think that is something self-directed learning can never really do, because that's where the value of critique comes in and until we have A.I. I don't think it may happen any time soon.
There is a lot of people that will even divert off the main course of the tutorial to show you a tool, and be like well that's irrelevant but you know you can do this with that tool and then go back to the tutorial, and for me that is real education.
A lot of the time for me it's the small things I miss. A lot of good tutorials will have a large emphasis on the important tools and mechanics behind what they are trying to teach and the little things might be

droned out as just normal talk.
A lot of the time, like mentioned before, I like to play around with the tool and sometimes there are tutorials that go a bit fast, or, as something I am completely new to like when I do a little self-directed study for dynamics, something that had not been taught yet. That I would pause quite frequently because I don't know what's going on. I don't know the UI ect.
So even though they tend to steer from the goal there is still something of value their, so I don't label it as a negative.
They will explain exactly what is in the tutorial and then I can know whether I should bother looking at the rest of the tutorial. Because normally with archives, that could be anything up to 3 hours worth of tutorials, and I could watch it all and it would benefit me nothing. There are tutorials that don't have that which you can waste time on.
When the guy or lecturer will start it he will say in the beginning, maybe for 15 seconds, he will quickly explain what he is going to run through which is really nice, especially when you have tutorials that are labeled video one, video two, videos three, and you can just quickly watch the first 10 seconds of each of them and then know exactly which tutorial you are searching for.
I can just pause the tutorial go away take a break or whatever and come back, where lecturers work on a pay cheque so they're there during that set hour and that's it.
Where as self-directed study I can wake up at 10 and the lecturer is quietly waiting away on my hard drive.
...can be put on a scale all the way from YouTube to Gnomon.
It's basically from scratch to finish and branches out every now and then with relevant things to tools, maybe further explanations on what you're doing or why you would do it that way. Maybe alternative ways to achieve the same thing, and then why are you doing it this way which is quicker and why it's more efficient and then ultimately you get to the goal.
A lot of tutorials will have the final goal put on the cover of the DVD like big dragon for the modeling thing, or something along those lines and you will be like wow, and then you'll do the tutorial and that's what you'll have at the end of the day and you'll be like, sweet, I made that, but the tutorials helped, but I made that.