Digital games for architecture and spatial design: Investigating game design and facilitation of learning

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The development of design thinking and practice amongst university students is often viewed as problematic. Within higher education architecture and corresponding design disciplines, the design studio remains the pivotal component of the program where students are thrown into the process of design before they know what it actually represents. Over the last few years, the complexity of the design studio has expanded with increased demands of manual and digital representation skills, the acquisition of a range of new software understanding as well as research skills. A key challenge for design teachers is how to manage these expectations while giving students suitable orientation to their selected discipline.

Video games, simulations and virtual worlds are current technologies advocated as artefacts and spaces for learning. A deeper understanding of educational game design and alignment to learning outcomes can reveal opportunities for the growing challenges in design disciplines.

This study uses a mixed method approach to capture perceptions and personal impact of the use of an educational digital game developed to facilitate spatial understanding and design in a collaborative learning environment. It explores the factors that influence the outcomes of a digital game-based learning (DGBL) approach and uncovers requirements for the design and delivery of a digital game as well as the facilitation of student learning. The study draws findings from developing an educational game, surveying students on their experiences as well as through interviews. In addition, images produced by students as part of the game are analysed.

The findings indicate that the students had positive perceptions of the value of a DGBL approach to spatial design and collaborative learning. For many, it facilitated a reflective process and provided scaffolding for subsequent learning within their course study. The research exposes the challenges for students in relation to collaboration, feedback and personalisation. A recommendation emerging from the research is the importance of authentic, situated frameworks, and developing clear roles and strategies for collaboration. In addition opportunities for personalisation and self-expression facilitate the creation of engaging and meaningful experiences in design-based contexts.

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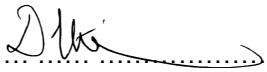
Signed 

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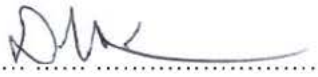
Signed 

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Abbreviations

DGBL	Digital Game-Based Learning
GBL	Game-Based Learning
LMS	Learning Management System
MMO	Massively Multiplayer Online game
MMORPG	Massively Multiplayer Online Role Playing Game
MUVE	Multi-User Virtual Environments
UNSW	The University of New South Wales
ZPN	Zone of Proximal Development

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Chapter One: The Challenge of Design

Introduction

> "We have begun to see cultural evolution as an informal, collective, generational process of design." (Schön, 1983, p. 77)

Donald Schön (1983), a highly influential researcher in design thinking and reflective learning, problematizes the concept of design in his seminal book, *The Reflective Practioner: How Professionals Think in Action*. He argues that our definition of design has broadened and continues to be, which can run the risk of unique qualities specific to the professions being missed. However, he suggests an advantage of opening a possibility for deeper discovery of the design process. Schön (1983, p.77) explores the lessons from architecture, which he argues "functions as prototype for design in other professions." The pedestal upon which Schön places architecture in relation to design thinking is based on his recognition of it being the oldest design profession and thereby most likely to reveal a fundamental process that can transcend the differences of other design professions. Schön's focus is on what he calls 'reflection-in-action'. The theory serves to guide to professional practice.

Schön's influence continues today and his reflective vocabulary has become part of the language of education and design disciplines. Within higher education, architecture continues to face challenges in the development of students' design thinking and learning. The design studio remains the pivotal component of the program where students are thrown into the process of design before they know what design actually represents. The pedagogy follows a 'learning by doing' approach. Bloomer (1998, p. B9) argues, "The studio, as I and many other architecture educators conduct it, is less about training students to design various building types in certain styles than about teaching students how to learn, and how to learn broadly about the circumstances and possibilities of a building before and during the process of designing it." Like Schön, Bloomer (1998, p. B9) describes the prevailing pedagogical mode as collaborative and conversational where the studio projects are explicitly creative exercises to serve as "vehicles for students' self-expression and self-understanding." While Bloomer's discussion of the architectural studio was written 15 years ago, the learning and teaching model still continues today. A key difference is in the technologies available for students, which creates a wider set of possibilities together with new challenges.

Lawson (2005, p. 6), an emeritus professor of the School of Architecture and previous Dean of the Faculty of Architectural Studies at The University of Sheffield, and having studied both architecture and psychology, challenges the way design is taught, arguing that "the designers of today can no longer be trained to follow a set of procedures since the rate of change the world in which they must work would soon leave them behind." Lawson suggests greater use and exploitation of technology that can provide closer relationships to the changing professional landscape. He identifies the problem of the design studio being too disconnected from the real world, where budgets, client specifications and time constraints do not come into play. Lawton (2005, p. 8) argues this disconnect can result in the design studio becoming "a place of fantasy removed from the needs of the real word in which the students will work when they graduate." Digital games offer an approach to address the design studio problem through engagement in authentic scenarios and challenges. Other potential solutions could include greater engagement in collaborative work to minimise a limited mindset and decision making process that occur when there is a focus on simply satisfying the individual student and the tutor.

Design is a complex process involving a plan of action to achieve an end result defined by numerous requirements and constraints. The challenge for students is in coming to terms with the various considerations and their resolution. This is particularly demanding for students early in their studies where no formal training has been provided in the process or in the meaning of design. This can lead to confusion of prioritisation of considerations and the expansion of the design brief. Students may draw on architectural precedents and theories for understanding the design process but even so, are limited in their architectural language of design. A common student approach to design may be to allow the functional requirements to drive the form. This approach can ignore the event and element of time that is integral to architectural spatial meaning. Within the first year design studio of Architectural Studies at The University of New South Wales Australia (UNSW), students' learning covers the intricacies of design, the development of manual and digital representation skills for architectural drawings, the mastery of a range of new software, as well as research skills. With the increasing demands of design-based learning and the confusion in architecture around the "multiplicity of voices" (Schön, 1983, p. 78), a key question is how to manage these learning expectations while giving students suitable orientation to their selected discipline.

Video games, simulations and virtual worlds are current technologies advocated as artefacts and spaces for learning, with their numerous benefits declared in academic publications and the mainstream press. In recent years, the playing of digital games has been promoted as offering

rich learning environments (Prensky, 2001; Foreman, 2003), engagement through narrative (Barab, Arici, & Jackson, 2005), motivation and challenge (Annetta, 2008), insights to an understanding of the nature of learning (Gee, 2003; Shaffer, 2006b), and even as tools to solve real-world problems (McGonigal, 2011). Gee (2003) identifies how video games reflect principles of good learning. Aldrich (2004) promotes the benefits of games and simulations in developing digital literacy as well as inventive thinking. Foreman (2003, p. 16) argues the significant advantage of immersive 3D games over traditional lectures or readings is that "learning through performance requires active discovery, analysis, interpretation, problem-solving, memory and physical activity." Squire (2006) suggests games can give real world context and direct engagement beyond content through active decision making and critical thinking. Shaffer (2006a, 2006b) advocates epistemic games in helping students deal with issues and solve real problems that do not have standardised answers. In addition, Shaffer (2006a, p. 224) argues they facilitate transfer, allowing students to "deal more effectively with situations outside of the original context of learning." Annetta (2008, p. 233) argues that games can "motivate learning by challenging and providing curiosity, beauty, fantasy, fun, and social recognition." Digital games are often promoted as effective in the learning of 21st century skills, epitomised in Prensky's (2006) mainstream book *Don't Bother Me, Mom, I'm Learning!: How Computer and Video Games Are Preparing Your Kids for 21st Century Success and How You Can Help!*

Tobias, Fletcher, Dai and Wind (2011, p. 209), in their review of literature on empirical research on games, suggest "games hold some promise for the delivery of instruction." However, they are tentative with this recommendation, noting further research is required, with game developers needing to become more familiar with emerging research findings to improve the instructional usefulness. Lang and O'Neil (2011) reiterate this view in their discussion on using computer games to teach problem solving for adult learners. While their empirical research studies with the game *SafeCracker* had positive benefits as an instructional tool, they suggest pedagogical research that could include cognitive load theory and interactive multimedia, can help guide game designers in developing the instructional support that achieves targeted learning objectives.

The literature identifies a broad range of benefits of digital games for learning. Games provide a medium for learning rather than act as the full message. The effectiveness of the learning is tied to the pedagogy, the way the message is designed and integrated with the medium. This exploration is a key focus of this thesis. In addition, the study investigates the question of what opportunities gameplay can provide to a design thinking orientation, an area that is limited in

current research. My proposition is that digital games can provide opportunities for engagement, collaboration, personal connections and creative inspiration that can enrich learning around design thinking. In order to evaluate the potential benefits, the research study aims to explore the wide range of factors that influence a digital game-based learning (DGBL) approach within a spatial design course context. It covers the design and creation of an educational game as well as implementation within an elective course available to design students across various programs of the Faculty of Built Environment, UNSW. The research aims to identify and explain how a digital game-based approach influences student behaviour and learning, including perceptions, motivation, and understanding of the subject. Through the game experience, the research intends to answer if, how and why digital games can be effective for learning in the design disciplines of the built environment. The research strives to expand on the broader understanding of DGBL, and in doing so, support the development of guidelines for these types of approaches that can be applied more broadly to other disciplines.

Research Questions

The key research questions are as follows:

- What factors influence the outcomes of an architecture digital game-based learning approach that is engaged with spatial design within an interdisciplinary elective course, located in the Faculty of Built Environment, UNSW?
    a) What are the design considerations and implications for producing an educational digital game for a specific course context?
    b) How does such a digital game facilitate learning within this context and what learning outcomes are produced?

The question on the design of games is guided by theories and what the literature identifies as key features of games that are best for learning. In addition, consideration is given to the type of learning and outcomes desired for the specific course context. A mixed method approach is adopted. It includes a qualitative evaluation of the game design and development, evaluations of graphic content produced through the game, interviews with students together with observations and critical reflections. These components of the study address both parts of the research questions in understanding the game formation and impact. The quantitative strategies include online analytics of student activity and a survey, and give a broader representation of the themes of learning and student perspectives as well as prior knowledge

and skills that can influence the outcomes. The multiple methods of data collection provide for triangulation in the analysis (chapters seven and eight).

As a consequence of finding answers to the research questions, a deeper understanding of the influences digital games have on learning is explored. In addition, consideration is given to the development of strategies for creating engaging and meaningful experiences using technology. The beneficiaries will be students, whose spatial and design learning may be better facilitated, and educators in the tools and approaches available. UNSW has a number of priority goals as part of the Learning and Teaching Enhancement Plan. This research aligns well to - "Enhance learning and teaching environments - virtual and physical, formal and informal - that will support and encourage learning" (Learning & Teaching @ UNSW, 2008, p. 2). The research explores virtual learning environments using both formal (class activities) and informal (play) approaches for a potentially enhanced learning outcome.

It is assumed that digital games have the potential to empower students in their learning as well as teachers in their practice. In order for this to be realised, more effective supporting material is required to aid academic staff in the use of digital games. This should include guidelines, case studies, and exemplars from current practice, to help improve the delivery quality of DGBL and support future planning and resource allocation. The research I have undertaken corresponds to this aspiration.

Why Digital Games

Beyond the many voices of support for DGBL, gameplay is becoming a ubiquitous activity in the lives of everyday Australians. Bond University conducted the *Digital Australia 2012 (DA12)* survey for the Interactive Games and Entertainment Association and identified the appeal and engagement of games to a growing audience (Brand, 2012). The survey revealed that 95% of Australian households have at least one device for playing games. This is up from 79% in a similar survey conducted in 2006 (Brand, 2007). The *DA12* survey found the average age of Australian gamer (classified as anyone who plays a game) is 32, which has steadily increased from 2005 to 2011 (Brand, 2012). Over this time, the gap between male to female gamers has closed from 38% female gamers in 2005 to 47% in 2011, with most gamers playing at least an hour every other day. Another statistic relevant to my research study around collaborative gameplay is that 70% of gamers enjoy playing games with others. The attitudes towards games are generally positive with over 80% of players believing games are mentally stimulating, educational and

create culture (Figure 1.1). While over 60% of non-gamers believe games are mentally stimulating and create culture, less than 50% believe they are educational. The demographics of Australian gamers closely match that of the USA, the world's largest market of commercial video games. The Entertainment Software Association's (2013) report, titled *Essential Facts about the Computer and Video Game Industry: 2013 Sales, Demographic and Usage Data*, identified gamers in the USA being comprised of 45% female to 55% males, with the average age of a gamer being 30, and 62% preferring to play games with others. The statistics from both the American and Australian surveys suggest that the bulk of university-aged students of today are experienced game players and see their value as tools for education and collaboration.

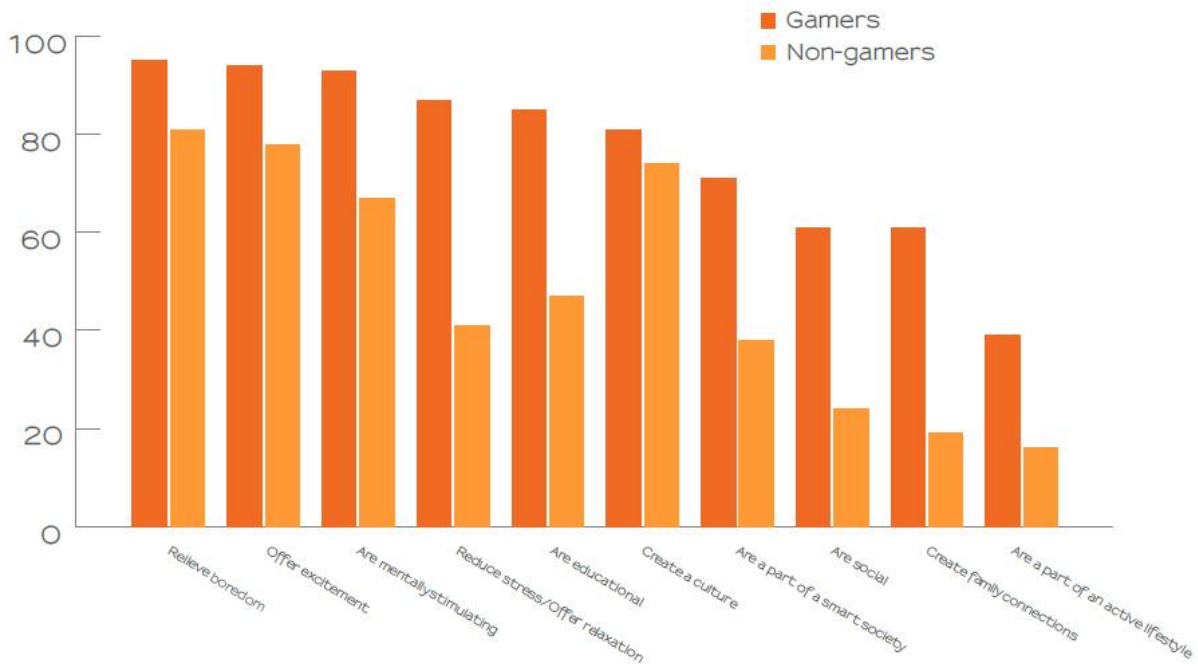

Figure 1.1: Views of gamers and non-gamers on the role of games (Brand, 2012, p. 17)

The omnipresence of gameplay, while being an attraction to the use of digital games for learning, is not the main argument for its choice in this research study. A key reason is that architecture and games are a good fit and their complimentary qualities offer great potential for a study of learning through a digital design game. The design of architecture has many game-like characteristics. There are rules and guidelines that define the nature of the process and outcome. There is a clear objective combining functional, aesthetic, environmental, financial requirements, as well as a range of other considerations. It is a problem solving activity and can be playful in the free experimentation of ideas.

Schell (2008, p. 330), coming from a game design background, argues that “architects and game designers are close cousins. Both create structures that people must enter in order to use. Neither architects nor game designers can create experiences directly - instead, both must rely on the use of indirect control to guide people into having the right kind of experience. And most important, both create structures which have no point other than to engender experiences that make people happy.” This perspective illustrates the close connection of architecture and games in creating spaces and human experiences. Götz (2007, p. 134) extends on this idea arguing that game designers and architects follow similar approaches, experience similar challenges and employ common tools, stating “in few other artistic spheres are there so many congruent tools used as in architecture and game design.” The sophistication of the 3D worlds of current games creates an overlap between the disciplines where architects draw on game technology for visualisation and spatial simulation and game designers look to architecture for styles and spatial solutions.

In *Games in Early Design Education: Playing with Metaphor*, a study of the use of games for beginning students in architecture, landscape architecture and urban design, Woodbury, Shannon and Radford (2001) state that they started with the view that play and games captured the essence of good designing. Woodbury et al. (2001, p. 202) argue that “experienced designers engage in play and reflection as principal tools in their designing repertoire, whilst frequently relying on informal rules for form-making which results in recognisable styles of individual and collaborative work.” Since the design process corresponds well to a game experience, it would appear to follow that a design game could draw on the strengths of games while not diminishing the architectural focus.

The genre of design games has been explored in a number of studies (Mazé & Jacobs, 2003; Brandt, Messeter & Binder, 2008; Triantafyllakos, Palaigeorgiou & Tsoukalas, 2011) and advocated for its benefits of idea generation, creativity, communication and group work. Triantafyllakos et al. (2011, p. 228) argue design games can “promote the establishment of a non-threatening, playful and creative atmosphere and constitute an excellent means for engaging participants, and especially students, in a focused and productive participation.” Brandt et al. (2008) provide a model for participatory design games that does not significantly differentiate gaming and prototyping, suggesting all collaborative design involves significant game-like qualities and elements of play. While these studies have been non-digital in the gameplay, they offer insight in the nature of the student experiences and benefits.

Following the view of architectural design being a game-like experience, this research endeavors to employ a design game as a collaborative, exploratory activity. Drawing on participatory and design games, play is a focus rather than competition or winning. The game for this study aims to encompass subject specific learning, creative thinking and expression in spatial design, as well as collaboration and adaptability in working with others and building on their ideas. In this way, it corresponds to Shaffer's (2006a, 2006b) description of epistemic frames and epistemic games as fundamentally being about ways of thinking like professionals, where experiences in one context help students deal with new situations. It is viewed that these goals fit in well with approaches and learning typical to design studio. The study serves well as a foundation that would allow transferability to design studio contexts in the future. The research findings would thereby benefit students and teachers who can employ a DGBL approach to help understand complex design concepts.

Thesis Structure

This thesis is structured into three main sections covering context, approach and outcomes. In order to investigate the full scope of a DGBL approach, the research has extended from game design to implementation and evaluation of the user experience. While the structure of the thesis suggests a traditional approach and pathway, the reality involved a spiral mix of contextual investigation, development and data analysis.

Context

The second chapter, following this introductory one, explores the meaning of games, drawing on definitions from game designers, researchers, theorists and a range of other perspectives across disciplines. Through this analysis, I draw out my own definition of games corresponding to the goals of this study.

Chapter Three describes the context for the research by discussing the course in which the game is located together with the pedagogical approach taken.

Chapter Four investigates theoretical positions suited to games and learning, with discussion on situated learning and activity theory. It compares approaches and findings of recent studies in game-based learning (GBL) tied to design thinking and practice. Through this evaluation, gaps in the literature and existing knowledge are uncovered.

Approach

Chapter Five unpacks the approach taken to this research study. It discusses the epistemology, theoretical perspective through to methodology and methods employed. Following the view that different methodologies expand the questions that can be answered, a mixed method approach is adopted to allow freedom of choice for procedures deemed best for particular purposes. Social constructionism forms the grounding for the epistemology of this research and view of learning, together with an interpretivist theoretical perspective, where meaning is constructed through engagement with the world being interpreted.

Chapter Six discusses the process of developing the game. Since the design and construction of the game is a core part of this research, the chapter is relatively longer than others and covers frameworks for educational game design, review of games in light of the frameworks as well as the use of the principles for my own game design. The development of the game has drawn on situated learning theory and an understanding of the architectural context. In addition, it takes into account the limitations for what is feasible to the study. Through the chapter, the first of the research questions is addressed.

Outcomes

Chapter Seven begins the outcomes section of the research with a focus on the findings gained through the survey and online analytics data. The chapter uses the quantitative data gained to discuss the broad perceptions of the DGBL experience, with qualitative data helping to explain the findings. It explores themes of learner satisfaction, relevance, collaboration and learning. It also compares the perceptions of different groups, namely male to female and younger to older students.

Chapter Eight follows the perceptions of learning discussion with an elaboration of the nature of the DGBL experience and meaning to participants. It explores the personal impact of the game on students, learning outcomes, benefits as well as elements that hindered the experience.

Conclusion

Chapter Nine concludes this thesis with a summary of findings as well as addressing biases and limitations, contributions to new knowledge and recommendations for practice, theory and further research.

Part One: Context

Chapter Two: The Meaning of Games

Introduction

> "Playing a game is a voluntary attempt to overcome unnecessary obstacles" (Suits, 1990, p. 34).

Games have been a popular pastime throughout history. However, the term 'game' comes with a degree of baggage and debate over what it actually means. Many definitions have been proposed with some scholars being precious with what counts as a game. This chapter explores various definitions from theorists, researchers, game designers and other perspectives. Through an evaluation of the meaning of games, a new definition is proposed corresponding to the specific context of this research study.

Defining a Game

An important starting point for any investigation on game-based learning (GBL) is the question, what is a game? The answer is not clear cut. The challenge relates to the term being used in many different contexts. Examples include 'gaming the system' as a strategic or tactical way to manipulate a situation, an area of expertise as in 'comedy is not my game', a target or object of ridicule or attack as in 'fair game', or an activity regarded as a contest of rivalry or struggle as in the 'political game'. These instances, while not directly related to this research study, provide insight into the complexity of deriving meaning to the nature of a 'game'. In terms of video and other digital games, there are many types from puzzles to immersive role playing experiences, games that are played independently by individuals to ones that are social and collaborative. Researchers, educators, designers, sociologists, theorists and philosophers have different views about what actually constitutes a game.

Some game definitions focus on the system and structural characteristics of the game delivery (Avedon & Sutton-Smith, 1971; McGonical, 2011; Salen & Zimmerman, 2004; Schell, 2008). Other definitions engage with the nature of the experience such as uncertainty and make-believe (Caillois, 1961; Crawford, 1982;, Suits, 1990). A third group attempt to balance the game systems and the experience (Abt, 1970; Aldrich, 2009b; Gee, 2005). There is a clear debate over what are the defining characteristics of games. Jesse Schell (2008), a game designer and author of the *The Art of Game Design: A Book of Lenses*, argues that a game is not the experience but

rather the way it is enabled. Bernard Suits (1990), a late philosopher who explored his interest in the nature of games and play in his book, *The Grasshopper: Games, Life, and Utopia,* gives more emphasis to the experience and activity as represented in the opening quote of this chapter. The challenge in creating a definition is in encapsulating the essence of what games are without being too narrow or too broad.

Table 2.1 shows a comparison of a variety of perspectives of key game qualities and characteristics, drawn from game definitions and descriptions of notable leaders in the field. It is organised by level of consensus, with the most agreed upon elements at the top down to the least at the bottom. As the table indicates, there are very few traits that have a majority level of consensus. All agree that rules are important in defining games with the goals/outcomes and structured system/tools being the only others with a majority agreement. Approximately 45% advocate to the defining traits of activity, conflict and the voluntary nature of participation, while 36% suggest interactivity/decision making, involves player(s), and representational, are key elements. The are many items that have a low degree of consensus, such as the characteristics of challenge, inefficiency, internal value, identity and that games must be won or lost. It is worth emphasising that the table represents characteristics highlighted as defining elements of games. It does not represent the only characteristics the authors believe are part of games. While the scholars selected are well regarded, there are many others with a further diverse range of views. It is clear that there is no consensus on what exactly the term 'game' represents. While scholars dispute its definition and the specific elements constitute and characterise a gameplay experience, their reasoning contributes to a deeper understanding of the meaning of games.

Activity and Play

The activity component of gameplay is raised by scholars and developers as a key element that defines games (Abt, 1970; Avedon & Sutton-Smith, 1971; Caillois, 1961; Schell, 2008; Suits, 1990). Clark Abt (1970, p. 6), a professor with an engineering background, suggests four key ingredients in his definition, "a game is an *activity* among two or more independent *decision-makers* seeking to achieve their *objectives* in some *limiting context."* Schell (2008, p. 37), coming from a game design background, simply suggests "a game is a problem-solving activity, approached with a playful attitude." Roger Caillois (1961, p. 9-10), a French sociologist and author of the highly influential book on play theory, *Man, Play, and Games*, defines games in

relation to play, where play is an activity that is free, separate, uncertain, unproductive, governed by rules and make believe. From a philosophical perspective, Suits (1990, p. 34) also gives focus to activity and play stating that "to play a game is to engage in activity directed towards bringing about a specific state of affairs, using only means permitted by rules, where the rules prohibit more efficient in favor of less efficient means, and where such rules are accepted just because they make possible such activity." These definitions place play and its activity at the heart of the meaning of games.

In relation to the approach in this study, activity and play are core components of the experience and thereby learning. The term 'play' can be as complex to define as a game. In *The Ambiguity of Play,* Brian Sutton-Smith (1997), a play theorist identified as "the most prolific and important scholar of play and games in the twentieth century" (Salen & Zimmerman, 2004, p. 78), identifies seven types of play: progress, fate, power, identity, imagination, self and frivolous. Katie Salen and Eric Zimmerman (2004, p. 304), as game designers and educators, have a simpler view of play as "free movement within a more rigid structure." The play types of identity, self and imagination align to freedom, common in open world and collaborative games, while fate and power correspond closer to competition.

Rules, Goals and Outcomes

Rules provide limitations and structure to play. It is not surprising that this ingredient of games is the most agreed upon defining characteristic (Table 2.1). A goal that corresponds to game outcome and typically guided by rules is the second most agreed upon trait that is important to a definition. Jane McGonical (2011, p. 21), the Director of Games Research and Development at the Institute for the Future, suggests goals give players focus and orientation through a game. Goals in this context refer to objectives within the game-rule system, as opposed to player desires such as personal reward from amusement, entertainment or even education. Michael Zyda (2005, p. 25), a Professor of Computer Science, University of Southern California, defines video games as "a mental contest, played with a computer according to certain rules for amusement, recreation, or winning a stake." His definition is relatively broad, extending to the wider purpose for playing and thereby not necessarily connected to an embedded game objective.

Salen and Zimmerman (2004, p. 80) provide a game theory definition, arguing "a game is a system in which players engage in an artificial conflict, defined by rules, that results in a

quantifiable outcome." The measurable outcome in this definition could be a win/lose situation, as identified by Schell (2008) in his a game defining traits, or a score. The definition rules out some role playing games that occur in virtual worlds as games because their outcomes cannot be quantified. Minecraft (discussed further in chapter six) is an example. It is an open world or sandbox environment where players have wide level of freedom in their objectives. In this way, the Salen and Zimmerman (2004) perspective considers it a playful activity rather than a game.

Avedon and Sutton-Smith (1970) also suggest a delineated outcome distinguishes games from other activities and pastimes. Clark Aldrich (2009b, p. 1), an author and practitioner who has pioneered and led the use of educational simulations, focuses on the virtual world in which games take place rather than the outcomes, stating that "even physical games are played in a synthetic world structured by specific rules, feedback mechanisms, and requisite tools to support them." The differences between the outcome focus to the environment perspective suggest one way of distinguishing games from simulations, where games are measurable in their outcome while simulations can be more open ended. Crawford (1982) suggests the difference between games and simulations lies in subjective representations versus an objective one, where a simulation aims to be realistic while a game is an artistic interpretation.

Conflict feeds into goals and outcomes and is the fourth most agreed upon trait of games (Table 2.1). Crawford (1982) argues that conflict is vital ingredient in all games, arising from dynamic obstacles that respond to players and interfere in their pursuit of the goal. Salen and Zimmerman (2004) suggest conflict can take many forms from cooperation to competition with single to multiplayer games, and is central to games. Other scholars also identify conflict/contest as a key ingredient of games to create challenge and interest (Zyda, 2005; Schell, 2008). The artificial element of the conflict in Salen and Zimmerman's (2004) definition suggests a boundary from real-life, corresponding to the element of safety identified by Caillois (1961) and Crawford (1982).

Feedback systems, while appearing to be left out of many definitions, also tie into goals and outcomes. McGonical (2011, p. 21) suggests a feedback system is a vital element of games that provides direction for players and communicates their level of success in achieving the goal. In addition, the feedback system would be expected to facilitate the adherence and understanding of the structure of rules and how the game is to be played. As such, this ingredient also corresponds to the interaction trait of games incorporated into the definitions of Crawford (1982), Gee (2005) and Schell (2008).

Within this research study, rules and goals are seen as intertwined elements where one guides the other. A goal leads to an outcome but not necessarily quantifiable. Together, these elements mould the activity and user interaction.

Safety, Make-believe and Identity

Avedon and Sutton-Smith (1970, p. 405) provide a definition that a game is "an exercise of voluntary control systems in which there is a contest between powers, confined by rules, in order to produce a disequilibrium outcome." The voluntary or non-obligatory quality is specified by many as essential to games (Caillois, 1961; Avedon & Sutton-Smith, 1970; Suits, 1990; Schell, 2008; McGonical, 2011). Caillois' (1961, p. 9) argues this in terms of the 'free' ingredient, which if missing could take away from its attraction and "joyous quality as diversion." McGonical (2011, p. 21) argues that the voluntary participation allowing freedom to enter or leave a game is important to ensure it is a "safe and pleasurable activity."

In line with the view that a defining quality of games relate to the choice to play, some authors suggest games should be representational, make-believe spaces to facilitate safety (Caillois, 1961; Crawford, 1982). Chris Crawford (1982), a pioneering digital game designer and well regarded author in the field, which includes the influential book *The Art of Computer Game Design*, defines games by four common factors: representation, interaction, conflict and safety. The representation component suggests that games are systems that subjectively convey an element of reality. This system is safe in that the consequences are less harsh than the real life situation upon which the game is modelled. The view corresponds to Caillois' (1961) 'unproductive' ingredient, where players are no better or worse off by the end of the game. The quality suggests players assume a different persona in a game in order for the severity to be diminished. An example is a game like Blackjack where the player assumes a new identity where real world consequences are ignored. However, if such a gambling activity was played with real money and thereby have real-world consequences, it would cease to be a game following Caillois' (1961) and Crawford's (1982) definition. While full voluntary entry to play is not tied to this study, a sense of safety is deemed as important in order to facilitate creative freedom and risk-taking.

Table 2.1: A comparison of elements of game definitions

	Abt (1970)	Aldrich (2009b)	Avedon & Sutton-Smith (1971)	Caillois (1961)	Crawford (1982)	Gee (2005)	McGonical (2011)	Salen & Zimmerman (2004)	Schell (2008)	Suits (1990)	Zyda (2005)
Governed by rules to provide limitation to play	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Goal/outcome focus	yes		yes		yes (tied to conflict)		yes	yes	yes	yes	yes
Structured systems / tools		yes	yes		yes	yes		yes	yes		
Activity	yes		yes	yes					yes	yes	
Conflict (incl. contest) / dynamic obstacle			yes		yes			yes	yes		yes
Voluntary			yes	yes			yes		yes	yes	
Interactivity/decision making	yes				yes	yes			yes		
Involves player(s)				yes		yes		yes	yes		
Representation / artificial / virtual world / make-believe		yes		yes	yes			yes			
Safe (not severe in consequences)				yes	yes		yes (linked to voluntary)				
Feedback system		yes					yes				
Quantifiable outcome								yes	yes		
Unpredictable / uncertain				yes		yes					
Challenge									yes		
Inefficient										yes	
Internal value									yes		
Problem solving									yes		
Involves player identity						yes					
Separate				yes							
Win / lose									yes		

James Paul Gee (2005, p.82), a researcher with a philosophy and linguistics background, looks at games from a learning perspective and gives focus to identity in his definition, “This complex system is an emergent property of the (sometimes not fully understood) rules that the designer has built into the game and the (never predictable) interactions of the player (in his or her gamer identity) with this rule system.” Corresponding to Caillois (1961), Gee (2005) identifies the uncertainty of the interactions and outcomes. While this can provide challenge and engagement in the gameplay experience, it can also create anguish if it is not free from reality.

Educational Games

Beyond the wide range of definitions, there is even a more disperse set of names being used for educational games. The term ‘serious game’ is often used interchangeably with educational games although there is a level of consensus that it is a game designed for purposes other than pure entertainment, which can be education, corporate training, or strategic communication (Zyda, 2005). In the book *Serious Games*, Abt (1970, p. 9) states that educational games “have an explicit and carefully thought-out educational purpose and are not intended to be played primarily for amusement. This does not mean that serious games are not, or should not be, entertaining.” Abt’s definition of educational games ties to the purpose but still corresponds to traditional games. The element of fun encapsulated in the idea of entertainment, is not a prerequisite for a game but rather an engaging quality. Fun or entertainment, however, would provide a strong incentive for playing the game.

Aldrich (2009a, xxxii) identifies the ‘babel problem’ of the lack of a universal name, questioning whether the term ‘serious games’ or ‘educational simulations’ should be mainstream terms. He argues that the lack of a standard name has hindered progress and development within the field due to confusion and communication problems. Aldrich (2009a) lists his top 10 terms used for educational games ranging from virtual experiences to sims. Ben Sawyer, co-director of the Serious Games initiative and co-founder of the Serious Games Conferences, and Peter Smith, a professor for the Humanities and Social Sciences, University of Central Florida, devised a taxonomy of serious games and list 14 different names beyond the term ‘serious games’ that are currently being used (Sawyer & Smith, 2008). Examples include edutainment, virtual reality, immersive learning simulations and synthetic learning environments. The term ‘edutainment’ brings together education and entertainment while others focus on the game spaces and their quality to facilitate learning.

A New Game Definition

A standardised definition is difficult to achieve due to the complexity of appropriately providing a distinction to game-like activities while not being overly exclusive. In designing games and applying them for a specific purpose, a definition is important to define one's own terms of reference and set of parameters that are clear to the players. Following an analysis of the discourse, I suggest the following definition – **A game is a fictional activity defined by rules, driven by an objective and encapsulated in an experience of play**.

The fictional quality ensures safety, the activity allows for a process of decision making and interaction that has structure through rules and objectives. For the meaning of 'play', I draw the qualities of freedom and imagination as characterised by Salen and Zimmerman (2004) and Sutton-Smith (1997). The game definition leaves out traits of being a form of contest/conflict, having measured outcomes and the voluntary entry into the experience. While these can be defining factors of some games, they do not represent all games. The definition aims to allow for a broad classification while still valuing distinct characteristics. Traits such as identity, challenge, reward, and feedback are important characteristics but are not vital in its determination of being a game. Rather, they provide key ingredients to achieve immersive and meaningful play.

The game definition does not cover the full scope of the nature of a game experience, and particularly the educational context. My philosophy of learning is that regardless of the activity, be it a game, online discussion, or group project, participant enjoyment and satisfaction will ensure a stronger learning outcome. Learning does not have to be arduous in order to be challenging and effective. The experience of learning should be satisfying and thereby become its own reward. This motivational perspective sits well in a game context, where the elements that engage, challenge and provide interaction underscore the learning goals, player motivations and outcomes.

Conclusion

It is unlikely that a universally accepted game definition will ever be formed due to the wide variety of game types, intricacies and perspectives. This chapter has identified the challenges in forming a game definition, and has proposed suited to this study where activity, structure through rules, an objective and play are core defining components. The definition provides the basis of the DGBL experience within the course context (discussed in the next chapter) and theoretical framework adopted (discussed in chapter five).

Chapter Three: Course Context

Introduction

> "Cinema constructs spaces in the mind, creates mind-spaces, thus reflecting the inherent *ephemeral* architecture of the human mind, thought and emotion." Pallasmaa (2001, p. 176)

This chapter covers the course context for the research study. The opening chapter identified challenges for architectural students in their learning of design. It also highlighted that the consideration of time is often neglected as an element of spatial design. The course, *Cinematic Space*, was chosen for embedding the educational digital game since its objectives correspond well to the research questions. The following chapter explains the reasoning of the course and its structure, covering how cinema facilitates learning of spatial design.

Cinematic Space Introduction

Cinematic Space is an interdisciplinary elective I teach within the Faculty of Built Environment, UNSW. The Faculty has long valued interdisciplinary learning. From the start of 2013, a new faculty-wide initiative was launched called Built Environment Interdisciplinary Learning (BEIL), becoming a core component to all of its seven undergraduate degree programs. Over the 2013 summer semester, *Cinematic Space* became part of the BEIL initiative, engaging students in space and place through interdisciplinary perspectives of cinema and games.

Academics, theorists and historians have explored how film can reveal insight into real architecture (Pallasmaa, 2001; Bruno, 2002; Schwarzer, 2004). Pallasmaa (2001, p. 13) suggests that cinema allows viewers to discover "a more subtle and responsive architecture." The relationship of the two disciplines is further theorised, connecting film to architecture "not solely because of its temporal and spatial structure, but fundamentally because both architecture and cinema articulate lived space" (Pallasmaa, 2001, p. 13). The use of cinema in the classroom is an attractive approach to engage students in scenes of life's situations. Commercial films are designed to captivate the audience, immerse them in the cinematic world and build connections with the characters. The film director is an artist who creates places with a distinct perspective compared to that of an architectural designer. The spaces form part of worlds rich in meaning to the film characters that interact within them and to the story that unfolds. Pallasmaa (2001,

p. 22) describes these spaces as “architecture of the mind”, incorporating mental images, memories and dreams. Schwarzer (2004, p. 40) extends on this view describing the architecture as not only “composed of sensation but also memory and imagination.” An analysis of the director’s vision can therefore provide insight into the nature of space and place and our real-life connections to them.

Cinematic Space explores the connections between architecture and film. It elicits meaning of spatial experiences and spatial design through the analysis of film as well as filmmaking. The insertion of a DGBL approach aims to provide a vehicle to initiate and heighten this engagement. In particular, it provides an opportunity for students to collaboratively experience spatial meaning as well as a new way of perceiving and engaging with the design process. Learning occurs through a situated experience where students design spontaneously in an online space and actively interact with other players. This type of learning corresponds closely with the assessment tasks. It is assumed that novices do not consider the theme of time and lived experience in spatial design. The game affords the opportunity to engage with these considerations both in a social context through peer interaction as well as in non-social spaces by individual exploration of the game space itself and movement within it. These learning experiences are extended into assessment tasks. The game design (discussed in chapter six) is closely aligned to the course learning objectives and the aims of the BEIL initiative. It achieves this by introducing interdisciplinary enquiry as well as facilitating work in collaborative interdisciplinary teams, thereby developing skills for professional practice.

Cinematic Space is a course designed for senior undergraduate and postgraduate students who are capable of greater rigor in interrogating new subjects. It is well suited to a DGBL approach. Films, like games, immerse their target audience into rich imaginative worlds and in doing so give their audience a new lens to the experience of space. The course is themed around space, place and time, using film as a lens for this exploration. Through the course, students come to understand the nature of spaces within film, extended through the process of making short films. In addition to a new thinking around space and place, students are exposed to a cinematic approach to the design of architecture. The approach involves using film as a case study for architectural research in the same way real buildings may be used, with the difference in the consideration of the element of time. Key components of the filmmaking process, including storyboarding of sequences through space, framing and composition, also contribute to this cinematic way of thinking about design.

Cinematic Space 2013 Course Structure and Description

The *Cinematic Space* course of 2013 took place over the condensed summer semester period of January to February. Classes were three hours a day, running three days a week for four weeks. An additional two weeks after the last formal class was given for the completion of the major assignment. The course thereby had equivalent face to face class time as the traditional 12 week semester.

Cinematic Space had three key aims:

1. To engage with an architectural investigation focused around the theme of space, place and time.
2. To explore film and cinematography in understanding the creative framing, composition and representation of spaces.
3. To develop technical skills and capabilities in the use of video cameras and appropriate software in the creation of short films.

Cinematic Space captured both the cinematic understanding of space as well as the application to architectural design. This engagement included watching and discussing short films as well as clips from feature films, readings covering theoretical studies of space, place and cinema, critical reflections through a blog and essay, film projects, as well as the educational game. The course had three assessments, two short films and a critical reflection. The first assignment was an experimental film of one to two minutes in length. It required students to develop an idea themed around 'emotion is emotion'. The theme was drawn from Bruno's (2002) *Atlas of Emotion: Journeys in Art, Architecture, and Film*, which explores the way our understanding of the built environment can be informed through film, exploring the motion, emotion and movement through time and space. The major assignment for the course was a team project. It required students to work collaboratively in the making of a short film of no longer than seven minutes, themed around space, place and time. In addition, the team was tasked with analysing existing films as a precedent studies for their own. This assignment was broken into two parts, with an initial pitch presented to the class for review and feedback that could then be developed further and shown at the end of semester. Students were required to document their process and rationale for the film, and produce a report that included story boards, conceptual diagrams and critical evaluations.

Following the theme of space, place and time in *Cinematic Space*, the name given to the game was *Space Place Play*. Within a classroom context, games can be used as pre-instruction (preparation strategy), co-instruction (practice with other learning activity) or post-instruction (assessment). The integration of *Space Place Play* into *Cinematic Space* corresponded to a pre-instructional strategy. By employing the game at the start of the course, it could serve as an anchor to be extended into other activities and assessment work. The gameplay experience thereby aimed to be a launching pad to build ideas and design thinking as well as provide a mechanism for knowledge transfer. In this way, the game facilitated constructive alignment to learning activities through the course.

Cinematic Space and Design

Design, as described by Schön (1983) over three decades ago, is a term that continues to evolve in its meaning and professional application. Ralph and Wand's (2009) review of the literature on the classification of design reveals the complex nature of the term with debate on its defining characteristics. Drawing on key areas of consensus, they formed a definition as "design activity as a *process*, executed by an *agent*, for the purpose of generating a *specification* of an *object* based on: the *environment* in which the object will exist, the *goals* ascribed to the object, the desired structural and behavioural properties of the object (*requirements*), a given set of component types (*primitives*), and *constraints* that limit the acceptable solutions" (Ralph & Wand, 2009, p.126). This definition compliments that of the nature of a game, as formed in the previous chapter. It is therefore unsurprising that GBL researchers have linked design and gameplay. Examples include Woodbury et al. (2001), identified in the opening chapter, who liken the design process to playing a game, and Gee (2004a), who proposes the co-design principle where players engage in design through decisions and actions during play. The key differences between design, as in the Ralph and Wand (2009) definition, and a game, as defined in this thesis, are that design results in a tangible product output and games encompass a fictional/make-believe experience of play.

Within *Cinematic Space*, design is facilitated through the game where players actively create spatial configurations, and through their films, which draw on Pallasmaa (2001) and Schwarzer's (2004) view of lived space and the formation of architecture of the mind, encompassing memory and experience. In both cases, collaboration is essential to the production and learning process.

Conclusion

This chapter identifies the objectives and approach employed in the *Cinematic Space* course. The game and subsequent assessment activities take advantage of collaborative learning with peers from different disciplines, together with reflective practice. The course provides students the opportunity to engage with ideas and processes for both the analysis and design of space. Films and games work well in this context in immersing students in new, rich worlds. The following chapter evaluates learning theory that provides the framework for collaborative engagement and development of design knowledge and skills.

Chapter Four: Games and Learning

Introduction

> "The medium is the message." (McLuhan, 1964)

The previous chapter discussed pedagogical strategies employed in the *Cinematic Space* course context of this study. The learning within the course and *Space Place Play* game is based on knowledge generation that happens collectively with others in the construction of artefacts (social constructionism) as well as through individual reflection and sense making (constructivist). This occurs within in a situated learning context.

As identified in chapter two, games are sometimes characterised by the inclusion of win/lose scenarios. The competitive game type has dominated the market over the years. However, collaborative and cooperative games are emerging, creating opportunities for social constructionist learning. These include games where players work together in creative ways, like Sony Playstation's *LittleBigPanet,* or those that provide players with opportunities to collaboratively design and modify the world, such as in the open-world sandbox of *Minecraft* (discussed in chapter six). These games correspond more closely to the approach of *Space Place Play*, where the game is embedded in a collaborative experience of design.

Other chapters in this thesis have reviewed literature on games and learning, including chapter two on game definitions and chapter six covering educational game design principles and frameworks. This chapter unpacks the theoretical foundations appropriate to a game-based approach to learning within design contexts. It begins with a discussion of situated learning, employed to describe the nature of the learning experience, which is then followed by activity theory to give a lens to the broader experience and the game implementation within the course. The chapter continues with an exploration of a selection of studies that investigate design-based contexts, covering the types of games employed, their theoretical foundations, objectives and outcomes. Throughout this investigation, McLuhan's (1964) quote at the start of the chapter provides reminder to consider how the ideas within the game environment are intertwined with the way players experience those phenomena.

Games and Situated Learning

Brown, Collins and Duguid (1989) were amongst the first to advocate a situated cognition approach to learning, arguing that knowledge is embedded in the context in which it is developed and thereby is part of the activity and culture. They propose a 'cognitive apprenticeship' model of learning, a representation of its situated nature by inserting learners into authentic practices of activity and social interaction similar to traditional apprenticeship. Lave and Wenger (1991), in their seminal publication on situated learning theory, expand the notion of the apprentice, arguing knowledge is socially constructed and emerges when individuals are active participants in communities of practice. In situated learning, participants come to know and understand by engaging in activity that has a context meaningful and directly relevant to the learning, which Lave and Wenger (1991) refer to as 'legitimate peripheral participation'. Gee (2004b, p. 77) builds on Lave and Wenger's model suggesting learners align themselves to groups of people who share common practices and thereby become an "important force in learning in the modern world." This alignment of people can range from learning to play video games with a guild to learning to cook in a family. Gee (2004b) distinguishes his view from the community of practice model by suggesting a notion of affinity spaces, thereby shifting the focus of grouping people by the community to which learners belong to the space in which they interact. Anderson, Reder and Simon (1996) bring another dimension to the discussion of situated learning, challenging claims that action and learning are always bound to the specific context in which it occurs, knowledge transfer does not occur between tasks, abstractions are ineffective, and instruction must occur in complex social contexts. Their argument highlights the value of situated learning in giving meaning and allowing transfer beyond the specific social context where knowledge is constructed. In addition, they suggest it can involve individual activity, and abstractions together with concrete examples can be valuable components of learning.

Situated learning is very much tied to social interaction and collaboration, whether through involvement in a community of practice or alignment with people in affinity spaces. Collaborative learning has roots in Vygotsky's (1978) notion of learning through social development, identified in his theory of Zone of Proximal Development (ZPD), discussed further in chapter six in relation to game design. ZPD explores the level of learning possible by individuals on their own as compared to the development achievable through guidance and collaboration with more advanced peers.

A number of researchers in DGBL argue that situated learning/cognition is a significant reason why video games are effective educational tools (Gee, 2003; Shaffer, Squire, Halverson & Gee, 2005; Van Eck, 2006, 2007; Barab, Gresalfi, Ingram-Goble, 2010). Shaffer et al. (2005, p. 107) argue that games bring together "situated understandings, effective social practices, powerful identities, and shared values that make someone an expert." Gee (2003, p. 209) puts forward the situated meaning principle, where the meanings of actions, objects, artefacts and other signs within a game are "situated in an embodied experience." This situated meaning principle is closely aligned to Salen and Zimmerman's (2004, p. 37) concept of meaningful play, where the meaning is a result of the close relationship between player action and outcome, defined as "both discernible and integrated into the larger context of the game." Barab et al. (2010, p. 527) discuss games as context with consequentiality, arguing that "an essential aspect of conceptual game play is that individuals are experientially situated within a space where they have a legitimate role and their actions have effects on a particular context." These researchers argue that the experiential nature and authentic context of games makes the learning more meaningful and effective.

Bransford, Sherwood, Hasselbring, Kinzer and Williams (1990), through the Cognition and Technology Group at Vanderbilt, put forward anchored instruction in addressing issues of transfer of knowledge. In their study, video materials serve as anchor (macro-contexts) for all subsequent learning and instruction. Bransford et al. (1990, p. 138) claim that the anchors allow learners to experience the value of the knowledge becoming "a means to important ends", which they argue "leads to a greater appreciation of the value of information plus a greater tendency to use it when it is appropriate in new situations." The Cognition and Technology Group at Vanderbilt (1990) build on the Brown et al. (1989) model of situated cognition to promote an anchored instruction approach through the use of technology that can simulate apprenticeships and address issues of feasibility. In this way, they can improve on real-life limitations associated with apprenticeship. Barab et al. (2010, p. 526), building on research in situated learning and anchored instruction, suggest a theory of transformative play that "integrates person, content, and context as part of a transactive system in which each type of positioning motivates and is motivated by the other types" (Figure 4.1).

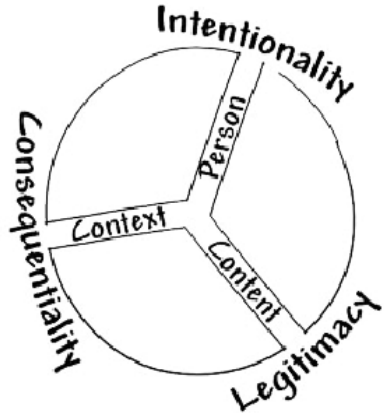

Figure 4.1: The core elements of transformational play (Barab et al., 2010, p. 526)

Drawing on situated learning theory, *Space Place Play* places learners into the role of designers within a digital space. The activity is not too dissimilar to the approach in a design studio where students create design solutions to a problem that has a set of constraints. A key difference is the fictional/make-believe nature of the design activity and the level of unpredictability in the collaborative outcome. This is central to the gameplay experience but does not diminish the authenticity and experiential nature of situated learning. In this way, it is analogous of a real world process rather than a direct representation. The game also aligns well to considerations addressed in anchored instruction. As a foundation activity, it aims to act as an anchor that is extended into other activities and assessment work. The gameplay experience thereby provides a launching pad to build knowledge and provide a mechanism for knowledge transfer.

Activity Theory

While situated learning theory informs the nature and character of the DGBL experience, activity theory provides a lens for the structure and broader implementation into the course context. Influenced by theorists like Vygotsky (1978), Leontiev (1978) and Engeström (1987), activity theory recognises that learning is not just a single event. Leontiev's (1978) model focuses on the link between subject and object mediated by a tool. Engeström's (1987) expanded mediation triangle adds community, as shown in Figure 4.2.

A number of researchers have championed the use of activity theory for design and analysis of educational games (Gros, 2007; Marsh, 2010; Sharritt, 2010; Paraskeva, Mysirlaki & Papagianni, 2010). Paraskeva et al. (2010, p. 502) suggest it is a theoretical framework that can account for all interactions within the game together with broader socio-cultural contexts that situate the

activity. Sharitt (2010, p. 177) argues the mediation triangle provides a "guide with which to analyse game player interactions and motives."

Marsh (2010, p. 217) acknowledges that Engeström's (1987) model has the higher degree of focus in Human Computer Interaction (HCI) due to its social and collective activity engagement but sees greater potential in Leontiev's (1981) hierarchical framework of activity, suggesting it is "arguably the most practical and operationalized theory in terms of the support for design and development of scenarios in serious games, and because it incorporates a multi-level structure providing multiple units of analysis (variable lens) that can be extended to analysis of learning." The Marsh (2010) activity theory model is composed of activity, actions and operations characterised by objective, goals and conditions, as illustrated in Figure 4.5. Its structure is dynamic and shifts between activity, actions and operations determined by the specifics of the scenario.

The Engeström (1987) activity theory model consists of a subject (the learner), object (the task or activity like a game), instruments/tools (mediating artefacts like a computer), rules, community and division of labour, together with an imperative interaction between all the components in the transmission of a learning experience, as illustrated in Figure 4.2. Gros (2007) applies the model to a context of video games for education, and includes experimentation, reflection, activity and discussion into the mediation triangle (Figure 4.3). Paraskeva et al. (2010) extend Engeström's (1987) model through a consideration of important psychosocial issues (Figure 4.4). These extended models of the activity theory guide the approach of *Space Place Play* as a tool that works alongside others, including the Learning Management System (LMS) and Internet resources to engage with the learners and the class community. In addition, it guides the relationship of the mediating artefact (the game tools) to the student players (subject), rules, community, roles and outcome.

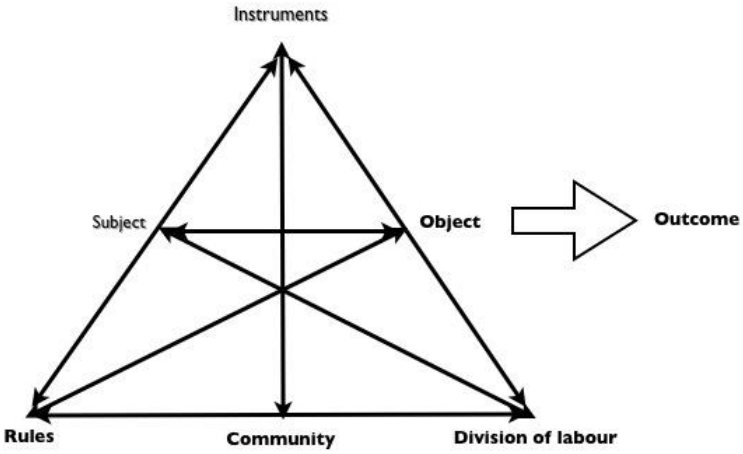

Figure 4.2: Engeström's (1987) model of the activity theory

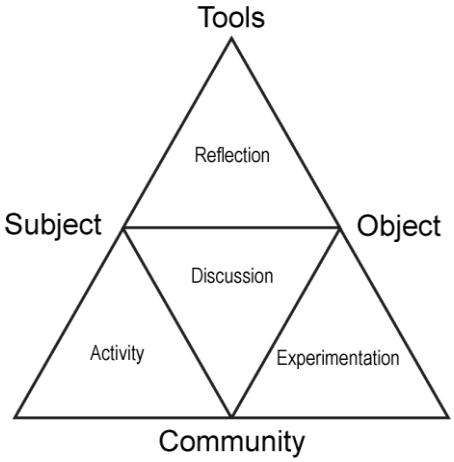

Figure 4.3: Gros' (2007, p. 34) activity theory model for the educational use of video games

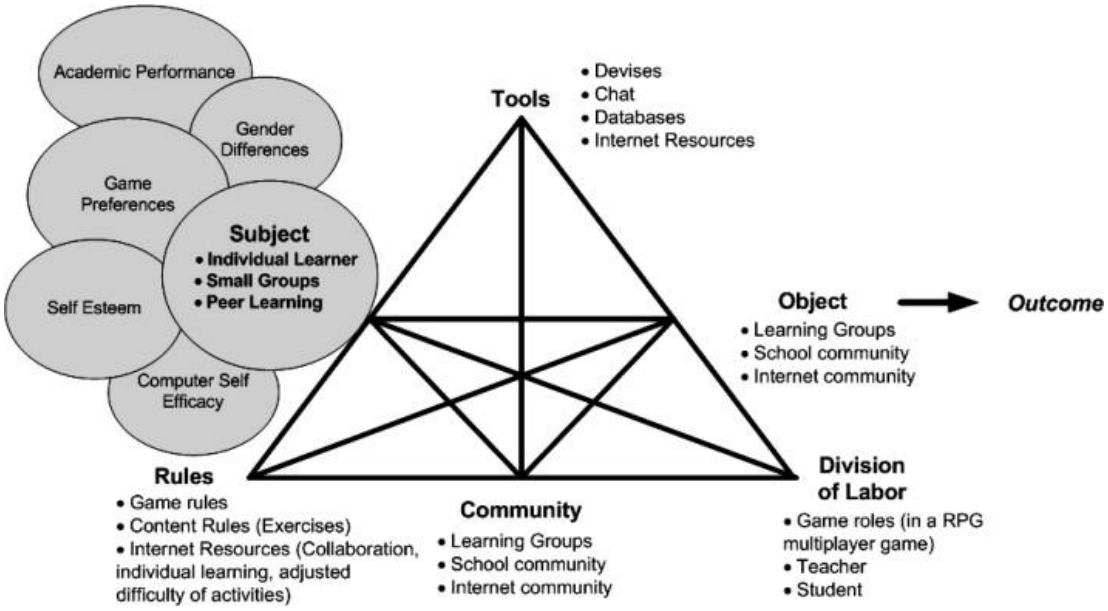

Figure 4.4: Paraskeva et al.'s (2010, p. 503) model of the activity theory for multiplayer educational games, highlighted by subject factors

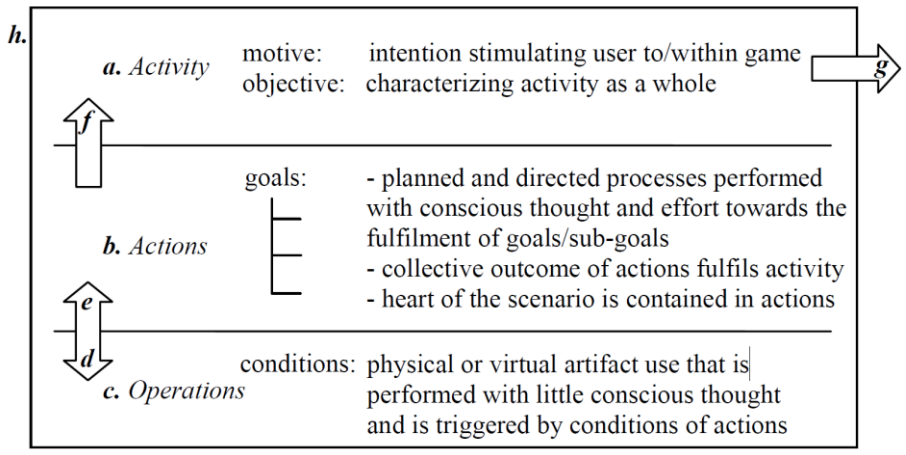

Figure 4.5: Marsh's (2010, p. 218) hierarchical framework of activity theory applied to games adapted from Leontiev (1981): (a) activity; (b) action; (c) operation; (d) shift in focus of attention from actions to operations; (e) shift in focus of attention from operations to actions; (f) transformation from action to activity; (g) shift in focus of attention from gaming to real world; (h) boundary for gaming context of use.

Process and Selection of Papers for Study Comparison

Throughout this research, a number of search tools were used in finding publications in the subject area. These included Google Scholar, ScienceDirect, Scopus, and Web of Science. In particular, The University of New South Wales' library search tool was employed as it incorporates all major databases to which the university subscribes. In finding papers focused on games for learning in design contexts, search terms included "computer game", "video game", "digital game", "virtual world", "serious game", "educational game", "design game", "digital game-based learning", "design learning", "design thinking", "design discipline", "design course." The date range for the study comparison to follow was limited to 1/1/2009 to 31/5/2014 with additional criteria that the papers be peer-reviewed journal articles and in English.

Following the keyword searches, titles and abstracts were read to identify a more targeted set. The broad nature of the term 'design' came through in the search results. The majority of papers identified used the term in relation to the design of the study, research instrument, or some other surface level component, rather than a design outcome or learning context. The studies that tied into design-based learning through the use of games fell into three main categories - (1) the use of games to support design thinking and practice, (2) the use of 3D virtual worlds, namely MUVEs (Multi-User Virtual Environments) and MMOs/MMORPGs (Massively Multiplayer Online Role Playing Games) to deliver design courses and facilitate student projects

and (3) the design and making of games by students. Since this research has a key focus on play as a component of learning, the third group of studies were excluded from this review.

The full criteria employed in the selection process of papers are as follows:

1. The study implemented and evaluated the use of a game, game-like scenario or game environment and activity with participants. Theoretical discussions were excluded.
2. The use of the game was tied to the learning of design or provided learning support for designers.
3. The study included elements of play rather than game creation.
4. The study covered adult education. This research addresses learning in higher education and as such, an adult learner audience type was deemed necessary for this literature review. In addition, design tends to involve higher order thinking skills that can be more challenging to children.

While the core focus of this study is GBL within a digital space, five papers exploring non-digital games are included due to their investigation of design processes and interactions. Employing the above criteria, 19 papers were identified appropriate for discussion.

Types of Games and Research Objectives

The games studies selected for comparison in this review have been classified into five types - virtual world (nine studies), design game (five), digital role-playing (three), alternate reality game (AltRG) (one), and trading game (one), as shown in Table 4.1. These types were chosen based on the primary objective or characteristic of the game space, be it of the outcome, activity or environment.

White and Le Cornu (2010, p. 184) divide virtual worlds into two categories.

1. Multi-user virtual environments (MUVEs) - described as having no predefined structure to activity with ranging degrees of creative freedom for participants. An example is *Second Life*, a popular virtual world, employed by five of the studies in this review.
2. Massively multiplayer online games (MMOs) - described as worlds that have player roles, goals and narrative. In this way, these environments provide a more 'true' game experience using the definition of chapter two. An example given by White and Le Cornu (2010, p. 184) is *World of Warcraft*.

While virtual worlds have faced debate on whether they belong to a taxonomy of games (Aldrich 2009a, 2009b), Thomas and Hollander (2010) argue that environments like *Second Life* provide rich game-like qualities, allowing for playful simulations and spatial design possibilities. They acknowledge the varied views on what classifies a game but argue the *Second Life* virtual world fits their adopted definition of facilitating an activity for players guided by rules and a goal.

World of Warcraft has a strong role-playing component to the game and belongs to the subgenre of MMOs, the MMORPG. As such, Dickey's (2011) study employing *World of Warcraft* has been located in the role-playing game classification for this review, together with a study using *SimCity* (Minnery & Searle, 2014) and one employing a specifically designed educational game (Hainey, Connolly, Stansfield & Boyle, 2011).

Within the group classified as design games, four are non-digital board games, the fifth a 2D online game. All these games have a design product output as a consequence of playing the game. The digital game in this category is called *eMedOffice*, a serious game created to educate medical students in organisational and conceptual arrangements for a medical practice, described as teaching the players interior design (Hannig, Kuth, Özman, Jonas & Spreckelsen, 2012). In contrast to the board games within the design game group, *eMedOffice* does not have a target audience belonging to a traditional design discipline. While an architectural perspective may challenge the level of design in this game, it does meet the elements of Ralph and Wand's (2009) definition (discussed in the previous chapter). Within this literature review, the disciplines encompass those from computer science, including human-computer interaction and software engineering, engineering and built environment disciplines of architecture, urban planning, design engineering, and aerospace engineering, disciplines that have design in their name including art and design and graphic design and the less design-centric field of medicine. This review reveals that the term 'design' like 'game' has particular meaning to a specific context. While some disciplines may feel they have greater ownership of the term, it is still broadly interpreted and applied.

Table 4.1: Comparison of game types, approaches and learning

Game type	Author	Theoretical foundation	Learning focus / objective of game	Discipline / participants	Research approach
Alternate reality game (AltRG) (blended across multiple systems, digital and non-digital, including *Second Life*)	Dondlinger, Wilson (2012)	Situated learning (problem-based learning)	As part of a general education curriculum to address mandated "core perspectives", that includes critical and creative thinking, and problem solving.	General Education as capstone course	Qualitative
Design game (board game)	Brandt et al. (2008)	Collaborative learning, involving participation and reflective practice (Schön, 1983)	Design skills and collaboration	Not specifically identified	Qualitative
Design game (board game)	Triantafyllakos, et al. (2010)	Not specifically stated (Collaborative learning inferred)	Design skills and engagement through the use of fictional characters in participatory design sessions	Undergraduate university students. Discipline not specified.	Mixed
Design game (board game)	Triantafyllakos, et al. (2011)	Not specifically stated (Collaborative learning inferred)	Design skills in participatory design sessions	Undergraduate university students. Discipline not specified.	Mixed
Design game (board game)	Kleinsmann et al. (2012)	Reflective practice (drawing on Schön, 1983), co-operative learning	Design collaboration skills	Design engineering students (First-year bachelor students, master students) and design professionals	Qualitative
Design game - (2D browser-based - *eMedOffice*)	Hannig et al. (2012)	Problem-based learning with cycle of expertise (Cognitive domain)	Design skills - learning optimal design of a medical practice of a general practitioner	Undergraduate Medicine students	Quantitative
Digital role playing - commercial video game (*SimCity™4*)	Minnery, Searle (2014)	Not specifically stated	Design and planning skill in developing a city and strategic plans.	Urban Planning courses (undergraduate and postgraduate)	Qualitative
Digital role-playing game	Hainey et al. (2011)	Constructivist (situated learning and experiential learning)	Skills in requirements collection and analysis.	Software Engineering (Higher Education (HE) and Further Education (FE) students)	Quantitative
Digital role-playing game - MMORPG (*World of Warcraft*)	Dickey (2011)	Social constructivist - communities of practice and situated learning (drawing on Lave & Wenger, 1991)	Develop understanding and analysis of game culture and dynamics.	Game design course (undergraduate students from microbiology, business, marketing, management, information science, computer science, graphic design, architecture, and Interdisciplinary studies)	Qualitative

Trading game (non-digital)	Wang et al. (2010)	Collaborative design learning	Collaborative design learning by stimulating students' design knowledge exchange	Architectural design studio (middle middle-grade students)	Quantitative
Virtual world	Gül, Maher (2009)	Reflective practice (drawing on Schön, 1983)	Design behaviour and collaborative actions (cognitive outcomes)	Professional architects	Quantitative
Virtual world (open source OpenSimulator platform)	Koutsabasis et al. (2012)	Reflective practice (drawing on Schön, 1984)	Collaborative design	Mix of professional architectural designers and graduate design students	Mixed
Virtual world (open source OpenSimulator platform)	Koutsabasis, Vosinakis (2012)	Constructivist learning (problem-based learning, collaborative learning, active learning, situated and reflective practice - Schön, 1984)	Design skills as well as more general skills including self-directed learning, intrinsic motivation, and critical thinking.	Human-Computer Interaction (HCI) Design Studio (postgraduate students from a variety of design disciplines such as Computer Science, Engineering, Architecture)	Qualitative
Virtual world (open source *OpenSimulator* platform)	Vosinakis, Koutsabasis (2012)	Constructionist learning - problem-based learning (drawing on situated learning, Lave & Wenger, 1991, and reflective practice, Schön, 1987)	Skills in critical thinking and design reflection in HCI design, collaboration, self-learning, digital design competence.	Human-Computer Interaction (HCI) Design Studio (postgraduate students)	Mixed
Virtual world (*SecondLife*)	Thomas, Hollander (2010)	Situated cognition	Design skills in Urban Planning	Urban Planning Studio (undergraduate and postgraduate)	Qualitative
Virtual world (*Quest3D* Game Engine, prototype called *Aeroquest*)	Okutsu et al. (2013)	Not specifically identified (Cognitivism inferred)	Learning about the design of spacecraft and aircraft.	Aerospace Engineering Design course	Quantitative
Virtual world (*Second Life*)	Wang, Braman (2009)	Active learning	Learning about the creative side of computer technology and the impact on society.	Main course in study is 'Computers and Creativity' , a general education computer science elective (undergraduate students)	Qualitative
Virtual world (*Second Life*)	White, Le Cornu (2010)	Experiential learning	To explore the cultural space of virtual worlds?	Draws on range of experiences of author with particular reference to a project undergraduate art and design students	Qualitative
Virtual world (*Second Life*)	Minocha, Morse (2010)	Not specifically stated (Situated learning inferred)	Socialisation and team work	Computing course	Qualitative

The alternate reality game (AltRG) study also results in a design output by student players producing a project informed by the game experience (Dondlinger & Wilson, 2012). However, design is not the primary learning objective of the game. AltRGs are unique in having a mixture of a treasure hunt, role-playing, and online community. Dondlinger and Wilson (2012, p. 155) further characterise this game type by "an AltRG provides players with an immersive digital experience that simulates the reality of information distribution and the skills necessary to seek, locate and evaluate that information in a highly meaningful way." The tools harnessed in such an experience include social media tools like Facebook, YouTube and blogs, and immersive virtual worlds like *Second Life*. The trading game differentiates itself from the others in that it facilitates design learning through a non-digital collaborative exchange of design knowledge (Wang, Shih & Chien, 2010).

Space Place Play fits in the design game type based on the classifications given in this chapter. However, it overlaps the other categories. The game involves a degree of role-playing and takes place in a virtual world corresponding closer to a MUVE. It draws on the qualities of the AltRG type in that it crosses over multiple platforms. While *Space Place Play* does not involve direct trading, it incorporates sharing of ideas and a trade-like experience in order to progress to subsequent levels. The game thereby engages with qualities employed in other research studies but is unique in its approach to structuring the experience and the primary learning objective of 3D spatial design incorporating the element of time.

The research purpose of the reviewed papers fit into four categories, including (1) evaluating learning outcomes, (2) evaluating game implementations/characteristics for teaching, (3) comparing games/virtual worlds with other teaching approaches and (4) proposing a framework for game implementation (Table 4.2). Evaluating learning outcomes tied to the game is the dominant topic of study, represented in 12 out of the 19 papers (63%). Evaluating game implementations/characteristics for teaching is also a prominent research aim, addressed by nine of the papers. Eight papers covered multiple research purposes. My research study also covers multiple aims, corresponding to the dominant areas of the evaluation of learning as well as the game implementation and qualities for teaching. .

While the selection of papers is relatively small, the examination across the broad literature has identified a gap. There appears to be little published research that investigates the use of digital games for learning of collaborative spatial design. In particular, there is a lack of research in

DGBL investigating immersive, open-word environments with design objectives that involve manipulation of the world to create new spatial experiences.

Table 4.2: Research purpose of game-based studies

Author	Evaluating learning outcomes	Evaluating game implementations / characteristics for teaching	Comparing games / virtual worlds with other teaching approaches	Proposing a framework for game implementation
Brandt et al. (2008)	x	x		
Dickey (2011)		x		
Dondlinger, Wilson (2012)	x			
Gül, Maher (2009)			x	
Hainey et al. (2011)	x		x	
Hannig et al. (2012)	x			
Kleinsmann et al. (2012)	x			
Koutsabasis et al. (2012)		x		
Koutsabasis, Vosinakis (2012)	x			
Minnery, Searle (2014)	x			
Minocha, Morse (2010)	x			
Okutsu et al. (2013)	x		x	
Thomas,Hollander (2010)		x		
Triantafyllakos et al. (2010)	x	x		
Triantafyllakos et al. (2011)	x			x
Vosinakis, Koutsabasis (2012)		x		x
Wang, Braman (2009)		x		
Wang et al. (2010)	x	x		
White, Le Cornu (2010)		x		x

Theoretical Foundations

The theoretical foundations of each reviewed paper are represented in Table 4.1. These theories correspond to those explicitly stated by the authors, except when otherwise identified. Five of the 19 papers did not specify the theories or principles underpinning their research. However, a critique has identified inferred theories for three of this group. The review shows a strong dominance of the more qualitative pedagogies, drawing on constructivist learning. The learning theories referenced in the papers include situated learning (eight of the studies), reflective practice (six), collaborative learning (six), problem-based learning (four), experiential learning (two), and active learning (two). Four of the studies in this review adopt a cognitivist perspective to the evaluation of learning, which Merriam, Caffarella and Baumgartner (2007, p. 285) suggest has a starting point in the mental processes involved in learning.

As noted by Vosinakis and Koutsabasis (2012), situated learning has much in common with reflective practice, which Schön (1983) describes as encompassing iterative cycles of learning by doing and reflection-in-action. Schön's (1983) model of a social construction of knowledge and reflective practice has provided a foundation for 32% of the studies covering multiple game types and platforms, including a non-digital board design game, trading game and virtual worlds. As discussed earlier in this chapter, broader DGBL research has also aligned to situated learning theory, drawing on Lave and Wenger's (1991) model of community of practice and Gee's (2003) principles of learning drawn from video games.

Research has linked community of practice theory to MMOs, which have been described as offering a "full range of social and material practices" (Steinkuehler, 2004, p. 9). Dickey's (2011, p. 201) use of *World of Warcraft* as a game platform for learning was chosen with the premise that the "underlying design of MMORPGs provides incentives for collaboration and in turn, these incentives shape individual and communal behavior." Other researchers included in this review have identified the benefits of virtual worlds in terms of providing affordances that foster collaboration, socialisation, presence, co-presence, awareness and real-word experience (Gül & Maher, 2009; Minocha & Morse, 2010; Wang et al., 2010; Koutsabasis, Vosinakis, Malisova & Paparounas, 2012; Vosinakis & Koutsabasis, 2012; Okutsu, DeLaurentis, Brophy, & Lambert, 2013). Minocha and Morse (2010) suggest that the positive benefits revealed in their study were facilitated by the avatar-based interactions. Through an immersive 3D experience, Wang et al. (2010) claim that the virtual world of *Second Life* enables students to actively engage with the understanding of the subject rather than be passive absorbers through simply watching content. In this way, active learning is seen as theoretical foundation for experience in this space (Wang et al., 2010).

Corresponding to the constructivist approaches in most of the studies, the qualitative research methodology dominates (11 papers) with only four as purely quantitative and four using mixed methods. This is not surprising since design by its nature is a qualitative process where understanding is developed through a typically iterative sequence of personal judgements and reflection. The literature reveals that qualitative methodology is well suited for understanding design-based learning. However, quantitative methods have a role to play in in evaluation of cognitive behaviours (Gül & Maher, 2009; Wang et al., 2010), measurements of perceptions of learning (Hannig et al., 2012) or measurement of learning outcomes (Hainey et al., 2011; Okutsu et al., 2013).

Evidence of Learning and Data Collection

The studies in this review indicate a high degree of positive learning outcomes from the use of games and virtual worlds. This occurred through informal social interactions, collaborative design, co-discovery and development of identity. Identity was especially powerful in the study using fictitious characters of alter egos, where the new identity liberated students from a self-conscious state of mind and thereby stimulated creativity and constructive performance with peers (Triantafyllakos et al., 2010). Virtual worlds were found to be advantageous for design by supporting prototyping (Koutsabasis & Vosinakis, 2012; Vosinakis & Koutsabasis, 2012).

Evidence of learning through games and virtual worlds was drawn predominantly from qualitative methods. This included semi-structured interviews and group discussions with students following the game intervention (Dondlinger & Wilson, 2012; Minocha & Morse, 2010; Wang & Braman, 2009), and reflections from both the students and teachers (Brandt et al., 2008; Minnery & Searle, 2014; Thomas & Hollander, 2010; White & Le Cornu, 2010).

Other data acquired for qualitative analysis included game logs. In the studies employing MUVEs, automated recordings of student behaviour in the virtual world was captured through the chat logs, internal video, audio and text chat recordings and other automated logs (Koutsabasis et al., 2012; Koutsabasis & Vosinakis, 2012; Vosinakis & Koutsabasis, 2012). Dickey's (2011) use of the *World of Warcraft* MMORPG also enabled automated recordings of student gameplay activities that were supplemented by data outside the game from student blogs and interviews.

In a number of studies, video recordings of design sessions provided observational data of interactions for qualitative analysis (Kleinsmanna et al., 2012; Triantafyllakos et al., 2010, 2011). Two studies employed protocol analysis with a quantitative process of coding video observations to analyse the occurrence and order of different types of activities (Gül & Maher, 2009; Wang et al., 2010). Other quantitative measurements included surveys with Likert scales for measurement of learner perceptions (Triantafyllakos et al, 2010, 2011) as well as usability questionnaires (Hannig et al., 2012). Hainey et al. (2011) measured learning outcomes through pre-tests and post-tests, together with a control group, while Okutsu et al. (2013) compared exam scores with a control group for measurement of learning. This study's comparison of virtual world to real world learning found no significant differences, drawing a conclusion that virtual worlds are feasible platforms to teach early engineering courses.

A number of studies reported mixed results. Dondlinger and Wilson's (2012) AltRG facilitated student learning in broad objectives of knowledge construction, social responsibility, open-mindedness, big picture thinking, and an understanding of their relationship to the larger society and world in which they live. However, many of the students' individual assignment work did not demonstrate key course learning objectives due to a need for better scaffolding and sequencing of assignments. In Minnery and Searle's (2014) study with *SimCity*, the students developed an understanding of trade-offs between planning and budget constraints but identified oversimplification of the game in constructing a realistic planning structure and involved too many complexities to make it useful. Hainey et al. (2011) role-playing game achieved success in an increase of knowledge of the Further Education (FE) and Higher Education (HE) participants, but did not reach the FE student expectations to the same level as those of the HE students. The difference could not be explained through pre-test data or age of the group (Hainey et al., 2011). The findings across the studies indicate games for learning are context dependant and can be reliant on prior knowledge or experience as scaffolding. In addition, games are not complete solutions for design-based learning.

Collaboration and Participant Dynamics

A theme that crosses over almost all the papers in this literature review is that of collaboration and the learner community dynamics. Design in professional practice is generally a collaborative activity drawing on multiple perspectives and expertise. It is therefore expected to be an important part of design-based learning. However, collaboration involves a mix of personalities, age groups and expectations, which raise challenges in games for learning.

The studies that employed the design game type identified the success of the games in facilitating collaboration and mutual learning (Brandt et al., 2008; Triantafyllakos et al., 2010, 2011; Kleinsmann et al., 2012; Hannig et al. 2012). While collaboration was deemed as valuable to learning, issues were raised on the performance across different groups. Kleinsmann et al. (2012) found first year bachelor students and professional teams outperformed master students in relation to collaborative design. The reason was that master students, while being more aware than the undergraduates of situational factors and the task complexity, focussed on details such as rechecking empirical components. As a consequence, they overwhelmed each other and thereby hampered their ability to design collaboratively. The lesson provided is to distinguish design expertise and design collaboration skills (Kleinsmann et al., 2012).

Hannig et al. (2012, p. 13) found that competition managed to coexist with collaboration, where game elements such as a visible public ranking "fostered valuable discussions and competitive collaboration among participants." The study revealed that students at lower achievement levels learned from their peers, resulting in improvements to their design work and a collaborative generation of new knowledge. It gives evidence of positive learning impacts of the game with students becoming more self-directed in their design knowledge and engagement with peers in collaborative learning.

Gül and Maher's (2009) comparison of virtual worlds to face to face interaction, in collaborative design production, identified issues of being remotely located. The remote location effect impacted on longer time taken on various components of the design process but the 3D virtual world sessions resulted in a more developed design solution (Gül & Maher, 2009, p. 135). While the results are stated as encouraging, Gül and Maher's (2009) argue the study is limited in its exploration of the area of teamwork through remote locations and the facilitation of individual work within a collaborative session. In contrast to Gül and Maher's (2009) findings, other studies employing virtual environments reported success in being very engaging for remote participants, facilitating novel and creative interactions, and improved motivation and performance (Wang & Braman, 2009; Minocha & Morse, 2010; Thomas & Hollander, 2010; Koutsabasis et al., 2012; Vosinakis, & Koutsabasis 2012). In Minocha and Morse's (2010) use of *Second Life*, students reported commitment to their team members because they perceived the virtual meetings to be similar to face-to-face ones. A key difference between Gül and Maher's (2009) study employing a virtual world and others in this review is that their participant audience were professional designers rather than students. Expectations are likely to be different between these groups, particularly around learning.

In two of the digital role-playing game studies, collaboration and team-work is raised but not extensively discussed (Hainey et al., 2011; Minnery & Searle, 2014). Minnery and Searle's (2014) study employing *SimCity* identified mixed results in terms of teamwork in that it encouraged a degree of collaboration but problems existed in the distribution of roles. Similar findings were uncovered in Hainey et al.'s (2011) study where collaboration ratings amongst students were mixed. The game placed students in teams where each player had a specific role, such as project manager, systems analyst, system designer or team leader. Students found a lack of clarity of the collaborative goals. The lesson these studies provide is the importance of care and clarity in the facilitation of gameplay roles. Confusion around roles and objectives can inhibit collaboration.

The value of collaborative learning was identified in Dondlinger and Wilson's (2012) alternate reality game. However, it faced tensions in classroom dynamics with student learning being strongest when developing projects with their peers but students still having a reliance on focused and guided direction from their instructors. Students where frustrated by a lack of leadership in the teams, reiterating their desire for guidance. The game was successful in some aspects of the course learning outcomes but lacking in others. Dondlinger and Wilson (2012, p. 164) see room for improvement in the course and game implementation with the "need to foster greater self-direction and interdependence among students." Class dynamics was also a challenge in the knowledge trading game. Although the game was deemed successful as a tool for collaborative design learning by facilitating the trading of design knowledge, its competitive elements that included extrinsic rewards of virtual value and game scores, conflicted with collaboration adding an element of self-interest (Wang et al., 2010). The game did not have a complimentary mix of 'competitive collaboration' as achieved by Hannig et al. (2012). This is possibly due to the core mechanic of the trading game corresponding to a personal strategic objective directly influenced by behaviour of other players. Another dynamic of the trading game was interpersonal relationships influencing behaviour where trades were made with friends rather than based on the virtual value of the traded knowledge. These items were identified as limitations that could be addressed in future research (Dondlinger & Wilson, 2012).

Dickey's (2011) study employing *World of Warcraft*, with a core objective of evaluating play and classroom dynamics in a game design course, had mixed results. While the game fostered positive student-student dynamics in peer mentoring and role-reversal, these activities generally remained within the game rather than being transferred into the broader classroom environment. The game benefits of collegiality and collaboration did extend out of the game by providing opportunities for casual socialisation, upon which further experiences could be built. In terms of the course dynamics, an element of game culture in *World of Warcraft* had significant broader repercussions. A student within the game chose to flaunt with game conventions and was thereby banned from the online game team. While this is not uncommon in *World of Warcraft* and allowances are made for an appropriate response, the banned player did not comply and was therefore deemed as untrustworthy within the game that extended into the classroom as a physical banishment, resulting in a degree of conflict. *World of Warcraft* has its own culture with conventions of behaviour for successful group work that can be difficult for learners to translate into the classroom setting. This is particularly challenging when it can be acceptable to take a villain type role within the game, such as where players are "rewarded in

experience for engaging in conflict" (Dickey, 2011, p. 207). Dickey's (2011, p 207) lesson is that students' perception of games is important as it is ingrained within "a culture of mastery and control." The findings do not argue the effectiveness of the game, but rather the complex issues linked to a DGBL approach. White and Le Cornu (2010) draw similar lessons in their paper, arguing that virtual worlds have their own specific culture, which does not always parallel real life. A problem found in their study was the social interaction and belonging within the *Second Life* virtual world. They suggest an acknowledgement of the differences of culture and interaction through virtual worlds to best harness their opportunities through experiential learning. White and Le Cornu (2010, p. 195) conclude that the use of these spaces for learning requires "teaching practitioners to immerse themselves in these environments, so that their understanding of them becomes cultural as well as functional, allowing them to use moments of disjuncture as key educational events."

The studies in this review reveal the benefits and challenges of collaborative learning in design contexts. They identify types of game environments and interactions that facilitate collaboration. While the existing research gives insight into game types, play interactions and connections to learning of design thinking and practice, further research is required to extend the understanding of perceptions of learning, interpersonal relationships and classroom dynamics in order to ensure successful learning outcomes.

Conclusion

A review of the literature has found a gap in research tied to the use of digital games for learning of collaborative three dimensional spatial design. In addition, more research is required on the nature of collaborative learning dynamics in design-based contexts covering student perceptions and outcomes, particularly with interdisciplinary design backgrounds. This research addresses the gap through the use of a design game, collaborative activities with interdisciplinary students, exploring perceptions as well as the question of if and how the game-based approach is beneficial to the understanding of design.

Situated learning theory has been argued as the most appropriate to architectural and spatial design learning. It has also shown to be a dominant approach by researchers in the field. The genre of design games appears to be well suited to the learning of design as the game objective is strongly aligned to the learning outcome. Virtual worlds, while providing tools to empower design activity and practice, face challenges with the game culture and expectations within the

environments being both similar and different to real life. Role-playing games, particularly ones designed for entertainment, also face challenges in the differences of behaviours and scenarios to real life contexts.

Collaborative learning aligns well to design objectives but requires consideration of class dynamics that correspond to both social and task dimensions of learning. The advice given by White and Le Cornu (2010) for virtual worlds resonates for all games in that they should be approached as an 'other' cultural space as well as a platform with a particular technical functionality. In this way, teachers are reminded that the medium is not always the message they may initially expect.

Part Two: Approach

Chapter Five: Research Methodology

Introduction

> "Truth, or meaning, comes into existence in and out of our engagement with the realities of the world." (Crotty, 1998, p. 8)

The previous chapter sets the context for the theoretical framework in which this research is located. The research into DGBL in higher education continues to evolve in the exploration of how and why games can be effective in engaging learners and enhancing outcomes. These studies cover both quantitative and qualitative methodologies. Following the view that different methodologies expand the types of questions that can be addressed, a mixed method approach is adopted in my research to allow freedom of choice for procedures deemed best for particular purposes. This approach corresponds to Johnson, Onwuegbuzie and Turner's (2007, p. 123) definition and rationale of mixed methods research where elements of qualitative and quantitative approaches are combined "for the purposes of breadth and depth of understanding and corroboration."

Since researchers in the field of DGBL, of both qualitative and quantitative methodology, appear to have a level of consensus of the value of digital games can have for learning, this truth is included as part of my assumptions entering my research and therefore does not form the core focus. Rather, the research aims to uncover the factors influencing spatial design learning through the use of a digital game. It explores two key questions under this umbrella theme:

1. What are the design considerations and implications for producing an educational digital game for an architectural design course context?
2. How does such a game facilitate learning within this context and what learning outcomes are produced?

The methodology relating to question one is covered in chapter six. This chapter focuses on the second question involving gathering data covering the student experience from engaging with the game. Table 5.1 illustrates the alignment of epistemology, theoretical perspective, approach and strategies in this research. In the sections to follow, these elements are discussed to articulate the framework for executing the study.

Table 5.1: Research alignment

Epistimology	Theoretical perspective	Approach	Strategies
Social Constructionism	Interpretivism - Hermeneutics	Phenomenological mixed with heuristic research	Survey Interviews Reflections

Epistemology, Theoretical Framework and Perspective

The epistemology upon which this research is based corresponds to social constructionism. Papert and Harel (1991, p. 1) define constructionism as extending on the constructivist tradition of "building knowledge structures" with the addition of it occurring “felicitously in a context where the learner is consciously engaged in constructing a public entity.” Underpinning constructionism is motivation that drives learning as students are able to produce an artefact to share with an audience. This has been realised through the game where students are afforded the opportunity to construct design products as part of their learning, facilitated through social interaction and collaboration with team members. These artefacts are shared with their game group as well as the broader class community. As a teacher, researcher and learner, I engaged with academic colleagues and industry professionals in the game design and development, which became a public entity. In this way, I too underwent a social constructionist process of learning.

Supporting a social constructionism epistemology, the theoretical framework underpinning the game experience integrates situated learning and community of practice (discussed in the previous chapter). It achieves this by situating the students in a collaborative scenario where they create spatial designs as a team. The knowledge and skills students develop around space and design occur through being immersed in the spaces they design, engaging in learning by doing, as well as learning through experiencing different perspectives and challenge from their peers. The experience corresponds to an input-process-outcome model (Figure 5.1), influenced by Garris, Ahlers and Driskell (2002), where instructional and game content flows into a cycle of design decision making, reflection, evaluation combined with feedback, and planning. The cycle leads to the game product and scaffolds broader course learning objectives. Students are part of a community within their team as well as with peers in the course who share in the experience and output. Through this phenomenon of learning, membership in a community of practice becomes a requirement where knowledge is developed through the integration and

internalisation of shared values, customs, and methods (Lave & Wenger, 1991). Central to this theoretical framework is the belief that knowledge is constructed rather than transmitted and students play an active role in their learning. The social nature of learning is fostered through opportunities for exploration, interaction and reflection.

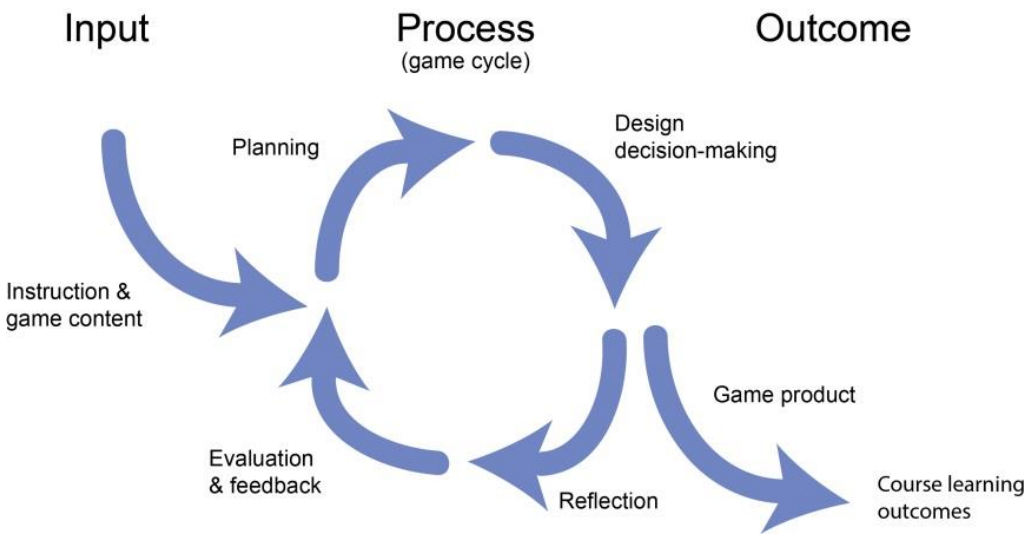

Figure 5.1: Input - Process (game cycle) - Outcome Model

The theoretical perspective of this research corresponds to the hermeneutics strand of interpretivism. It assumes "all human action is meaningful and hence has to be interpreted and understood within the context of social practices" (Usher, 1996, p. 18). Understanding and sense making of game-based learning involves meanings constructed through and by interactive human behaviour. It involves what Usher (1996) refers to as a 'double hermeneutic', where both I, as the researcher (subject), and the participants of the research (object) act as interpreters and sense makers. These interpretations draw on the hermeneutic circle, where interpreting the part depends on interpreting the whole and vice versa.

Usher (1996, p. 19) argues that the hermeneutic circularity is always situated in a backdrop of "assumptions, presuppositions, beliefs and practices, of which the subjects and objects of research are never fully aware and which can never be fully specified." Examples in the context of this research include the analysis of students' emotions during gameplay, whether exhilaration or frustration, as well as prior experiences that can provide scaffolding. Such considerations require more than simply a description of what happened within the game experience. They demand an explanation of the wider context in which the behaviour took

place. Since the behaviour can have different meanings in different contexts, a cultural description of its association also needs to be explored. Usher (1996, p. 20) reinforces the need for such deeper meaning suggesting student action is "immersed and inseparable from a network of culturally-conditioned beliefs and practices, assumptions and pre-suppositions." It is therefore vital to interpret human actions within the hermeneutic circle, and include interpretations of interpretations, the double hermeneutic.

In line with this interpretivist perspective, Squire (2008b, p. 14) acknowledges in his own game-based learning study that "no findings are (or could) be made outside of the theoretical traditions and language in which they are situated." The situated view to language corresponds to Usher's (1996, p. 22) assertion that the experience of hermeneutic understanding involves a "dialogue between ourselves as researchers and that which we are trying to understand."

Research Approach

The research approach includes a study around a phenomenon of playing a game as an intervention of the regular learning in a higher education course. Phenomenological research is therefore a likely starting point to understand the lived experience that is inherent to this approach (Creswell, 2003, p. 15). Phenomenological research essentially attempts to describe rather than explain, and puts a focus on the participants of the study to the exclusion of the researcher's experience (Husserl, 1970; Patton, 1990). This appears to be a limitation and is somewhat at odds with the hermeneutics interpretivist theoretical perspective, which recognises the assumptions, questions and values the researcher brings, thereby becoming an integral part of the research.

Douglass and Moustakasm (1985, p. 40) describe heuristic research as "a search for the discovery of meaning and essence in significant human experience. It requires a subjective process of reflecting, exploring, sifting, and elucidating the nature of the phenomenon under investigation." Heuristic inquiry extends the understanding of human experience and the interpretative nature of the research more so than the phenomenological approach. It is also inclusive of the researcher's role in the study. However, it too does not fully align to my research philosophy. It is very much focused on the researcher's experience, thereby becoming overly autobiographical. I see my study as somewhere in the middle of phenomenological and heuristic approaches, where I realise assumptions exist coming into the research, seek the deeper

meaning corresponding to heuristic inquiry, but do not intend to make myself the centre or more important than the participants and the wider context.

Strategies and Data Collection

The main instruments for data collection within this study included the game itself, a survey and semi-structured interviews. The survey preceded the interviews and aimed to collect information on attitudes, beliefs and opinions of the research participants, using a set of predefined themes. The interviews built on the surveys by capturing student interpretations of themes of learning and uncovering the students' lived experience. The semi-structured nature of the interviews facilitated a similar sequence of questions for the various participants while still allowing for flexibility of focus and direction for each student.

The strategy for developing both the survey and interviews questions employed the seven stages of interview inquiry as advocated by Kvale and Brinkman (2008), beginning with forming the design and themes, clarifying the research purpose and articulating questions to address that purpose. The design of questions avoided what Patton (1990, p. 297) calls 'the horns of a dichotomy', in suggesting a "yes" or "no" response. These dead-end questions provide little value in understanding views.

The survey was organised into four sections. The first part covering background information posed questions of student demographics, including gender, age and program of study. The second section covered digital literacy (measured through a four point Likert scale) as well as past gameplay experience, including hours spent on games, and preferred game types. These questions were incorporated into the survey in order to identify if any correlation exists between prior digital literacies and experience in commercial games to perceptions of learning through a specific type of educational game. Since the game involves digital construction that is similar to 3D modelling, it was assumed that prior digital literacies and gameplay experience would provide scaffolding for the 3D development to occur in the educational game. However, the game was designed to minimise the requirements of prior 3D skills. The questions served to check the level competencies amongst students that could help explain technical challenges when playing the game. The third section was the main part of the survey and measured perceptions of the game experience and learning outcomes. A five point Likert scale was employed to rate various themes, including satisfaction, relevance, collaboration and learning. A subsequent question asked students to rate the overall experience, also employing a five point

scale. This further tested the satisfaction theme. The survey ended with two open-ended questions to allow for qualitative comments on the positive and negative aspects of the students' experiences.

The Likert scale statements were designed according to Krosnick and Presser's (2010) four conditions for the rating scale effectiveness.

1. The points within the scale cover the entire measurement continuum.
2. The points are ordinal with a clear progression across the continuum with no overlap.
3. The respondents have a stable and clear understanding of the meaning of each point.
4. Respondents should have consensus over how each is understood.

To address condition one, a five point scale was chosen allowing a clear midpoint for neutral responses. The scale extended from 'strongly agree' to 'strongly disagree', addressing condition two. In order for the statements to have clear and transparent meaning, simple, familiar words and syntax were employed. Technical terms, or words with ambiguous meanings, were avoided to ensure interpretation was consistent. The questions were given to three past students of the course, who also play tested the game, as well as to the research supervisors, for review and feedback, addressing condition four.

The survey addressed the research questions by identifying if, from a student perspective, the game was effective for their learning and in what ways. Since the statements covered core qualities and objectives of the game, as well as broader elements that related to other course activity, the results provide evidence of prominent outcomes as well as how the game facilitated learning. These perceptions could then be fleshed out further through the interviews.

In developing the interview questions, Kvale and Brinkman's (2008) taxonomy, covering warm-up introductory questions to ones of a more probing nature, were referenced. Since I was in the role of both the research interviewer and the students' teacher, a relationship already existed. The warm up questions were deemed less important in building an interviewer-interviewee rapport. However, they still added value to ease the students into the interview. For this reason, these question types were kept to a minimum. Through the interview process, and wider context of the research, Patton's (1990 p, 54) suggestion of thinking in terms of 'empathetic neutrality' acted as a guide to ensure the participants were not steered in any

particular direction while at the same time maintaining empathy in understanding their positions, feelings and experiences.

It is understood that questions need to be unpacked in a way that participants understand what is being asked and have the opportunity to fully engage with the process. The interviews and survey therefore avoided overtly direct questions like, “How did the digital game enhance your learning?” Instead, questions were developed to engage with participant experiences, feelings, challenges and outcomes in relation to the larger context. A question posed in the interview included, “Describe your feelings during the playing of the game, including the challenges you faced.” It aimed to act as a trigger for students to identify elements of the personal experience that could be expanded upon based on their responses.

To ensure greater trustworthiness of the interviews and survey, the questions were subjected to a rigorous process of planning, construction, evaluation and validation. An iterative process of question design and review occurred with two academic research supervisors as well as three past students. This group read the questions and provided feedback. The process helped identify problems in language and clarity to what was being asked. In addition, it also aided in a greater degree of empathetic neutrality. As an example, the open-ended questions within the survey were modified with an additional statement for clarity and guidance of thinking. One of these questions was articulated as “In what ways, if any, did the game hinder your learning within this course? Here you can identify aspects of the game that were troublesome / unhelpful and why.” In addition to piloting the questions with others and employing guidelines from literature, the survey instrument drew on questions and statements from one that had been validated (Bourgonjon, Valcke, Soetaert, & Schellens, 2010) to further reinforce its validity.

The data collected for the study went beyond the surveys and transcribed interviews. It included personal reflective notes (including informal observations), follow-up questions with interview participants, online analytics data and product from the game itself (online discussions and graphics output).

Validation

While the debate over the term ‘validity’ and its suitability to both qualitative and mixed methods research continues (Onwuegbuzie & Johnson, 2006), this research adopts the definition of Creswell and Clark (2011, p. 239) who suggest “validity in mixed methods research as employing strategies that address potential issues in data collection, data analysis, and the

interpretations that might compromise the merging or connecting of the qualitative and qualitative strands of the study and the conclusions drawn from the combination." Onwuegbuzie and Johnson (2006) suggest the use of the term legitimisation over validity for mixed methods research and identify criteria for findings and interferences as - being credible, trustworthy, dependable, transferrable and confirmable. These elements have been addressed in this research to ensure the study is rigorous and the findings are conveyed accurately.

The questions asked in both surveys and interviews were designed to generate authentic and truthful accounts of the experience. Following the interviews, key points were summarised and confirmed with the students to ensure the data recorded was an accurate representation of their views. There is reproducibility in the data instruments (survey and interview questions) in that they could be used by someone else to generate similar data outcomes. The interpretations and inferences drawn from the findings were systematic and ensured data was not cherry picked to support preconceived or preferred results. The supervision of the thesis provided a check to the data where full details of results were disclosed. This included discussion of both the negative and positive elements of the findings and their interpretations. Data triangulation was achieved by collecting and reviewing data from multiple sources and perspectives (survey, interviews, reflections, online discussions and game product), giving additional credibility to research findings. This thesis is transparent and explicit in the data collection, analysis and reporting. Discussions are comprehensive to ensure auditability and dependency.

Data Analysis

Following Onwuegbuzie and Teddie's (2003) model, the data underwent seven stages of analysis. These included data reduction, display, transformation, correlation, consolidation, comparison and integration**.** The analysis process involved selecting, focusing, simplifying, abstracting, and transforming the data and occurred continuously through the research rather than just at the end when all had been accumulated.

Data reduction for this study involved tabulating quantitative information and producing summaries of qualitative text. The quantitative data was analysed through the development of five point means, standard deviations and frequencies. These results were visualised through bar graphs, allowing comparison of levels of consensus on individual statements, as well as the embedded themes of satisfaction, relevance, collaboration and learning. Comparisons were

also done to different groups within the data set, including males to females and students 23 years and younger to those 24 and older.

Coding was applied to the text through multiple iterations in order to generate strong, yet concise assertions, avoid overlap and reflect the data as true as possible. These iterations involved reading and rereading the text and tagging elements with key words and interpretations. The quantitative results were constantly used as a reference to see connections to qualitative accounts by students. Through these cycles of data review, dominant themes were identified. Patton (1990, p. 390) describes this classification of patterns, categories and themes as typology, with the primary purpose to describe, and only later be used to make interpretations. While initial phase of the analysis underwent a text reduction by condensation through summaries, it was soon followed by expansion through theme development and the associated meaning interpretation.

The NVivo software was explored for qualitative data coding and management but the decision was made to simply use Microsoft Word with commenting and highlighting, together with Excel to manage the codes and emergent themes. The approach was deemed suitable since it was possible to do manual coding of the qualitative data due to the small sample. It allowed easy comparison to quantitative data that was also managed in Excel. The survey data was collected through the online service, Survey Monkey, which allowed exporting to Excel as well as a preliminary word analysis of open-ended questions to quantify qualitative data in a first iteration of theme development. Using Excel and Word as text management tools, all types of data were easily indexed in a combined management structure, thereby facilitating an efficient analysis process.

Through the data analysis and transformation stage, correlation and comparison occurred between all the data sets. It included the survey, interviews, reflective notes and the game product to allow for a holistic approach to the interpretation. Comparison was also applied by drawing on other research. The use of the multiple sources of data acted as a means of checking the integrity of the inferences drawn, providing data triangulation and contributed to establishing validity. The triangulation was conducted in the analysis where links were made between qualitative and quantitative data sets as well as identification of how they supported each other. The final stage involved integration of all the data into a coherent whole.

Conclusion

This chapter has detailed the processes of data collection through to analysis. A mixed method approach was taken to broaden the questions to be addressed and provide multiple sources for data triangulation. The quantitative instrument of the survey was developed primarily to gage perceptions and levels of consensus about key themes of the game experience, but also identified the background of students, covering their digital literacies and gameplay experience. It provided an indicator to prominent benefits and challenges within the game as well as prior knowledge and skills that could influence the DGBL experience. The qualitative data collection through interviews was designed to flesh out themes of learning and uncover deeper interpretations of the impact. By drawing on both phenomenological and heuristic perspectives, this study embraces both the lived experience of students and the researcher.

Chapter Six: The Design of an Educational Digital Game

Introduction

> "Games are effective not because of what they are, but because of what they embody and what learners are doing as they play a game" (Van Eck, 2006, p. 18)

Van Eck (2006) epitomises the idea of why games can be beneficial to learning through a focus on the activity. Often viewed in simplistic terms of 'fun and games', suggesting a frivolous endeavour for injecting enjoyment, games have the potential to offer much more. They can facilitate deep engagement and understanding by setting up meaningful experiences where learners are active participants in authentic situations. This chapter examines the design of educational games that embody a meaningful activity aligned to learning. It covers game design frameworks, a review of two games in light of the frameworks, and the alignment to my own game design. The last section outlines the process and development of the game employed in this research study.

Educational Design Frameworks

The design of a digital game is an intricate task. The addition of an educational objective adds another layer of complexity. Many researchers, game designers and authors in the mainstream press have put forward frameworks or guidelines for the design of games (Crawford, 1984; Salen & Zimmerman, 2004; Björk & Holopainen, 2005; Schell, 2008; Annetta, 2010; De Freitas, Rebolledo-Mendez, Liarokapis, Magoulas & Poulovassilis, 2010; Chamberlin, Trespalacios & Gallagher, 2012). The frameworks tend to address key aspects of the game experience. However, since the spectrum of the game space is so wide, it is difficult to develop a standard system that answers all the questions in approaching such an endeavour. Three frameworks have been identified as most relevant to this research study in addressing pedagogical considerations, gameplay experiences and learning theory. These are Annetta's (2010) Six "I's" of SEG (serious educational game) Design, the Four Dimensional Framework by De Freitas et al. (2010) and Gee's (2003, 2004a) model of learning principles formulated from video games.

Annetta (2010) proposes a framework of Six "I's" for developing digital educational games, derived from years of game development, testing educational games and the research of the use of commercial video games for learning. The "I's" include Identity, Immersion, Interactivity,

Increasing Complexity, Informed Teaching and Instructional. They represent an order of magnitude as indicated in the nested model diagram in Figure 6.1. This model is used by Annetta (2010) to teach students how to go about their own game development process.

The Four Dimensional Framework (Figure 6.2), put forward by De Freitas et al. (2010), is another approach for the design of educational games, developed and tested through multiple studies. It involves four processes referred to as dimensions. The first is a process of profiling and modelling the learners and their requirements to ensure a close alignment of activities and outcomes. The second dimension involves consideration of the learning theories and teaching models adopted, such as constructivist learning or situated models with socially constructed approaches, employed in order to anticipate the type of learning outcomes. The third dimension is the game representation itself, covering the level of fidelity, interactivity and immersion. The last dimension considers the context such as the school or broader setting where the learning is undertaken and includes supporting resources. The Four Dimensional Framework brings together educational elements and game design, as well as addresses the need for stakeholder involvement. It was initially developed to help educators better understand how games are selected and used for education but its use has extended into the support of game design and development (De Freitas et al., 2010). While the Four Dimensional Framework organises game considerations differently to Annetta's (2010) Six "I's", they correspond closely to each other. Both start with a focus on the individual and extend to the broader context. A key difference is that the Four Dimensional model places emphasis on characteristics of the learner, game, pedagogy and context, while the Six "I's" model focuses on the game experience, its understanding and support.

Gee's (2004a) model of 'games as learning machines' was not proposed as a framework for game design but rather principles of good learning that effective video games employ. The principles were originally developed as a list of 36 in Gee's (2003) landmark book, *What Video Games Have to Teach Us about Learning and Literacy*. They have since been condensed into 13 principles in three categories; empowering learners, problem solving and understanding (Gee, 2004a). These learning principles were not the result of quantitative or qualitative research studies as is typical with other principles and theories of learning. However, they are well regarded with Gee's (2003) book receiving over 3,100 peer-reviewed journal citations (using the UNSW Library search engine conducted on 24/06/14*)* and over 5,600 citations across the broader spectrum of publications (identified through Google Scholar on 24/06/14). The learning principles are the first to have a specific focus on digital games. They are useful not only in the analysis of good

games but in their design as well. As such, a number of the principles (Table 6.1) have been selected for discussion as an additional framework for educational game design. Gee's (2003, 2004a) principles feed well into both the Six "I's" and the Four Dimensional Framework in exploring identity, design, challenge and learning.

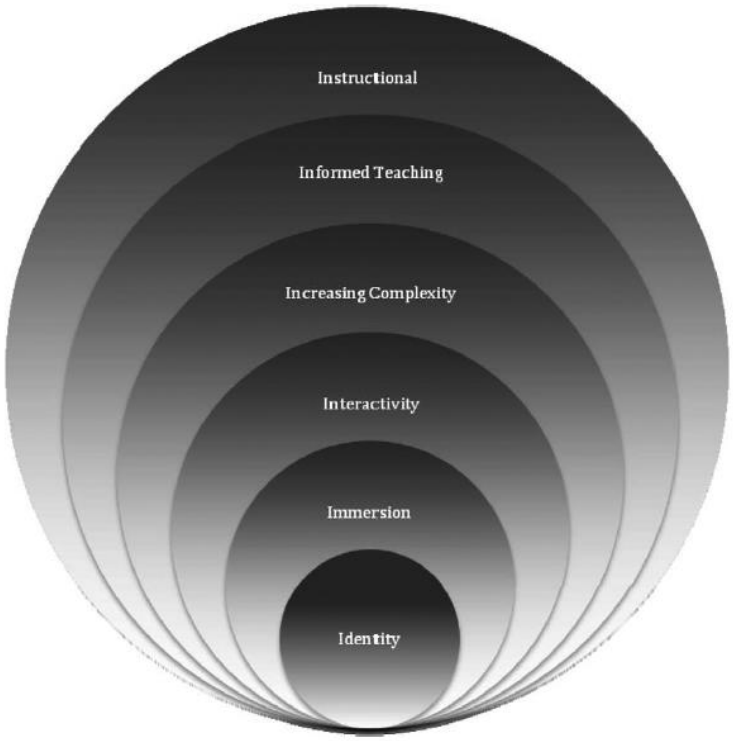

Figure 6.1: Six "I's" of nested elements for educational game design (Annetta, 2010, p.106)

Four Dimensional Framework	
Learner Specifics	**Pedagogy**
Profile	Associative
Role	Cognitive
Competencies	Social/Situative
Representation	**Context**
Fidelity	Environment
Interactivity	Access to learning
Immersion	Supporting resources

Figure 6.2: The Four Dimensional Framework (De Freitas et al., 2010, p. 72)

Table 6.1: Selection of Gee's (2003, 2004a) principles for a game design framework

#	Gee Principle Name	Description
1	Identity (Empowered Learners)	"Deep learning requires an extended commitment and such a commitment is powerfully recruited when people take on a new identity they value and in which they become heavily invested." (Gee, 2004a, p.18)
2	Co-design (Empowered Learners)	"Good learning requires that learners feel like active agents (producers) not just passive recipients (consumers)" (Gee, 2004a, p. 17)
3	Regime of competence / Pleasantly frustrating (Problem Solving)	"Learning works best when new challenges are pleasantly frustrating in the sense of being felt by learners to be at the outer edge of, but within, their "regime of competence."" (Gee, 2004a, p.19)
4	Information "On Demand" and "Just in Time (Problem Solving)	"The learner is given explicit information both on-demand and just-in-time, when the learner needs it or just at the point where the information can best be understood and used in practice." (Gee, 2003, p. 138)
5	Cycles of Expertise (Problem Solving)	"Expertise is formed in any area by repeated cycles of learners practicing skills until they are nearly automatic, then having those skills fail in ways that cause the learners to have to think again and learn anew." (Gee, 2004a, p. 20)
6	Probing	"Learning is a cycle of probing the world (doing something); reflecting in and on this action and, on this basis, forming a hypothesis; reprobing the world to test this hypothesis; and then accepting or rethinking the hypothesis." (Gee, 2003, p. 107)
7	Situated Meaning / Meaning as Action Image (Understanding)	"The meanings of signs (words, actions, objects, artifacts, symbols, texts, etc.) are situated in embodied experience." (Gee, 2003, p. 108)

Identity

The theme of identity is an element of all three game design frameworks. Gee (2004a) proposes an identity principle of empowering learning, suggesting players develop a new virtual persona through the choices they make in the game. Through this commitment, deep learning is better facilitated (Gee, 2004a, p. 18). The principle identifies the impact of substantial investment by the player, which results in a strong personal connection and sense of ownership of the game identity.

The identity principle is closely connected to another in Gee's (2004a) empowered learner category, that of the co-design principle (#2 in Table 6.1). It states that learners should feel like active agents (producers) rather than passive recipients (consumers) (Gee, 2004a, p. 17). It ties into a sense of pride of what the players produce in the game. Gee (2004a) argues that through the process of playing a game, the player becomes a co-designer (alongside the game

designer) since the player's actions affect the game and outcome. Squire (2006) extends on the design aspect of the player arguing that video games provide opportunities for a "designed experience" on the part of the player. The argument put forward is that the experience and learning will be stronger when players believe that their game actions and production are meaningful.

Annetta (2010, p. 106) corresponds to Gee's (2003, 2004a) views by arguing that identity, as the foundation of the Six "I"s framework, is critical to "capture the player's mind and trick him/her into believing he/she is a unique individual within the environment." While the Four Dimensional Framework does not specifically mention identity, it too begins with a focus on the learner profile (De Freitas et al., 2010). Like the identity principle, it considers the goals and role the learner will play. This is deemed important to align learning activities with outcomes.

In many of modern video games, avatars are employed as the graphical embodiment of identity. Annetta and Holmes (2006) suggest the use of avatars provide a sense of presence in virtual learning environments, which leads to personal satisfaction as well as the development of closer bonds between classmates and their teacher. Baylor and Kim (2005), through their study of the role of avatars in DGBL, suggest it is better to have two avatars than one, one as the expert, the other providing the motivation. Fox and Bailenson (2009) argue that if the avatar looks like the player, it has greater influence on the person doing the same or a similar activity in the future. The arguments around avatars have a sound logic in suggesting that if players can identify with their game character and can influence the nature of that virtual identity, it will become more meaningful and thereby have greater impact both within the game and beyond. The lessons extend to all games, rather than simply those employing avatars, in giving players the sense that their game identity is an extension of themselves.

Immersion, Interactivity and Flow

The Four Dimensional Framework explores immersion across all the dimensions, with strong focus in the representation component. De Freitas et al. (2010) suggest the potentially negative impact the virtual world can have due to a misalignment with player expectations. Its design is therefore reliant on an understanding of the learner profile. In Annetta's (2010) Six "I's" framework, the immersion "I" builds on identity to create engagement with content as well as intrinsic motivation. In this way, Annetta (2010) suggests players can enter a state of flow.

Interactivity and immersion are identified by De Freitas et al. (2010, p. 73) as challenges for game designers as they affect the level of engagement and motivation of the player. Interactivity, in this context, relates to the degree of activity of the learning experience tied to levels of fidelity. Annetta (2010) defines interactivity more broadly, suggesting it is linked to communication with fellow players in the game or the computer agent, where explicit rules guide behaviour. In both frameworks, motivation is a key factor in interactivity, immersion and flow.

The concept of flow was put forward by Csikszentmihalyi (1990) as a component of his theory of positive psychology. The nine dimensions of flow are identified as:

1. Full and focussed concentration
2. Merging of action and awareness
3. Free from concern of failure
4. Self-consciousness disappears
5. Distorted sense of time
6. Intrinsic reward – autotelic (experience becomes its own reward)
7. Clear goals throughout
8. Immediate feedback
9. Balance between challenges and skills

While they are discussed in terms of dimensions, the first six represent the experience of flow while the last three suggest conditions for it to be achieved.

Researchers and game designers argue that games generate a positive effect in players and are most successful when they facilitate an experience of flow (Gee, 2003; Salen & Zimmerman, 2004; Kiili, 2005; Schell, 2008). Flow is achieved by increasing the level of challenge with the right balance between boredom and frustration or anxiety (Annetta , 2010; Killi, 2005), which feeds into the Annetta's (2010) Increased Complexity "I." This also corresponds to Gee's (2003) regime of competence principle, also referred to as 'pleasantly frustrating' in his problem solving category of learning principles (Gee, 2004a, p. 18). Gee (2004a) argues that learning is strongest when challenges are at the outer edge but still within regime of competence of the learner. Other researchers relate this experience of gameplay to Vygotsky's Zone of Proximal Development (ZDP) (Kiili, 2005; Barb, 2005; Epper, Derryberry, Jackson, 2012). Vygotsky's (1978, p. 86) defines ZPD as "the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers." ZPD thereby refers to the range of a learner's ability that can be performed with assistance but not

yet independently. Applying ZPD to a gameplay, the argument is that a boring game with too little challenge will elicit no interest, while a difficult game will replace learning with anxiety or frustration. Kiili (2005) graphs the relationship of these factors, with ZPD sitting on the upper edge of the component of flow (Figure 6.3).

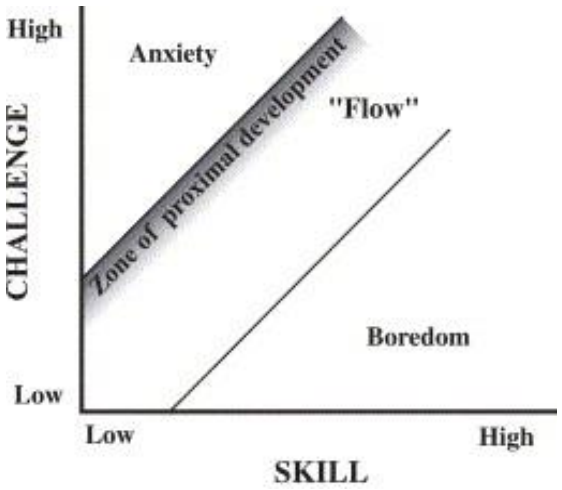

Figure 6.3: Three channel model of flow (Kiili, 2005, p.16)

Pedagogy

The Four Dimensional Framework places a strong emphasis on pedagogic considerations and learning theories without advocating any single one. Gee's (2003, 2004a) principles have a focus on situated learning, expressed through the situated meaning principle (#7 in Table 6.1), and "meaning as action image", where games provide meaning of concepts and actions through the player experiences (Gee, 2004a).

Gee (2003, 2004a) also hints at an experiential learning approach through the principles of cycles of expertise and probing involving repeated practice and reflection (#5 and #6 in Table 6.1). A key element of this cycle of learning is feedback. Gee (2004a) discusses the principle of 'Information "On Demand" and "Just in Time"', where good games provide both types of feedback without the need of a manual. This principle is one of the most challenging as a guiding framework for educational game design as feedback in learning is quite broad, covering elements of correction, reinforcement, forensic diagnosis, feed-forward, benchmarking (Price, Handley, Millar & O'Donovan, 2010). It is particularly complex in design disciplines where there is not necessarily any right or standardised answer. Both Annetta (2010) and De Freitas et al. (2010) look at feedback more broadly as elements of the learning facilitated by the teacher.

Context

Within the Four Dimensional Framework, a thorough understanding of context and the interactions between learner and the physical or virtual space is deemed vital to the game's success (De Freitas et al., 2010). A study conducted by De Freitas et al. (2010) raised issues of personal connections to the virtual world, the inability to relate, as well as issues of usability. Annetta's (2010) framework explores context in terms of how the learning can extend into broader classroom learning activities as well as how data from the game can be used for analysis and future enhancement. It forms part of the Informed Teaching layer in the Six "I's" framework, defined as the feedback and assessment that is embedded within the educational game. Annetta (2010) argues that educational games must go beyond simply an internal lesson and should be designed for analytics data collection. It could be gained through virtual observation, implementing a mechanism for recording events and behaviours of players. The data collection gives the teacher an understanding of player interactions and processes, which can inform teaching, improve instruction and ultimately result in enhanced learning (Annetta, 2010, p.109). The Instructional "I" deals with the consideration of the artificial intelligence or intelligent tutoring systems within a game as well as the instructional approach extending outside of the game. Annetta (2010, p.109) describes one of his earlier studies where the game was built with other unit activities in mind so that it "was not a one-time adventure for the students, but something that connected to traditional lab activities." By creating scaffolded structured interactions, learners are guided in their progress through zones of proximal development. The interactions that occur outside of the game thereby compliment and extend the GBL experience.

Conclusions from the Game Design Frameworks

The three frameworks discussed take different perspectives to the development of a game but have a degree of similarity. They are far from complete. It is to be expected as it is difficult to develop an overarching approach and framework as a guaranteed formula of success. Björk and Holopainen (2005, p. 4) reiterate this point in providing words of warning for their own game frameworks, arguing that while providing a language of gameplay, they are not the total solution for designing good games. Each of the models discussed in this chapter outline important considerations for starting the development of an educational digital game. A key lesson to be drawn relates to thinking about game-based learning more broadly than simply the in-game experience. This includes the way an identity can be shaped through interactions extended out of the game, alignment to other learning activities and assessment, as well as the broader

context of support. If a DGBL approach is to be successful beyond a one off pilot, elements of Annetta's (2010) Six " I's", the Four Dimensional Framework as well as Gee's (2003, 2004a) learning principles, can help formulate strategies and guidelines for a wider set of stakeholders. Annetta (2010, p. 106) provides a reminder that educational games "are not a panacea; they are simply an instructional tool for potential use by all ages."

Game Review with Frameworks

Frameworks can go beyond simply facilitating approaches and design considerations for games. They can also act in the reverse in assessing the success of games for learning. As an early step in understanding games within the genre of this research study, a number of commercial games were reviewed for their learning and gameplay strengths and weaknesses, as well as to explore the game frameworks as tools in this investigation. Two games were selected for discussion in this chapter - *Minecraft* and *Armadillo Run*. *Minecraft i*s a game where players are given the opportunity to creatively build and design objects from small scale instruments to buildings and worlds. It has a massive community as represented by the enormity of content posted to YouTube with over 36 million results (from a search on 10/01/14), and the millions of views many of the videos receive. Minecraft's statistics page on the official website states over 13.6 million sales have been made of the game with about 13,000 in a 24 hour period as (Majong, 2013). *Armadillo Run* has a relatively smaller audience compared to *Minecraft* with approximately 23,900 videos posted to YouTube (as of 10/01/14). It was deliberately selected for its difference in scale and approach to *Minecraft. Minecraft* and *Armadillo Run* are both games where the player builds objects in three dimensions. This is where their similarities end. The games take very different approaches to engaging the player with the activity and the way that process is guided. They are good games for understanding the playful side of developing engaging experiences involving design and construction.

Minecraft

Minecraft has multiple modes of play, namely creative and survival. Within these modes, the game allows for individual exploration, co-operative play and imaginative expression through building. For this review, the main focus is on the building and creative expression elements. The game begins by placing the player's character in the *Minecraft* 3D world of beaches, lakes, forests, and mountains. There is simplicity to the world. Its look and feel has a pixel and eight

bit colour character that refers back to the era of adventure and arcade games of the 1980s. It also appears to be influenced by Lego, which ties into the building side of the game where everything begins with a block. This style works for the game and defines its visual identity.

Figure 6.4: *Minecraft* start scene

***Minecraft* encourages play in four primary ways:**

1. Exploration and discovery

The player must find and extract building blocks from the environment rather than being given them up front. This encourages an approach of (1) coming up with a plan, (2) mining resources to build the plan, and (3) building. Between steps one and three, the player can get distracted, resulting in doing something completely unplanned. In addition, unanticipated elements are introduced when day turns to night, in form of monsters. This unforeseen discovery adds to the fun of the game.

2. Novel/Imaginative Interaction

The process of collecting resources is unusual in its approach. For example, the basic way of getting started with block collection is punching a tree. The *Minecraft* avatar waves his hand with pixel wood dust flying off the tree with each punch. There are other elements of the

character behavior that reinforce an imaginative depiction, which lends well to the player's identify following Gee's (2003, 2004a) identity principle.

3. Creative Freedom

Once the player collects building material like wooden blocks, there is full creative freedom of what to do with it, encouraging experimentation. However, this can add a degree of confusion too. The creative freedom and choices embed Gee's (2004a) co-design principle where players shape the world and create their own unique game experience. The players become partners in the game design by their choices and gameplay engagement. This flows onto other players that may be simultaneously interacting in the space.

4. Avatar Ownership and Development

The player is given an avatar, which can be customised and upgraded. This gives strong alignment to Gee's (2003, 2004a) identity principle.

Using Annetta's (2010) Six "I's" framework for reviewing the game, *Minecraft* meets many of the requirements for meaningful learning. The game's avatar facilitates identity development, particularly since gameplay is first person, which allows for a strong connection with the character. Players personalities can extend into their avatar and define the approach taken, be that more of discovery, building or survival. My game identity began as an explorer, wondering through the world, climbing hills, swimming and drowning in a lake. It evolved into a miner and builder. However, the subsequent roles were limited due to a low level of experience and knowledge of the *Minecraft* functionality.

Minecraft has the ability to immerse the player into the world and its gameplay. One can enter a state of flow with an altered sense of time and full concentration on the task at hand. It can be slow however, and therefore requires a level of player commitment to get to this immersed state. One of the criticisms of the game is the lack of guidance. When entering the environment for the first time, there are no clues to the goals of the game or what the player should do. It is also unclear how the player should start mining and building, a process that is unintuitive and lacking of direction. As a consequence, the game can potentially frustrate players and drive them away. In *Minecraft's* case however, the community has filled this gap. Online instruction is found outside the game environment in tutorial videos posted by other players. The deficiency within the game has resulted in greater community support, avoiding failure of maintaining its audience.

In terms of the Annetta (2010) Interactivity layer, *Minecraft* is more than just the interaction within the game space itself. It extends through the community it has formed, resulting in rich communication between players. The interaction occurs on YouTube as well as the Minecraft community wiki. As an example, Machinima's (2011) YouTube tutorial, *42 Ways to Die in Minecraft,* has received over 11 million views and over 27,000 comments within two years of being posted (as of 10/01/14). While this tutorial video appears to be one of the most popular at the time of writing this chapter, there are many others that attract tens of thousands of views and extensive discussions through comments. The community is clearly an extended learning space to the game with YouTube playing a key role.

Minecraft engages with the Annetta (2010) Increased Complexity "I" by providing varying degrees of sophistication to building once players have mastered mining and tool creation. The wider community shares their experiences through video recordings and reflective audio commentary. These videos provide observations of player behaviour within the game, supporting Annetta's (2010) Informed Teaching. At the time of writing this chapter, *Minecraft* does not give users access to an analytics monitoring system. If such a system exists, it likely designed for commercial purposes. An analytics system could provide observational data of user interactions and behaviour, which could potentially enhance understanding of learning.

The success of the game and the significant community that has developed addresses Annetta's (2010) Instructional "I" in how the guided learning and tutoring extends outside of the game. *Minecraft* appears to be dependent on the community for this component. From a learning perspective, *Minecraft* could benefit by catering for more in-game guidance or intelligent tutoring, particularly for newcomers. While the community is the backbone to the broader game experience, it does highlight the gaps of missing instructional and feedback components that are vital in games. This problem has not limited its success. The game is engaging because of the creative expression it gives to players. *Minecraft's* design is not restricted to a specific scenario with a constrained vision of how it is to be played. Instead, it allows players to decide on their own objectives and the nature of the game experience. The choices empower the player and strengthen identity development and the power of self-determination reinforcing Gee's (2004a) principles.

Armadillo Run

Armadillo Run is described as a physics-based puzzle game on its official website. It is a very different type of game to *Minecraft*. Its building is tied to understanding physics and the use of different types of materials. The payer is given rope, cloth, metal sheets and bars with the goal to create a device that transports a ball (the armadillo) to a desired location. Its puzzle activities provide a set of smaller challenges that are much quicker to comprehend and achieve than *Minecraft*. The game allows player to enter the game and continue from beginning to end without leaving for instruction, contrasting that to *Minecraft*.

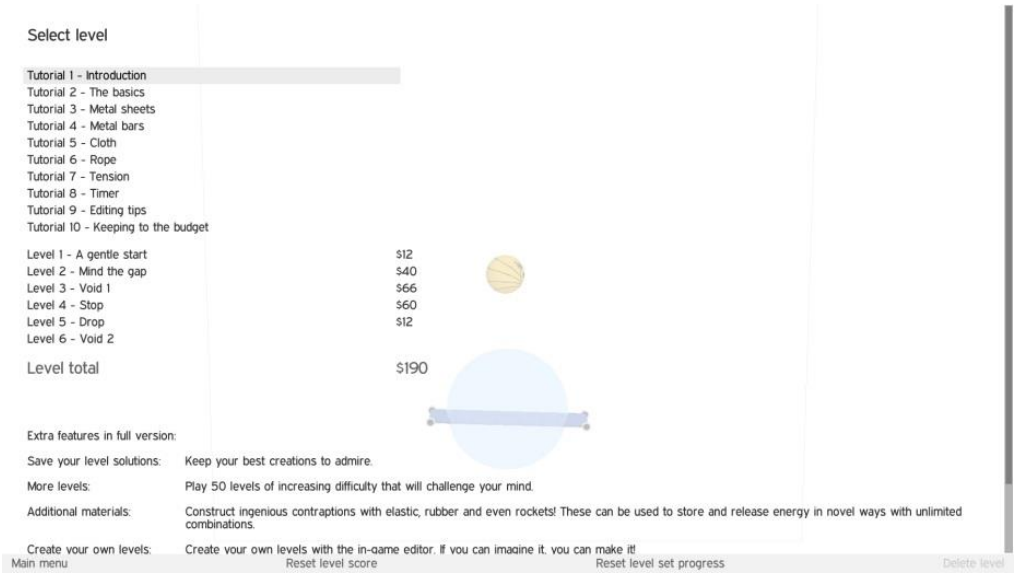

Figure 6.5: *Armadillo Run* main menu with tutorial start

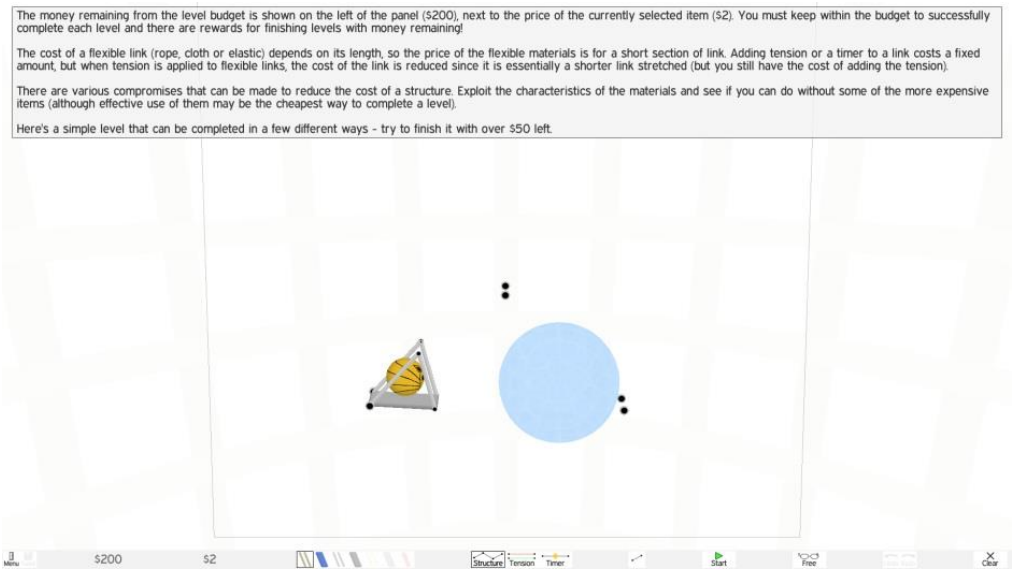

Figure 6.6: *Armadillo Run* guided tutorial start with instructions

Armadillo Run starts with a picture of the armadillo ball with its face and the text, "No armadillos were harmed in the making of this game." This provides a light hearted entry to the game and introduces the armadillo ball character. The armadillo's character is limited in its development. The game could have established more personality to the armadillo ball through its animation or the way it responds to success or failure. This could add to its playful nature and the player's affiliation with the armadillo character. In addition it could be an agent to give player feedback and guidance through their learning.

Play begins in *Armadillo Run* through a tutorial guided approach to understanding how the game works and how it is to be played. It is highly successful on this front in providing a clear starting point for the player. The look and feel of the game is very basic and bland. The graphical user interface feels somewhat simplistic. However, consideration beyond the visual side reveals that gameplay can be fun and engaging. A key factor in influencing this experience is the ability to simulate the functionality of a contraption the player has built and observe the outcome. With no penalties for failure, no time limit and having the ability to undo all last actions, it encourages experimentation. The dollar budget given for purchase of materials forces players to be efficient with their use and be more thoughtful over which are best suited for the particular challenge.

The game has embedded learning, particularly around the structure, materials and the physics of how they work. Using Anetta's (2010) game framework, the identity component is created by making the player a builder, though not quite as strong as *Minecraft*. This may be due to an avatar having a strong influence over player identity as well as the amount of time spent in the game for that identity to evolve. Immersion occurs in the play of *Armadillo Run* game where a player persists with a task until a solution is found in order to move onto the next level. The Interactivity "I", representing the player-computer communication, is through a guided approaches with the initial tutorial as well as the 'play' button that gives an immediate animated simulation showing the implications of players' decisions. The budget tool gives clues to approaches; a bigger budget suggests more materials are required or more expensive ones are important. The game increases in complexity by presenting the player with more intricate contraptions in the higher levels, resulting in greater amounts of materials and their combination to be employed.

Considering the Informed Teaching layer, *Armadillo Run* has a clear flow of choices that, if recorded, would be valuable in understanding player approaches and learning. The integration of this game with an analytics system that records the attempts by payers in each level, including

the budget used, contraption made, and number of attempts, could inform common mistakes or misunderstandings by learners. The last "I" of Instructional exists to some degree in the game through the provision of the tutorial at the start. There is also an instruction page with information about material properties but it lacks visual appeal and engagement quality. The instructional side has the potential to be extended if employed within a course that aligns the game with other learning activities, such as connections and discussions around real case studies of bridges and other real structures.

Game Review Lessons

Minecraft and *Armadillo Run* are successful in different ways. The rich environments of *Minecraft* and the opportunities for creative expression are captivating. *Armadillo Run's* simplicity and the immediacy of feedback it provides makes it responsive and easy to play.

There are a number of lessons these games provide for the development of educational games and in particular the one for this research study. The following are principles derived from the games to provide additional guidelines and detail a game design framework and further feed into engagement and learning.

Management of choices in games directly influences players' state of mind and thereby gameplay outcomes.

The choices available to players in a game can create challenge and fun, but can also overwhelm and frustrate. In *Armadillo Run*, the choices of the materials to use were clear and the placement into the contraption was limited, encouraging a manageable level of experimentation. As a novice in *Minecraft,* the degree of choices can be frustrating because they are unclear and numerous. Schell (2008, p. 179) discusses the need for "meaningful choices" that have a real impact on the game outcome. He argues that the number of choices relate to the number of things the player desires. If the choices available are greater than the desires, the player is overwhelmed. If the choices are less than the desires, the player is frustrated. If the number choices match the number of desires, the player feels "free and fulfilled" (Schell, 2008, p. 179). It is therefore important to understand what the player wants to do as well as the learner details of profile, role and competencies, recommended the Four Dimensional Framework. This will help planning and ensure a good balance of meaningful choices to cater to the game-based desires. This principle suggests that more choices do not necessarily translate into better or richer game experiences, or in the case of a design game, a more creative player outcome. In

line with Gee's (2004a) co-design principle, player choice impacts pride of game production. The management of choices in a game is also likely to impact a state of flow.

Guided/scaffolding learning facilitates satisfaction and motivation to continue.

An internal guided approach or a tutorial type game level can be beneficial in game orientation and the player's sense of direction. Even an external how-to video can help accommodate this need. Whatever guidance approaches are employed, making them concise will better cater for an audience with low patience for a lengthy instruction. This learning ties to Gee's (2003) 'Information "On Demand" and "Just in Time' principle and the pedagogical dimension of the Four Dimensional Framework.

A situated identity with strong connection to interactivity and player choices encourages investment and solidifies the game identity.

In line with Gee's (2004a) identity principle and Annetta's (2010) identity layer, deep learning in game is related to development and commitment to identity. A game identity facilitates thinking about choices and engagement. Simply suggesting an identity without strong alignment to the way the player interacts and makes choices can devalue its meaning. In *Minecraft*, the player identity grows when interactions and choices are meaningful as well as contextual, directly relevant to the game objectives.

Design of *Space Place Play* Educational Game

The approach taken with the design of the educational game, *Space Place Play,* employed for this study was through a combination of strategies and processes drawn from experience in multimedia design and development, game design frameworks, as well as learning principles and theory, particularly situated learning (as discussed in chapter four). The game, delivered online, has a site at www.spaceplaceplay.com.

Design Process

The process followed an iterative design, often employed in software development. This included cycles of planning, design mock-up, development, testing, and evaluation leading to deployment (as represented in Figure 6.7). Due to the limited time and resources available to

the production of the game, design development and idea modifications (including feature specifications) occurred alongside the product development and programming.

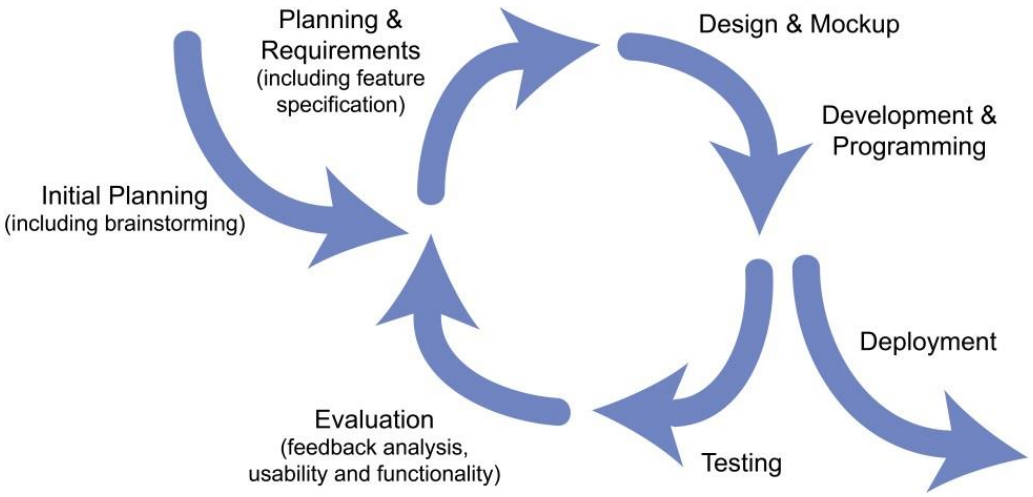

Figure 6.7: Game development cycle

The initial planning began with the development of a mood board, an approach I have employed in teaching multimedia development and game design. A mood board is a form of visual brainstorming, creating a collage of graphics to explore a range of ideas. Through this activity, a more focussed idea can be uncovered. The mood board allowed an exploration of the representation of cinematic and spatial ideas, their colours and general expression.

The process continued with the development of a game document covering considerations of the learning goals, target audience, game platform, and description. The first phase of the Four Dimensional Framework (De Freitas et al. 2010) was taken addressed by developing a learner profile tied to the target group of the *Cinematic Space* course. The profile included the minimum age, level of academic maturity and discipline understanding. The game document provided the foundation for the game specification outline, covering features of the tool to be developed as well as storyboards mocking up the flow and game interface.

The consideration of the pedagogical element of *Space Place Play* focused on the following key learning aims:

1. The use of a cinematic approach in interrogating the nature of spaces and its application to design, through framing, colour, texture and lighting;
2. The evaluation of *time* in spatial understanding and design through the creation of a storyboarded sequences and time-based spatial experiences.

3. The production of idea generation through collaboration and adaptability.

The third learning aim encompasses creative thinking and expression by experimentation with spatial ideas and builds on the design thinking skills represented in the first and second aim.

With production starting and ending later than planned, the time available for testing was short. Two weeks were provided for external beta testing in the form of three past students of the course and a multimedia/game developer. The students engaged with the tool through experimentation with its features. As a collaborative game, where a key part of the experience is the development of ideas on top of that of others, the beta testers were limited in the testing of the full game experience. Their feedback was therefore focussed more on the user friendliness and functionality of the tool itself. The responses gave an indication that the tool was relatively easy to use and 3D forms could be created without the need to refer to the help documentation. The feedback also suggested that there was an unwieldy aspect to the way 3D objects were inserted and moved around. This did not come to as a surprise and was simply a result of a compromise of functionality over creative playful design. A more creative approach to the technical user interactivity would need additional development time and cost, which was not available. A number of the usability suggestions were taken on board such as the ability to zoom in and out of a scene, incorporated by the use of the mouse wheel (rolling up to zoom in, down to zoom out). The size of the axis for each 3D object was increased to allow easier transformations. The level of testing, while incorporating a number of users, was still fairly limited and the realisation was that the *Cinematic Space* students would provide the greater insight into the game usability and functionality.

Game Authoring Tool

Unity 3D was chosen as the authoring software for *Space Place Play*. It is a 3D game engine and development tool capable of producing applications for the web, standalone desktop executables or mobile apps. Three key reasons for the selection of Unity 3D included:

1. Accessibility and ease of use

The product is available for free use as a trial and there is a strong community of support resources available to help in the development. Unity 3D is used in a number of courses within the Faculty of Built Environment, UNSW. Prior knowledge of the tool was an important consideration to minimise the learning requirements of the tool itself. While a small grant was given to support the production of the game for programming and backend development, the

software availability and ease of use remained a priority for my own input and extension beyond the budget.

2. Ability to publish to the web

This was deemed important for ease of distribution, maintenance and update.

3. Quality of 3D

Unity's 3D engine and rendering quality is high, in line with those employed in the development of current commercial video games

Figure 6.8 shows the game tool in the Unity 3D authoring environment and reflects the way it corresponds in look and feel to the program in which it was created. In this way, the game tool represents a simplified lockdown version of the Unity 3D engine. The 3D tool formed one of multiple components of the game experience together with external instructions and support, and an online forum space for sharing game product output and discussion. The forum was located in the Moodle LMS. The game evolved into an activity hybrid in nature in that it crossed digital platforms and involved a degree of face to face student discussion as a feedback mechanism.

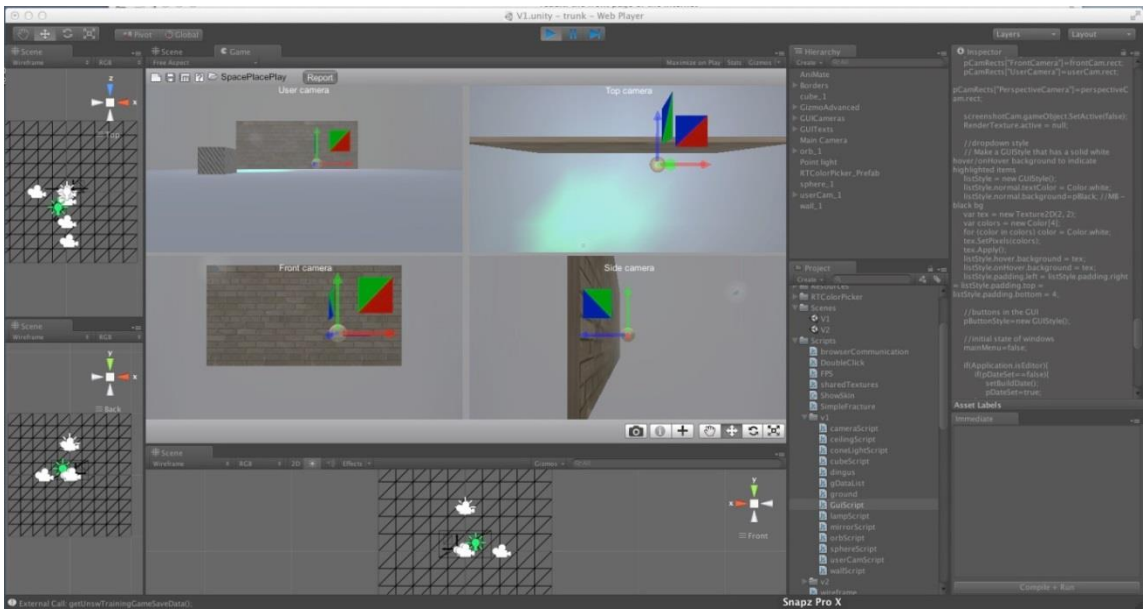

Figure 6.8: Unity 3D game environment

Space Place Play Game Description

Space Place Play is a game centred on spatial design with film paralleling the experience. Taking into account the general ill-defined nature of design problems, the game intends to be a collaborative, exploratory design experience. It draws on collaborative and design games where play is at the core rather than competition or winning, as well as epistemic games where there is no standardised answer. The core concept of *Space Place Play* is an adaptive, evolving design of a space and its story through the process of passing on spatial creations between players. In essence, the game is a form of *Chinese Whispers* where one player designs a space only for it to be passed on and developed by another. However, unlike *Chinese Whispers*, which becomes a metaphor for error and miscommunication, *Space Place Play* deals with adaptability, improvisation and creativity of new interpretations.

Space Place Play begins with all players engaging in a design exercise of creating their own alter ego. The alter ego becomes a key element in defining an emotional starting point upon which spaces will be designed. In addition, it provides the player with an identity through the game. By developing an identity at the start, the game corresponds to Annetta's (2010) Six "I"s framework and Gee's (2003, 2004a) identity principle. The identity development also draws on findings from Triantafyllakos et al. (2010, p. 231), who argue that the alter ego character can act as a communication agent for the players and "liberate students from the fear of straightforwardly exposing themselves." The development of the alter ego is informed by a profile document given to students with questions and personality descriptors. Connections are made to a film document for character design as well as an online questionnaire to define character personality. In this way, the identity is not only a game-based object but is tied to approaches in film, corresponding to the subject matter of the course.

Once the alter ego is created, the players begin level one, the creation of a space based on the emotion of the alter-ego character, informed by a suitable scene in a film. The game deliberately sets limitations in the way the space can be designed by the forms and colours that can be added. This provides challenge to the gameplay while also accommodating creative license in abstract representations of space. The completion of this space allows for levelling up, which involves passing on the space to another player. All players receive a level one space from another in the team to extend with a new set of constraints and objectives, similar but slightly more complex to the previous level. The game continues through four levels, allowing for a range of iterations of the 3D designed spaces. A series of images, the spatial frames, are produced at each level. The final outcome is a sequence of images that describe a storyboarded

experience through the space encompassing the emotions and story of the characters. The images correspond to films in thinking about the composition within a cinematic frame and the sequence that reflects time and movement through the world and tells a story. Between levels, the student players are required to explain their space and inform the subsequent player of their reasoning. This interaction occurs both online through Moodle forums and face to face while the game levels are created in class. The game thereby incorporates a conversation between players and peer feedback.

Alignment to Learning Frameworks

Space Place Play aligns to situated learning theory addressing the pedagogy dimension of the De Freitas et al. (2010) Four Dimensional Framework as well as Gee's (2003) situated meaning principle. It is achieved by students taking on a role of designer within a digital space where the activity is not too dissimilar to the approach in a design studio or professional context. Design begins with a posed problem, constrained by certain parameters, and continues with an iterative staged process. The process involves drawing, thinking and rethinking. Design is very much a progression of seeing and understanding with a creative viewpoint. Lawson (2005, p. 265) describes design as "a process based on conversation and perception." The development of solutions to design problems is equated to a conversation involving "changing the way the situation is perceived by 'talking it through'" (Lawson, 2005, p. 265). Schön (1983) suggests drawing is an extension of the minds' design thinking at work. As the image of the drawing develops, it enables the designer to see new possibilities or problems**.** Using an example of an architectural student in a design studio, Schön (1983, p. 94) describes how the design process evolves as a problem is framed and reframed, where "Each move is a local experiment which contributes to the global experiment of reframing the problem." The reframing of problems aligns to Gee's (2003) probing principle and encompasses the essence of the activity of *Space Place Play*. In professional contexts, design is typically a process of team conversation that often requires specialist knowledge and members from multiple disciplines. *Space Place Play* provides this multi-disciplinary team, tools for spatial drawing and an activity that encourages conversation.

Figure 6.9: *Space Place Play* starting space in level one

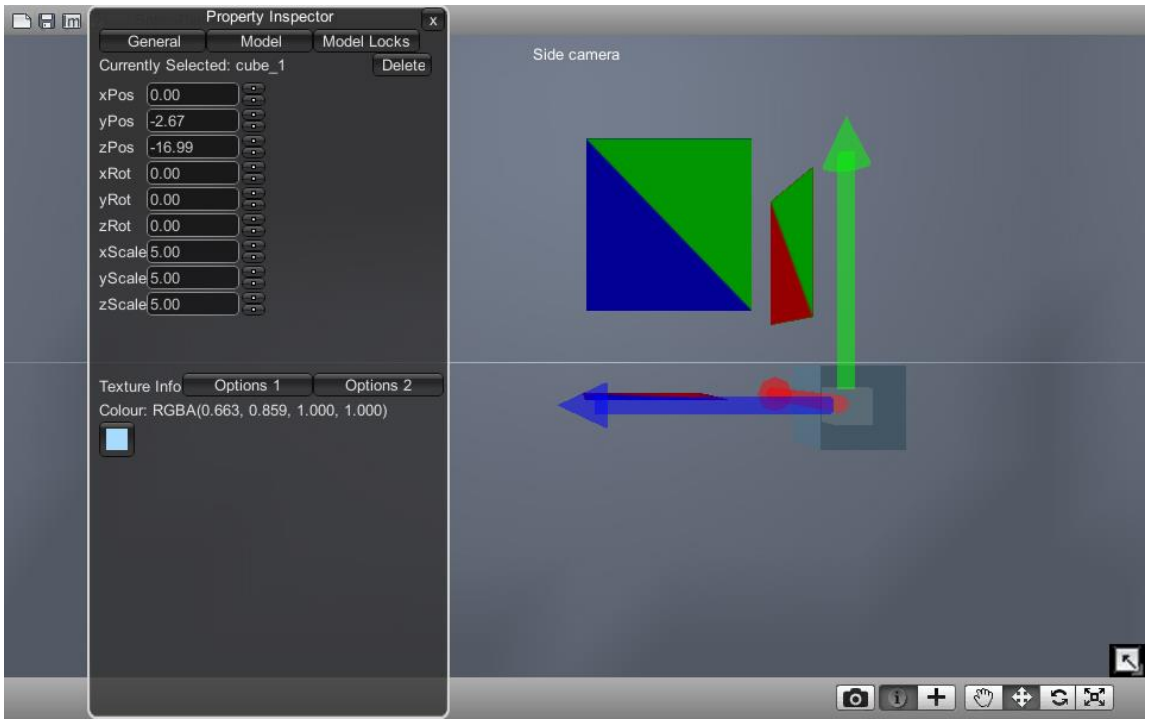

Figure 6.10: *Space Place Play* user interface with property settings

Space Place Play corresponds strongly to Gee's (2004a, p. 17) co-design principle where players are active producers through each level. The decision making given to players, in terms of

objects that can be created and how they can be transformed, aim to follow Schell's (2008) argument for meaningful choices. These choices and gameplay interactions correspond to the situated identity principle, encouraging investment and pride in the design production. The embedding of Gee's (2004a) co-design principle is thereby intertwined with the identity principle.

In *Space Place Play*, learners are actively creating their game experience. The challenge for players through the design activity aims to facilitate immersion and flow corresponding to the second layer of Annetta's (2010) Six "I"s. The component of representation in the De Freitas et al. (2010) Four Dimensional Framework, involving immersion, interactivity and fidelity, is taken into account by considering the spatial starting point of the game. It begins with a grey, empty scene (Figure 6.9), intending to act as a neutral, blank canvas in which the players can insert themselves and begin its transformation. In this way, it aims to correspond to expectations and player desires.

The interactivity layer of Annetta's (2010) Six "I"s is addressed within the tool to produce spatial graphics and notably with fellow players in the collaborative exchange. Within *Space Place Play*, interactivity is reliant on the tool's interface being understandable and user friendly. Corresponding to architectural design, the metaphor of digital drawing inspired the game. To give *Cinematic Space* students familiarity and comfort with the game environment, the interface drew on 3D modelling software and conventional symbols and icons, such as a hand icon to move / pan the scene, and arrows to rotate. Figure 6.10 shows the interface where the user can move objects along 3D axes and access a Property Inspector to adjust object settings.

Space Place Play challenges players through different levels that increase in complexity due to the nature of ideas and objects embedded in the scenes from previous players. Through the process of engaging with each other and witnessing the outcomes, the game aims to push students to their outer edge of competence without appearing as unachievable. The approach corresponds to Annetta's (2010) Increased Complexity "I" and Gee's (2003) regime of competence principle (#3 in Table 6.1). The process also considers the probing principle (#6 in Table 6.1) where learners engage in the world by making something within it, reflecting on this action, creating a hypothesis, and continue "reprobing the world to test this hypothesis" (Gee, 2003, p. 107). It also involves Gee's (2004a) principle of cycles of expertise (#5 in Table 6.1) and Schön's (1983) reflective practice theory, where learners explore ideas, reflect in action and post action, engage with others and then repeat the cycle.

The development of *Space Place Play* was aided by a small grant that covered time for programming, backend setup and hosting. The limited resources of time and cost of building the game meant some elements of the game frameworks could not be fully embraced. While Annetta's (2010) Instruction "I" is addressed by resources external to the game as well as alignment to other course learning activities, an internal intelligent tutoring system suggested for educational games was too ambitious to achieve. An internal tutor has the potential to better address Gee's (2003) Explicit Information On-Demand and Just-in-Time principle supplying feedback for the learner as needed. The immediacy of information and feedback in *Space Place Play* is tied to the interaction of peers, which is recognised as a limitation. The Annetta (2010) "I" of Informed Teaching, which argues for analytics recording of player behaviour analysis, is also out of scope. The context component of De Freitas et al. (2010) Four Dimensional Framework is addressed, considering issues of player physical location and institutional support. While the *Space Place Play* implementation within the *Cinematic Spac*e course began in the faculty's computer labs, the availability of broader faculty IT support was limited due to a separation from the actual online application. A more extensive engagement with issues of context would help ensure long term sustainability. As an initial study, the game can only give evidence for that broader context.

Lessons from the Game Design

Process and Time Management

A key lesson from the development of the game is the need for substantial time for design and planning prior to the coding and development. Since the project had a tight turnaround, many design changes occurred during the production. While design changes are to be expected when development begins as the product is seen in a new light and unforseen considerations are uncovered, core design changes impact the schedule. It adds time and typically increases the overall cost of the project. The multiple iterations of the *Space Place Play* game development in the application's design and functionality squeezed the limited resources. As a consequence, the end product became limited to a tool with functionality taking priority over playfulness and creative expression.

Often the production process takes longer than expected. A ramification is that it takes way time from testing. This was the case in the *Space Place Play*'s process. Limited testing took place prior to the implementation. However, the main evaluation of the application occurred in its

first deployment within the course. The students thereby were beta-testers of the platform. While this has advantages for student learning, it can lead to frustration when technical issues disrupt the game activity.

Expectation Management

When designing an educational game, it is easy to become ambitious with its learning aims, level of engagement and playfulness. Using commercial games as precedent studies can add to a high expectation of one's own game. The quote "Less is more" was adopted by prominent architect Ludwig Mies van der Rohe as an assertion for minimalist design (Mallgrave & Goodman, 2011). The approach can hold true for a game with 'more' in terms of functionality and learning requirements not equating to better but rather more complications and potential problems. Managing one's own expectations is a challenge. It extends to the management of the expectations of those involved in the game's implementation to avoid or minimise disappointment.

Resource Management

Games are complex applications that ideally require a team of experts. Chamberlin et al. (2012) suggest a multi-disciplinary team of experts including game designer, programmer, content specialist and an education specialist. While team members generally take on multiple roles, a need exists for a varied set of specialised skills and perspectives. It is possible to build games with limited resources of small budgets and people, as was the case with *Space Place Play*. However, efficient management of resources will better guarantee positive outcomes. Consideration of resource management should be included in the planning phase, to carefully estimate time and budget for different elements of the application, implications of changes and scheduling.

Conclusion

This chapter has identified and evaluated design considerations and implications for the production of digital games for education, answering the first of the research questions. These include identity, immersion, interactivity, flow, pedagogy and context, derived from educational game design frameworks and further substantiated through review of commercial games. The game reviews highlighted other features important for games, particularly those involving construction and spatial experience, and include exploration, discovery, creative freedom, management of player choice, and guided instruction. The process of designing and building a game highlighted implications of the choice of a development tool for accessibility, ease of use,

distribution for the web and quality of 3D graphics. It also uncovered lessons in process and time management, expectation and resource management, all of which can result in additional cost and time repercussions.

Frameworks and learning principles are helpful to guide key decisions and planning for educational games. Annetta's (2010) Six "I"'s, along with corresponding elements from De Freitas' et al. (2010) Four Dimensional Framework and Gee's (2003, 2004a) learning principles, provide a solid foundation for developing an educational game. However, there many other variables, such as learner diversity, level of challenge required to reach the optimal state of flow and management of meaningful choices, which add uncertainty to the outcomes of the gameplay experience. In addition, the logistics of the design, development and programming of games provide further complications and limitations. A successful product is the result of the careful management of all the considerations and their resolution. The development of games, and particularly ones designed for educational purposes, will always involve an element of the unknown until their actual implementation. The *Space Place Play* game was built with limited resources and time. Any new tools have teething issues in their first utilisation. The lessons derived from this research study are therefore taken as a starting point for realising the potential of future enhancement and broader applications.

Part Three: Outcomes

Chapter Seven: Results - Perceptions of Learning

Introduction

> "Video games have the power of visualizing things, of creating open-ended environments for people to explore things, of engaging and motivating learners. What you have is a strong learning approach that should be added to the educator's toolbox."
> Jan Plass (2014), Co-Director, Games for Learning Institute, New York University

The sandbox genre of digital games provides players with "open-ended worlds, through which there is no one single, correct pathway" (Squire, 2008a, p. 170). In these games, considerable freedom is afforded to players in their exploration, interaction and even manipulation of their virtual world. *Space Place Play* provides such a sandbox with the aim to empower visualisation and design-based experiences. This chapter focuses on the student perceptions of the learning through a digital game-based experience. It is drawn out from the survey (N = 26) conducted with *Cinematic Space* students and supported by interviews (N = 5).

All students in the class were invited to complete the anonymous survey following the conclusion of the course and once final grades were released. Of the 29 students in the course, 26 participated, equating to 90% of the class. There were two students who missed classes when the game was initiated and an additional student dropped out of the game once it started. It is likely these students were the three (10%) who did not participate in the survey. The survey therefore well represents the *Cinematic Space* students' views of the gameplay experience. The game was played in small groups of three to four students with seven game teams across the whole class. The five students interviewed were drawn from separate game groups. They therefore constitute a credible and indicative sample of the class.

A key research question of this study is: how do digital games facilitate learning and what are the associated outcomes within an architectural design context? The data collected and discussed in this chapter goes to answering this question. The survey aimed to assess student perceptions of the DGBL approach through four main areas - satisfaction, collaboration, relevance and learning. In addition to a quantitative capture of views of the game experience, the survey recorded the background of the students, their digital interests and expertise as well as their prior digital gameplay experience. A number of open-ended questions provided a qualitative elaboration of the benefits and drawbacks of the game-based approach. However,

the main qualitative investigation was achieved through interviews, which explored the students' experience at a deeper level in order to uncover the personal impact. The evaluation of the personal experience is discussed in chapter eight.

Background of Students

The *Cinematic Space* course was made up of students who had completed at least two years of their undergraduate degree (15) or were in first or second year of their postgraduate studies (14). This roughly equal distribution of postgraduates (48%) to undergraduates (52%) corresponds closely to the survey distribution (46% postgraduates, 54% undergraduates). The postgraduate students were mainly from the Master of Architecture program with one from Master of Information Technology. The survey indicated two main groups, those in their early 20s (50%) and those in their mid to late 20s (42%), with a small number (8%) as mature aged students above 35 years of age. The age distribution does not neatly align to the older group being postgraduates and the younger an undergraduate cohort. Within the Faculty of Built Environment, the Master of Architecture program is a professional degree that extends from the undergraduate Bachelor of Architectural Studies. Both degrees form part of a full architectural qualification. Unlike post-professional degrees that attract students who have spent significant time in the workforce, students in Master of Architecture are often continuing their studies immediately following completion of the undergraduate degree. Within *Cinematic Space,* there were a small number of postgraduate students in their early 20s and a few older students undertaking undergraduate study.

Table 7.1: Background of *Cinematic Space* students

Gender	
Female	46.2%
Male	53.8%
Age	
20-23	50.0%
24-29	42.3%
30-35	0.0%
36 or older	7.7%
Program of study	
Master of Architecture	42.3%
Bachelor of Architectural Studies	15.4%
Bachelor of Architectural Computing	7.7%
Bachelor of Interior Architecture	11.5%
Bachelor of Landscape Architecture	3.8%
Bachelor of Town Planning	11.5%
Bachelor of Industrial Design	3.8%
Master of Information Technology	3.8%

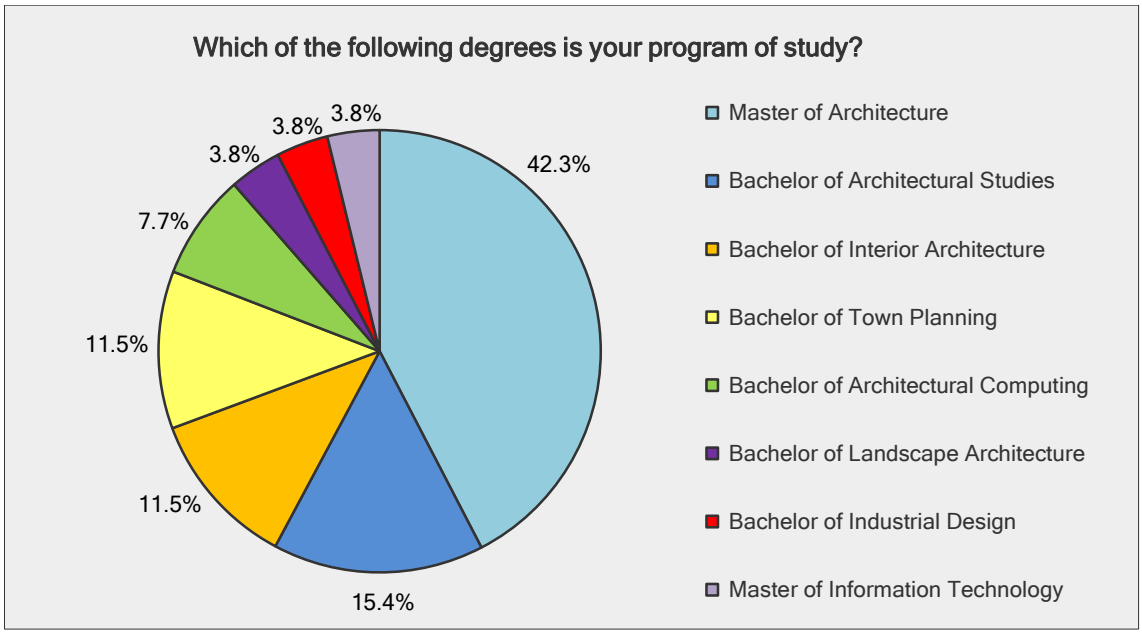

Figure 7.1: Programs of study of *Cinematic Space* students

Digital Literacy

Digital literacy capabilities of students were recorded as a means to investigate their potential connection to learning outcomes and gameplay approaches. The survey indicated that the *Cinematic Space* students had high degrees of digital literacy in image editing (89% either very proficient or somewhat proficient) and the writing of documents (85%), with less proficiency in areas of 3D modelling (39%), video editing (35%), multimedia authoring (39%), and the use of 3D game engines (15%). Figure 7.2 displays a bar graph of students' confidence in digital skills, employing a four point Likert scale. Since the bulk of the class came from design degrees where graphic work is a standard part of the programs, it is not surprising that editing/manipulating images was rated the highest. The areas of 3D and game engines, while becoming more popular tools in various courses in the faculty, are still more specialised and therefore have a lower degree of student confidence in their use. The *Space Place Play* game was built with a 3D game engine (Unity 3D) and modelled aspects of working within such an environment. A key reason for building the tool itself rather than simply putting the full engine in the hands of the students was to make it more accessible and reduce the learning curve. The results of the survey align with assumptions of the student group having familiarity and a level of confidence with graphics and text based tools but would find the more complex 3D platforms more challenging.

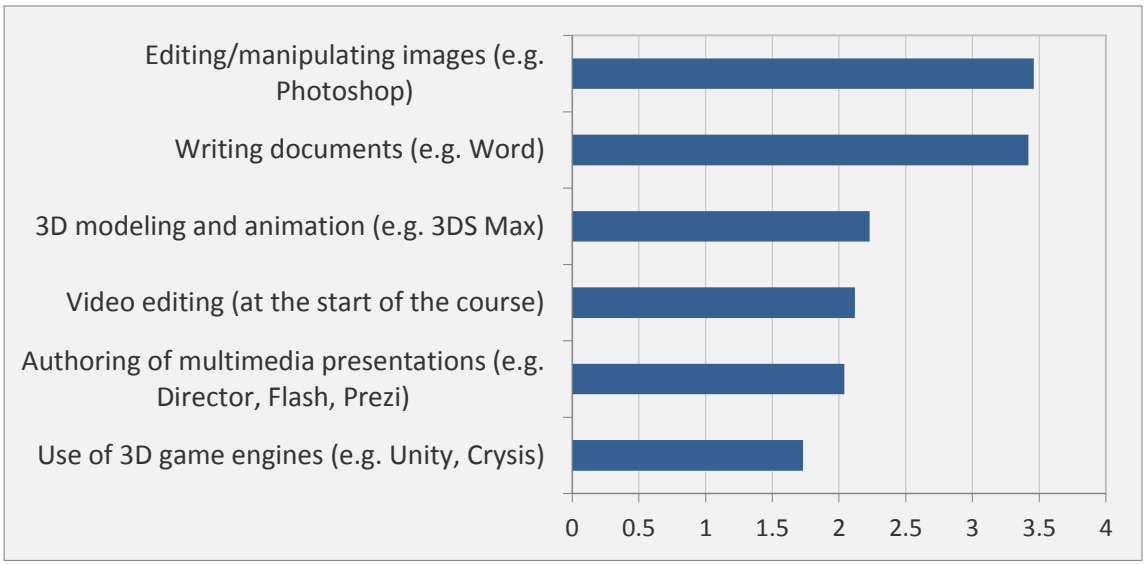

Figure 7.2: Proficiency in various digital contexts using four point Likert scale

Digital Game Playing Experience

The majority of the students, 85% as indicated by the survey, have played some type of digital games, with only 15% saying they do not play games (Figure 7.3). Of those that stated they do

not play games, three were female, one male. The games played by students cover a range of devices and contexts, including mobile (35% of all responses), online computer (31%), offline computer (27%) and game consoles (23%) (Figure 7.4). The majority (58%) prefer playing single player over multi-player games (Figure 7.4). The most popular genre of games amongst the participants is strategy (46%), action role-playing (42%), and puzzle (35%). Other types included adventure (27%), simulations (23%), fighting (15%) and sports (12%) (Figure 7.5). While the numbers spread across all the various game types are small, the results indicate that the female cohort has a stronger preference for puzzle games (58% of female responses), while males prefer both strategy and action role playing (57% of male responses). The ratings of the most popular games amongst the *Cinematic Space* students are not too dissimilar to the *Digital Australia 2012 (D12)* survey where puzzle, strategy and action games are amongst the most favourite types played by Australian gamers (Brand, 2012) (Figure 7.6). A difference is the comparison by gender where the *DA12* survey indicates a larger proportion of males favour puzzle games as compared to females and slightly more females prefer strategy and action games over males. The *DA12* survey shows a close spit between male and female interest in fighting games, different to the class survey showing only male interest in these types of games.

Of the *Cinematic Space* gamers, 53.8% spend less than 10 hours a week playing games, 23.1% spend between 10 and 19 hours, 3.8% spend between 20 and 29 hours, and another 3.8% spend over 30 hours (Figure 7.7). The results indicate that the majority of the students do not spend an excessive amount of time on gameplay but games still represent a significant day to day activity. The *DA12* survey corresponds to the *Cinematic Space* student group and indicates 60% of gamers playing between a half to an hour either daily or every other day and only 3% playing five or more hours in one sitting (Brand, 2012).

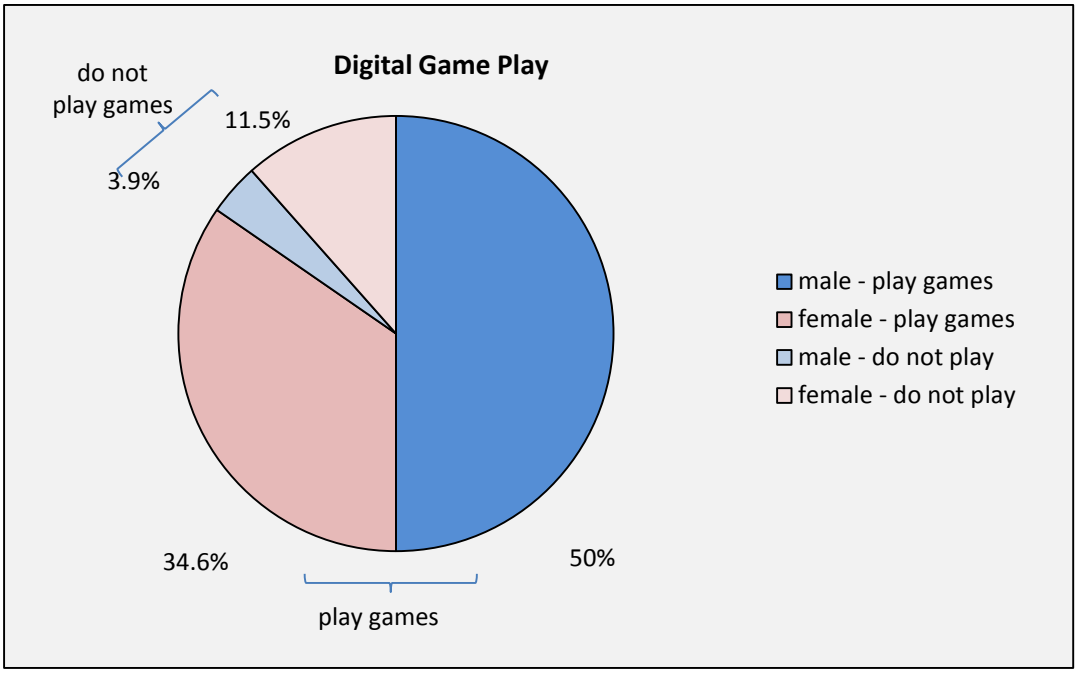

Figure 7.3: Digital game play

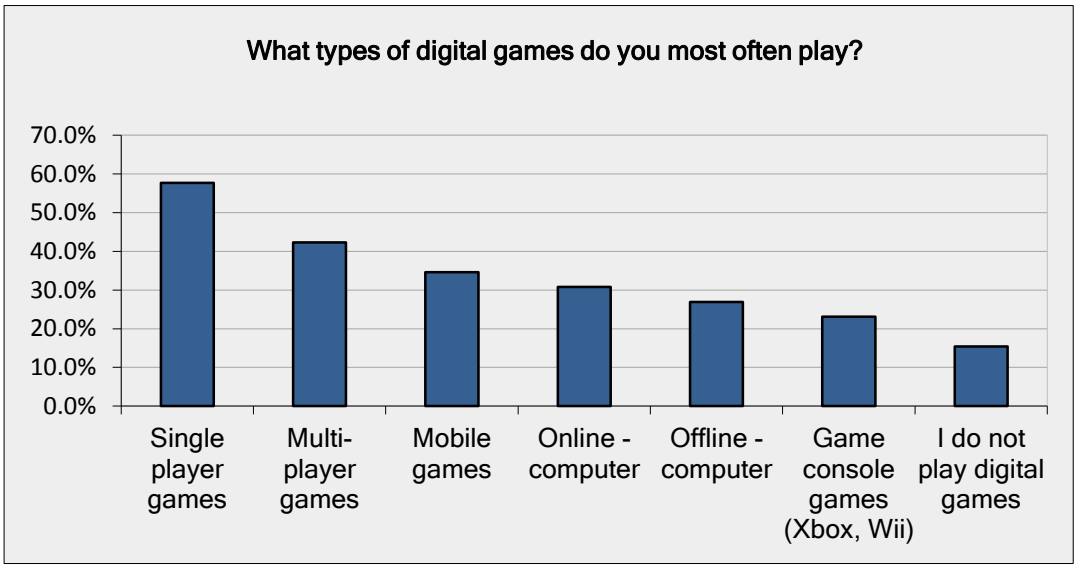

Figure 7.4: Types of devices used for games

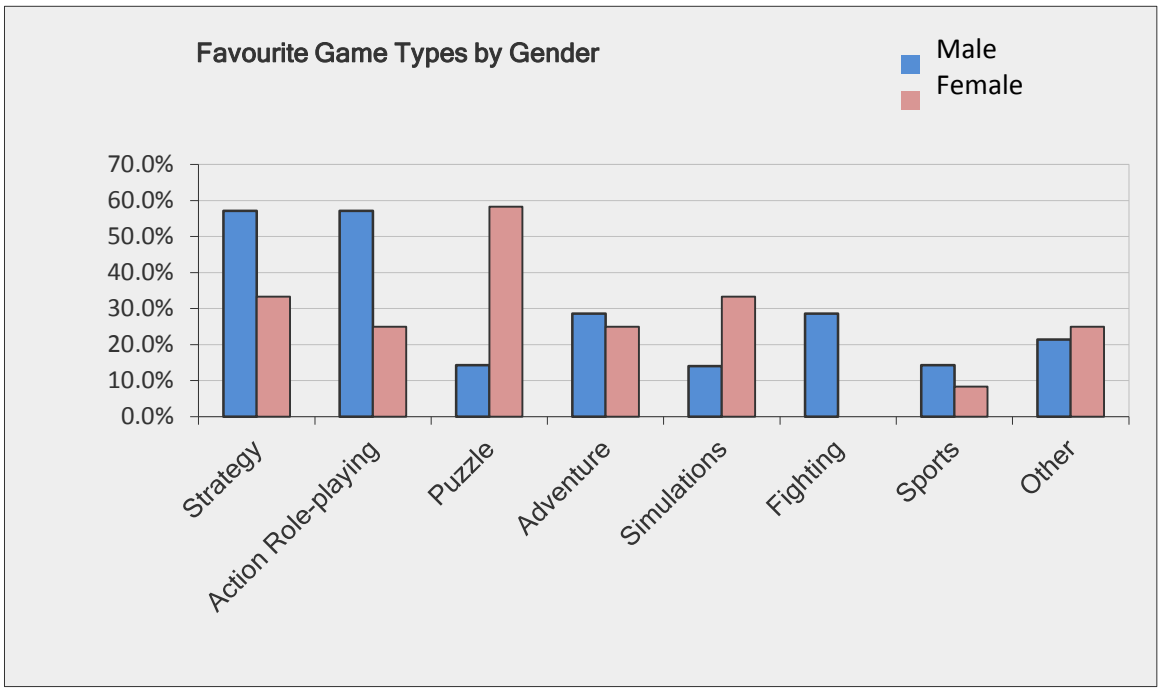

Figure 7.5: Favourite game types by gender

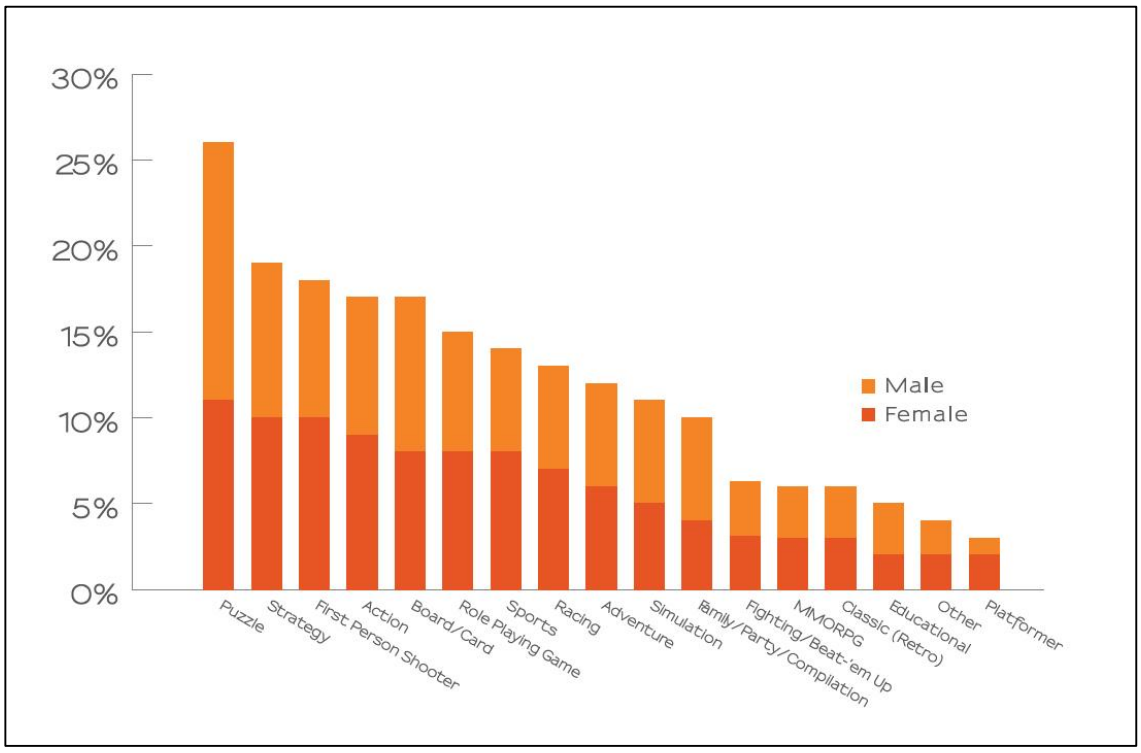

Figure 7.6: Australians' views of favourite types of game by gender (Brand, 2012, p. 10)

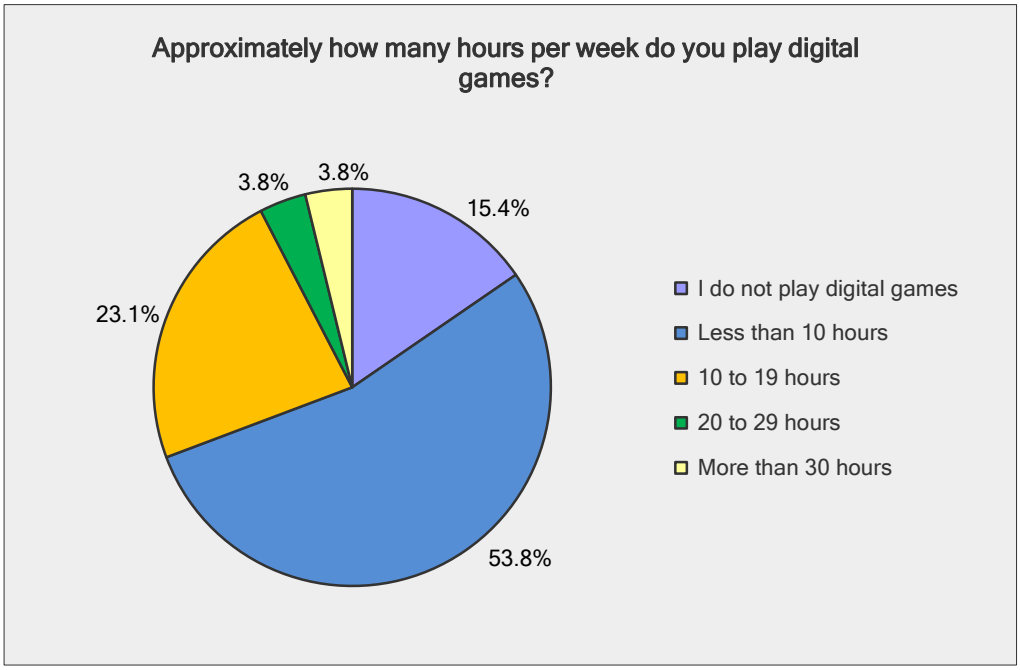

Figure 7.7: Time spent playing digital games

Perceptions and Reported Learning

Through the class survey, students responded to various statements relating to the game-based experience, measured by a five point Likert scale from strongly agree (5) to strongly disagree (1). The statements corresponded to the four themes of satisfaction, relevance, collaboration and learning. These themes were not identified as specific titles in the survey but simply captured in the underlying meaning of the various statements.

Table 7.2 shows the mean rating, standard deviation and percentage of agreement (combination of strongly agree and agree) that reveal the level of consensus with various statements posed to the participants. They have been rearranged into four categories following the main themes. In addition, they have been ordered in each section from the highest to lowest mean rating.

The students found that the game was relevant with a high mean value of 4.14 (SD: 0.83, 86.5% agreement). Perceptions of learning and overall satisfaction were also high with mean ratings of 4.05 and 4.01 (82.67% and 78.5% agreement) respectively. The satisfaction rating corresponded closely to a subsequent survey question, “Overall, how do you rate your learning experience with the game-based approach in the course?” rated on a five point scale from excellent to poor. This question received a rating of 4. The collaboration theme was rated the lowest with a mean rating of 3.46 (SD: 0.72, 56.25% agreement).

Figure 7.8 illustrates the percentage of agreement to the statements with the red line indicating 75%. Figure 7.9 shows a bar graph with the five point mean of the four categories with a red line at the 3.75 point mark. In the analysis of the data, the following interpretation system is used:

Rating	**Interpretation**
Rating higher than 3.75 or 75% agreement	High satisfaction, positive perception of this area
Rating higher than 3.00 or 60% agreement	Majority satisfaction, however a significant portion is not, suggesting further exploration of issues.
Less than 3.00 or 60% agreement	Polarity in responses, suggesting significant problems that need to be explored.

Two statements that contrast the others include 'I would have preferred if the game was an individual activity' and 'Feedback I received from my peers in the game activity had little/no influence on my learning'. Since the nature of the game corresponds to a collaborative learning approach, the desire is for students to identify and value this component of the experience. Therefore, the preference would be for 75% or higher in disagreement to both statements. In the statement referencing the game as an individual activity, 35% either strongly disagreed or disagreed, 23% were neutral, and the remaining 42% were in agreement. In relation to the statement on the value of feedback, 27% disagreed, 30% were neutral, and the remaining 42% were in agreement. In both Figure 7.8 and 7.9, as well as Table 7.2, the ratings are reversed for the two aforementioned statements, with strongly disagree being the highest at five points, down to strongly agree at one point. This allows a better comparison to other statements in terms of desired results.

The results indicate that students found the game beneficial to learning in all areas covered in the survey. including understanding of spatial design (4.31 rating), time as a component of design (4.19), creative thinking (4.19), storyboarding (3.92), films as tools for spatial understanding (3.88) and critical thinking and problem solving (3.88). The learning tied to spatial design received the highest level of consensus amongst the students with 96% of response in agreement (either strongly agree or agree) and the remaining 4% (one student) responding as neutral. The responses reveal that the students saw the relevance of the game to professional processes as well as a connection to assessments within the course.

Table 7.2: Views on game-based learning by theme

Satisfaction	**5 point mean**	**SD**	**% Agree**
The game-based approach was engaging and interesting and I was enthusiastically involved.	4.15	0.54	92
I think more courses should use digital games in learning.	4.04	0.77	81
Proud and satisfied by what was produced through the game	3.96	0.79	76
Increased my motivation in the subject	3.88	0.86	65
Average	**4.01**	**0.80**	**78.5**
Relevance			
Aided the development of my assessment tasks	4.23	0.82	85
I could see a direct connection of the game to real world applications to that I could apply in my future profession	4.04	0.77	88
Average	**4.14**	**0.83**	**86.5**
Collaboration			
Working collaboratively and discussing the game with classmates developed my understanding and learning	4.08	0.74	77
Working within teams in this type of design game was a good way to learn.	3.96	0.82	85
I would have preferred if the game was an individual activity	2.88	1.28	35
Feedback I received from my peers in the game activity had little/no influence on my learning	2.77	0.95	28
Average	**3.42**	**0.72**	**56.25**
Learning			
Helpful in my understanding of spatial design	4.31	0.55	96
Gave me a better appreciation of designing with a consideration of time and human experience	4.19	0.63	88
Valuable tool in developing my creative and design thinking	4.12	0.71	81
Effective in illustrating the value of a storyboarding approach to spatial design	3.92	0.77	77
Illustrated how films can be used as references / case studies for understanding the emotion spaces	3.88	0.95	77
Enhanced my analytical and critical thinking ability for problem solving	3.88	0.59	77
Average	**4.05**	**0.81**	**82.67**

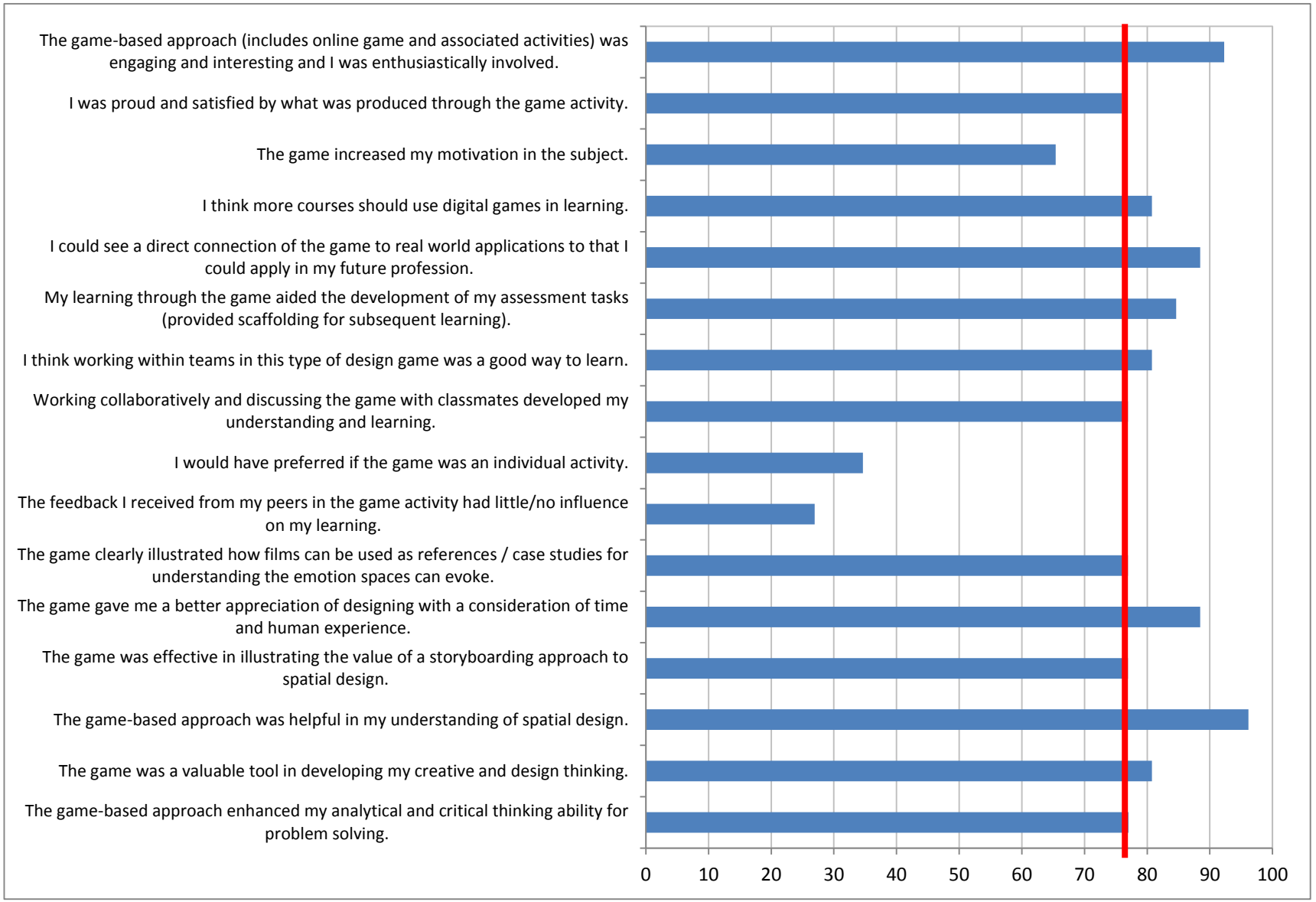

Figure 7.8: Responses to statements on game-based experience represented by level of agreement

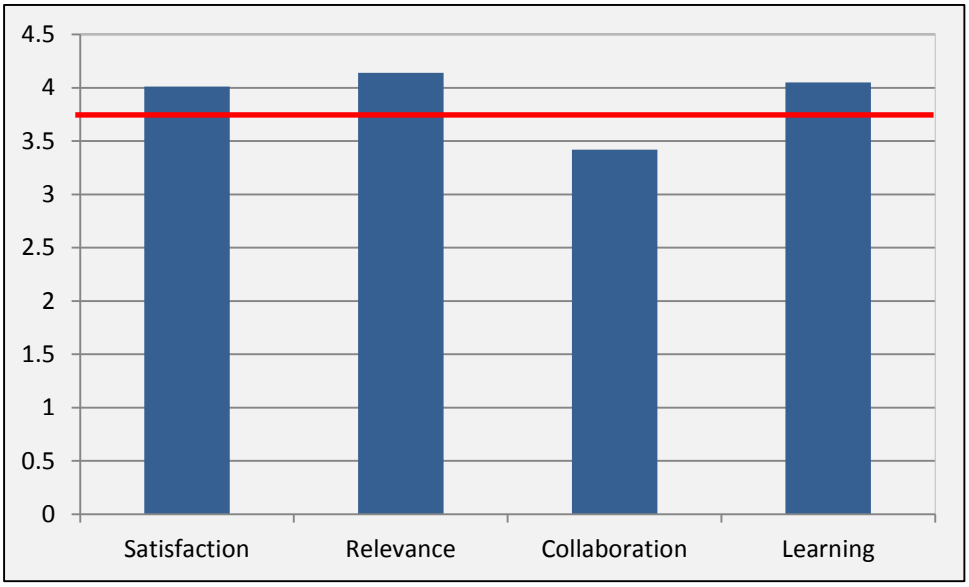

Figure 7.9: Ratings of game experience categorised by theme using five point scale

Collaborative Learning Perceptions

The lowest rated theme was that tied to collaboration, receiving an average rating of 3.42, below the minimum desirable rating of 3.75 (Figure 7.9). Students were positive about the benefits of working collaboratively within teams with 81% in agreement to 'I think working within teams in this type of design game was a good way to learn'. The statement of 'Working collaboratively and discussing the game with classmates developed my understanding and learning' received 77% agreement. However, there was a significant proportion (42%) who responded that they would prefer the game to be an individual activity. Likewise, 42% were in agreement that the feedback provided by peers within the game was of little benefit to their learning. This suggests an apparent contradiction to the positive benefits of collaboration to the perception that an individual activity may have been better and that peer feedback was not valuable to their learning. Looking at students' gameplay preferences, 42% chose single player games over multi-payer ones. This close match of prior game-play experience to the desire for the course game to be single player suggests a possible reason for their choice as simply personal preference. Of those that preferred single player games, 67% were in agreement with the *Cinematic Space* game being better as an individual activity. While the majority of this group of students who preferred single player commercial games stated they would also prefer the *Cinematic Space* game to be an individual one, the percentage is not substantial enough to provide a conclusive reason that it is simply a personal preference.

The positive benefits versus negative issues of collaboration were reinforced in the qualitative, open ended questions in the survey. While collaboration and teamwork received a significant response (8 of 23 students responded) in the question of learning benefits of the game, it also received relative high (6 of 18) amounts of comments in relation to what hindered learning. While students did not give substantial elaboration on why they found the collaboration a problem, they did hint at possibilities of reliability and communication. One student identified frustration being *"there was a bit of rushing and nagging between group members."* Two comments mentioned that a peer in the group dropped out without any word. These students were surprised by the lack of communication from the individuals concerned as well as the unreliability. This reliability and communication between team members was an issue with others who felt it impacted on the effectiveness of the game. A student succinctly described this by stating *"the effectiveness of the game also depended on the level of participation by other members of the group."* This was reiterated in interviews with a student expressing *"if the one person did do their work it meant I couldn't do the work."* These comments explain the students' desire for the individual rather than collaborative activity. Team work requires an interdependency on others which can cause problems if not well managed, if members are not motivated or are unreliable. The lack of participation by some, as well as their poor communication, did not simply affect the individual but others in the team, who felt let down. While the majority of the students clearly understood the value of learning from others, it is not inconsistent for them to perceive team work as a potential obstruction to successful learning outcomes. The game was designed with collaboration driving the experience. This appeared to be successful for many, although further development would be required in how the communication is facilitated.

In higher education, students often dislike group based assessment due to the reliance on others, inequity of contributions and grading that does not reflect the level of effort, as well as extra pressures of the dynamics of working with others (Burdett, 2003). While the influence of grading was not directly relevant to the *Cinematic Space* game experience, the issues of reliability, equity and communication did come into play. Grades and participation was raised in the survey as well as in two of the interviews. In the survey, a student suggested some people lacked the motivation to participate in the game since it was not graded. This was reiterated in one interview where the student related personal dialogue with peers where they commented that it was pointless because it was not assessed.

The literature on teamwork and assessment gives greater insight into the issues of participation and motivation. The Australian Universities Teaching Committee's (McInnis & Devlin, 2002) publication on assessing group work offers ways to minimise problems, including the provision of explicit guidelines and processes. Burdett (2003, p. 187) reiterates the need to build confidence and cooperation through "the encouragement of inclusive practices so all are involved and the confidence of less assertive students is improved." *Space Place Play* was deliberately defined as a non-assessable task in the *Cinematic Space* course to avoid it complicating the approach and adding extra pressure. However, as indicated by a student in the survey, assessment can be a core motivator for activity and, in the context of team-work, can result in in a lesser contribution by some. Biggs (1989) suggests that intrinsic motivation is tied to the need for students to see the relevance of learning, and their ability to identify with as well as own the material. This would suggest that making the game an assessment is not necessarily a solution to motivation and engagement problems. A more important consideration is to ensure that activity has a clear and strong personal relevance to the students, while highlighting the inclusive nature and collaborative benefits.

Beyond issues of personal relevance and ownership for intrinsic motivation, literature on games gives insight to elements that influence engagement. Malone's (1981) seminal work identifies three factors of intrinsic motivation, which he defines as engagement 'for its own sake'. These include challenge, fantasy and curiosity**.** Malone and Lepper (1987) extend Malone's original theory to include control. The challenge factor ties closely to Csikszentmihalyi's (1990) flow theory (discussed in chapter six) where goals are clear, feedback is immediate and there is an optimal balance of challenge and skill, corresponding to Vygotsky's ZPD. The survey did not provide a measure of the feedback or challenge students faced but it did uncover a desire for more immediacy of collaborative responses. It is likely that the clarity of goals and issues of feedback could have impacted the intrinsic motivation of some students and thereby reduced the experience becoming its own reward.

A reason for the wide variance in the responses relating to collaboration and feedback could also be due to expectations for higher levels or simply differences in the understanding of the term 'feedback'. Traditionally, feedback is associated with words, either written or verbal. Through the interviews, corresponding to my own observations, it was revealed that learning was also facilitated by visual feedback mechanisms. The way the students interpreted and visualised each other's spaces made a statement about their own views and their understanding of each other's. In an interview with a Landscape Architecture student, she communicated how

the visual layering of the subsequent student in her game revealed new ideas she had not considered before and resulted in a level of personal growth, as reflected in the following quote:

> An architecture student was very sensitive to the landscape that I had produced… … So, it was a growth scenario for me in that, I think, working as a group, and particularly with <student name>'s sensitivity to environments, that it perhaps expanded my knowledge of what you could do that with that scenario of the game.

This type of learning from others may not have been classified as feedback for some students when they responded to the survey questions. However, as the above quote indicates, the collaborative approach facilitated learning. It highlights the constructionist learning benefits that scholars advocate as important to the design and delivery of instruction, and corresponds to the Rovai, Ponton and Baker's (2008, p. 106) objective of collaborative or cooperative strategies where "the goal of such (group) work is to share alternative viewpoints and challenge, as well as help develop alternative points of view." The lack of reported peer feedback through the survey thereby does not necessarily correspond to a lack of interaction and collaborative learning.

It is understood that feedback does impact motivation, which in turn plays into effective learning. Building on Malone (1981) and Csikszentmihalyi (1990), Garris et al. (2002) suggest an 'input process outcome' model of for sustained motivation and learning. This involves a motivational process where "game play triggers repeated cycles of user judgments (e.g. enjoyment), behavior (game play), and feedback", and is supplemented with debriefing to enhance learning outcomes (Garris et al., 2002, p. 452). The inference could be drawn that if the game within this study provided more varied and increased levels of feedback tied to individual player's behaviour, students would be more motivated and encouraged through cycles of self-judgement and reflection, and thereby experience more compelling learning.

Feedback mechanisms and processes is an area that can be developed further to enhance the game. If feedback is provided promptly and at appropriate times, student motivation is likely to increase. Potential ways to further embed feedback could be through rules and use of rubrics, which could be part of the levelling up process. In this way, the collaborative learning could be further guided to ensure motivations do not wane by insufficient feedback.

Gender and Age Differences in Perceptions

The learning experience as reported by students through the class survey had some variations between different groups of students, namely male versus female, and those aged 23 and under (included three postgraduates and ten undergraduates) versus those 24 and higher (included eight postgraduates and five undergraduates). All groups gave a similar response to the statement that the game was engaging and interesting and they were enthusiastic in their involvement. The response was between 92% and 93% in agreement for all groups (Table 7.3). In terms of the categories of satisfaction, relevance and collaboration, the averages revealed big differences between the groups (17% or higher between the most agreeable group and the least). The averages across the learning statements correlated more closely with a difference of 6% across groups.

Comparing female to male responses, the results reflected a much more favourable perspective from the female side in all categories. In the satisfaction category, the female responses were between 18 to 30 points higher in agreement percentages. The biggest difference related to pride and satisfaction in what was produced in the game, with 92% of females in agreement compared to 62% of males. The relevance category had an average of 96% females in agreement as compared to 79% of males, with all in the female group stating they could see a connection of the game to their professional practice. A high difference was revealed in statement covering the benefit of the game for collaborative learning with 100% female agreement compared to 57% of males. In the learning category, the responses were closer with the average of 86% female agreement as compared to 80% of males. In the learning theme, some parts of the learning were more favourable to males over females, such as spatial design (100% to 92%) and design with consideration of time (93% to 83%), while females were more favourable in aspects of relationship to film (94% to 64%) and creative and design thinking (92% to 71%).

The difference in perceptions across genders may relate to the view that motivations amongst females tend to be more tied to process and social factors as compared to males, and that males focus more on the usefulness of a new technology (Ong & Lai, 2006; Venkatesh & Morris, 2000). The DGBL in this study engaged highly with process, collaboration and social engagement, thereby suiting any group motivated by these factors. While this study illustrates a lower personal satisfaction, perception of relevance, and value of collaboration for males compared to females, the male group still reported high degrees of the learning through the game. This would suggest that while they perceived problems in the process and structure, they still managed to reach a good level of learning outcomes.

Table 7.3: Views on game-based learning experience by group

Satisfaction	**% all (26)**	**%fem (12)**	**%male (14)**	**% <24 (13)**	**% >23 (13)**
The game-based approach was engaging and interesting and I was enthusiastically involved.	92	92	93	92	92
Proud and satisfied by what was produced through the game	76	92	62	77	75
Increased my motivation in the subject	65	75	57	62	69
I think more courses should use digital games in learning.	81	92	71	77	85
average	**79**	**88**	**71**	**77**	**80**
Relevance					
I could see a direct connection of the game to real world applications to that I could apply in my future profession	88	100	79	77	100
Aided the development of my assessment tasks	85	92	79	77	92
average	**87**	**96**	**79**	**77**	**96**
Collaboration					
Working within teams in this type of design game was a good way to learn.	81	83	79	85	77
Working collaboratively and discussing the game with classmates developed my understanding and learning	77	100	57	77	77
I would have preferred if the game was an individual activity (rating in disagreement)	35	67	14	38	31
Feedback I received from my peers in the game activity had little/no influence on my learning (rating in disagreement)	27	42	14	23	31
average	**55**	**73**	**41**	**56**	**54**
Learning					
Illustrated how films can be used as references / case studies for understanding the emotion spaces evoke.	77	92	64	85	69
Gave me a better appreciation of designing with a consideration of time and human experience	88	83	93	77	100
Effective in illustrating the value of a storyboarding approach to spatial design	77	83	71	69	85
Helpful in my understanding of spatial design	96	92	100	100	92
Valuable tool in developing my creative and design thinking	81	92	71	69	92
Enhanced my analytical and critical thinking ability for problem solving	77	75	79	85	69
average	**83**	**86**	**80**	**81**	**85**

Comparing the groups by age (those 24 and older to students 23 and younger), the results showed similar percentages for most statements, with the older group slightly more favourable. The biggest difference was the relevance category averaging 96% approval in the older group and 77% in the younger group. The older group has a higher proportion of postgraduates as compared to the younger group. A comparison of undergraduate to postgraduates in the relevance theme gave an average of 86% to 88% in agreement, the postgraduates only slightly more favourable. The difference in perceptions between the age groups could therefore be simply due to the level of maturity and life experience of the students rather than academic qualifications. The life experience could perhaps allow the students to see broader career and personal relevance.

Engagement

The survey data captures students' views of their experience. Analytics data captured from Moodle LMS give a sense of the student behaviour and their level of engagement. Table 7.4 represents the amount of views of different components of the Moodle course site. The game forum, which formed a key part of the game interaction, received the highest activity of 2,534 views in the period of one week of the gameplay experience. It received much more activity than tasks tied to assignments such as the reflective blog that received 1,744 views across the full six week duration of the course and the 'Social and Cinematic Forum' (1,317 views), which formed part of non-assessable class requirements in discussing topics feeding into the course subject matter. In terms of single pages or files, the game related pages also received high levels of attention. The game help and rules pages received more than double the views of the assignment two outline document and approximately 1.8 times higher than a grading rubric to aid the first assignment. This illustrates that assessment matters do not always outweigh students' focus from everything else in the course. Looking at the activity at the individual student level, the numbers show a significant difference in degree of participation in the game activity as compared to others occurring online. As an example, the most active student in the game forum posted or viewed other posts 236 times. The same student posted or viewed others in the 'Social and Cinematic Forum' 46 times. This difference is typical of the majority of the class. In terms of discussion thread replies (Table 7.5), the game groups on average replied 26 times, which is higher than the most active threads in other discussion forums and is particularly significant since the game threads' activity generally represent a group of four students while the other discussions represent the whole class of 29.

Table 7.4: Views of different resources and activities within Moodle

Online Activity	**Views**
Game Forum	2,534
Reflective Blog	1,744
Announcements	1,328
Social and Cinematic Forum	1,317
Course Outline PDF	238
Readings and Online Material	184
Space Place Play-Help	157
Space Place Play-Rules	156
Assignment 1 Grading Rubric	85
Assignment 2 Document	72

Table 7.5: Number of replies to discussion threads

Discussion Thread	**Replies**	**No of students**
Game Group 3	32	4
Game Group 1	32	4
Game Group 5	29	4
Game Group 4	26	4
Game Group 2	21	3
Game Group 6	20	4
Game Group 7	16	5
Average of game groups	**26**	**4**
Short Film Discussion	31	29
Introductions	25	29

The level of online interaction as indicated by the Moodle analytic reports (Table 7.4 and 7.5) clearly illustrates a high level of engagement with the game. This suggests a high degree of student motivation with the activity and a sense of its relevance, which corresponds to the survey results. Not everyone engaged to the same degree. As shown in Table 7.5, group seven with five students, had half the number of replies compared to the most active groups. There

was one student who dropped out completely and did not participate at all but this was due to personal issues as was communicated later in the course. In group five, a student participated briefly and then dropped out. These engagement issues, whether based on lack of interest or personal reasons, contributed to a level of disruption in the group dynamic and represented itself in both the survey comments and rating of collaborative statements, as discussed earlier.

Conclusion

The students within *Cinematic Space* were generally experienced in digital tools and technologies prior to their entry to the course. In particular, their prior experience in digital gameplay was high. These experiences provided groundwork for a level of comfort and acceptance in coming into a DGBL scenario. For many however, class issues of teamwork and collaboration proved challenging in achieving the best possible outcome. The students' perceptions of their learning through the game were positive. All the statements within the learning category rated highly and the one tied to understanding of spatial design scored the highest rating of the full set of 16. Since a key learning objective of the game corresponded to spatial design, it would appear the game was successful in engaging students and facilitating their learning in this context. Comparing perceptions across subgroups within the class, results were similar and generally positive. The female group were more favourable than males in all areas of satisfaction, relevance, collaboration and learning. Older students (24+) were more favourable to the game in the area of relevance to younger students (under 24). The survey provided a broad brush stroke of students' impressions of the learning, relevance, collaboration and overall satisfaction. The Moodle logs indicated a high degree of participation.

The results indicate that from a student perspective a collaborative game can be effective for design-based learning for built environment disciplines. One of the research questions of this study relates to uncovering the factors that influence outcomes and facilitation of learning. The findings indicate that the key factors include digital and prior game experience, difficulties in collaboration and technical challenges. Gender and age differences did not appear to be significant factors in influencing outcomes.

The findings discussed in this chapter do not go into the deeper meaning behind the student perceptions or provide a measure of the learning. The next chapter gives focus to the qualitative interview data of the research study in developing an understanding of how and in what ways a digital game can facilitate learning of spatial design.

Chapter Eight: Results - Learning and Personal Impact

Introduction

> "I believe game designers can make worlds where people can have meaningful new experiences, experiences that their places in life would never allow them to have or even experiences no human being has ever had before. These experiences have the potential to make people smarter and more thoughtful." (Gee, 2004a, p. 16)

Gee (2004a), as a strong advocate of digital games for learning, argues that the immersive worlds and experiences of good video games trigger deep thinking and thereby can increase the intelligence of players. This research study explores the way a digital game can provide a new and meaningful experience for student learning in spatial design. It does not attempt to measure Gee's (2004a) proposition of how smarter players become through gameplay or test whether a game-based experience produces better learning outcomes than a traditional approach. It does investigate how a digital game can facilitate deep thinking in a spatial design context and endeavours to identify the ways learners become more thoughtful.

This chapter evaluates the personal experience of the *Cinematic Space* students with a focus on the qualitative data but in connection to quantitative findings. The class survey included a number of open-ended questions to capture the benefits and pitfalls of DGBL within the course. This provided a small window into the thinking of the class. The interviews allowed for a deeper exploration of the student experience, the personal meanings drawn from it, and the nature of the learning that was facilitated. The interviews (N = 5) were between 30 and 50 minutes long and expanded upon perceptions and themes raised in survey. Table 8.1 gives a representation of the five students interviewed who are referenced in the subsequent parts of this chapter. The discussion to follow analyses the data to uncover both the nature of the experience and its interpretation by the students.

Table 8.1: Interviewees

Student Reference	Gender	Program of study
F1	Female	Master of Architecture
F2	Female	Master of Architecture
F3	Female	Landscape Architecture
M1	Male	Master of Architecture
M2	Male	Master of Architecture

Themes of Learning and Deep Thinking

In both the survey and interviews, students discussed the ways that the game facilitated deep thinking about the choices to be made, their implications as well as personal meaning. In response to the survey question on how the game helped students with their learning in the course, five main themes were uncovered, drawn out through a coding analysis by looking at common terms used as well as underlying meaning of comments. The most commonly used words to describe students' learning included - space, scene, design, ideas, approach, architecture and perspective. The five main themes drawn out of the comments were: (1) design and space (15 comments of 23 responses), (2) collaboration and team building (8 comments), (3) perspectives (7 comments), (4) spatial mood and emotion (7 comments), and (5) ideas and creative thinking (4 comments). A more general theme of preparation for assessments was also uncovered (5 comments). This theme was more thoroughly explored in the interviews. While the themes were distinct on some level, there was large a degree of overlap.

Design, Space and Emotion

The theme of 'design and space' attracted the most number of comments in the survey (15 comments of 23 responses), corresponding to learning of spatial design as the highest rated statement (4.31 mean, 0.55 SD, 96% agreement). Students stated that they developed greater understanding of the makeup and organisation of a space and the human experience within it. This overlapped with the theme 'mood and emotion', where they revealed their appreciation for the elements that influence the emotion of space, including colour, lighting, shapes, texture, framing and angles. In discussing emotion and spatial design, students made film connections in relation to their alter-ego game characters, the sequencing of their storyboards, meaning of time and camera views.

The interviews reiterated the theme of spatial design and emotion with students drawing on different aspects of the game experience for personal meaning and impact on learning. In two interviews, students (F1 and M1) talked about the canvas of the world and the ability to draw and frame views as key factors in developing a spatial understanding. For F1, the framing component was the most meaningful in the learning experience achieved through the process of zooming in and out and the defining of boundaries in order to appreciate depth and perspective. In the survey, a student used the metaphor of drawing to describe the experience saying:

> The game helped me create a sense of mood and portray abstract things in physical ways. In a way it can be compared with reading about drawings, and doing an actual drawing.

M1 elaborated on this idea of the sandbox nature of the game saying:

> Anything can become a stage. Anything can become a backdrop. It's how you fuse them to your storyline, or your storyboard, or your mood board. It's how you use those elements, how you use the environment, and the game taught me that.

For M1, the 3D environment was his canvas, the objects within it were tools for digitally drawing ideas and creating a story. F1 and M1's reflections, reinforce the connections to an architectural design studio context, where design is very much an iterative process of reframing of problems. The reflections correspond to Schön's (1983, p. 94) notion of drawing as the mind's design thinking at work and the design process involving experimentation where "Each move is a local experiment which contributes to the global experiment of reframing the problem." This reframing is also illustrative of Gee's (2003) probing principle, represented in the game through the students probing of the world, reflecting in and on this action, developing their story and associated explanation, then reprobing the world to further test ideas. For both F1 and M1, the generative process of the game facilitated reflection, which led to deeper spatial understanding.

A number of comments in the survey identified that the game process illustrated a new way to approach design and spatial analysis. This new experience related to the 3D environment in which design took place, the ability to change the ways the space was framed (such as through camera angle changes or zoom levels), the sequencing of a pathway through the space, as well as being situated in the space while it was being designed. The strength and impact of situated learning was reinforced by students in the interviews who spoke about the lived experiences of the spaces they designed.

For other students, a key part of the spatial design learning was that the game provided a structured system for challenging thinking about ideas and choices. One student interviewed (F2) described the game as a practical system of applying problem solving, stating:

> It's in a way kind of just exercising the way you think.

This view corresponds to Gee's (2004) assertion that good games provide learning through 'cycles of expertise' where players practice skills through repeated cycles of challenge. For F2, the learning through problem solving and creative thinking coincided with her response to the

spaces she received. The challenge was how to insert her alter-ego character into a space designed for another.

In another interview, a student (F3) also saw the game as a mechanism for deep thinking. F3 commented:

> It certainly makes you think about object form… The game provided for me a way of 'seeing' space as a building block for experience.

F3 explained that her personal beliefs could be applied to the design of the space. For F2, the game created scenarios upon which she had to deeply consider choices based on the current state of the game world and characters, while F3 saw personal connections and opportunities to draw her own beliefs into the world and game outcome. For both students, the game was highly personalised and ownership of the worlds was developed by the choices they made. This in turn made the experience more meaningful and engaging.

Another student interviewed (M2) also the encountered a high degree of personalisation within the game activity, which was closely tied to the design of the alter-ego character and its influence on the flow of the game experience. He described his alter ego as:

> Something that you could be, so it was kind of that person that you always, in the back of your mind, if you ever became a superhero, you could become.

He went on to describe how his values were challenged through their application to the game story and their juxtaposition with those of his fellow players. Like F3, M2 also applied his personal beliefs into the game. For M2, personalisation became very strong to the point that he felt somewhat exposed, as reflected in the following comment:

> You put all of your memories and all your kind of values into this character. I did. It felt like it was a bit too personal to be sharing everything about it to everyone.

For M2, the alter-ego was a significant factor in influencing his overall game experience from his own design approach to interactions with peers. The following excerpt from the interview reveals his thinking about the alter-ego and its impact on thinking within the game:

> Through the process of getting someone else's idea and having to change it to suit your character, you really had to think about what your values were, what you were trying to portray. Through manipulating other people's ideas and work, you kind of had to think about your own. You have to brainstorm, but it's a lot deeper than that. It's not just idea. It's about my character as well.

The game directed students to design emotive spaces drawing on the alter-ego characters they created. It is clear that student M2 fully embraced this approach and immersed himself in the character. This strong engagement with the alter-ego was common amongst other students. For example:

> I actually always refer back to my character to build the environment that the character will be in. I think that the thoughts of the character actually carry through my design. (F1)
>
> The generation of characters was useful for how one manipulated the landscape, acted within it, remembered it, experienced it and chose to change it. (F3)

M1 described how the alter-ego developed for the game allowed him to become a protagonist in the story and shaped his journey. The experience corresponds to Gee's (2004a, p. 18) identity principle stating that "Deep learning requires an extended commitment and such a commitment is powerfully recruited when people take on a new identity they value and in which they become heavily invested." The students interviewed were able to deeply critical reflect on their experience by unpacking their game identity and the nature of their investment within it. For some, like M2, the game provided challenge by the personal conflict of identity and exposure to others. For others, the challenge was simply the interactions between one alter-ego and another. For all interviewed, the creation of the alter-ego identity facilitated a personalised entry point to the game and a reference for subsequent choices. In this way, their commitment to the game identity was reinforced and grew in importance through the experience.

Teamwork, Collaboration and Perspectives

The game was designed as a collaborative activity where the outcome was reliant on interaction between the various players. It is therefore not surprising that the theme of collaboration and teamwork was prominent in both the survey (8 comments of 23 responses) and interviews. The previous chapter analysed challenges and reasons for some parts of collaboration rating poorly by students in the survey. This section fleshes out the ways collaboration impacted learning.

Since the game occurred in the first few days of the course, it acted as an ice-breaker and facilitated communication between classmates. This point was reiterated in the survey with one suggesting it encouraged team building. Through the collaborative activity of the game, students were exposed to different perspectives of their peers, which created challenge, as discussed in the previous section. The collaborative learning was described in comments

covering students' need to adjust to new situations and respond to ideas of others. An indicative student survey comment on this theme was:

> The game made me think outside the box and figure out ways to adapt and change my thinking when confronted with the unknown (previous student's adaptation of the space).

Students' survey comments suggested that the collaborative nature of the game also helped them break out from their preconceived ideas and push the boundaries of their imagination, stimulating creative thinking. This outcome corresponds to the mutual learning process Be´guin (2003, p. 715) describes in 'cooperative prototyping', where "design is achieved by separate actors, engaged in an interdependent process, during which mutual learning is achieved on the basis of the differing qualifications and expertise of the actors." The game teams were deliberately formed to include students from different disciplines and have a mix of genders. These differences augmented the mutual learning of the collaborative experience.

The students' discussion around collaboration overlapped with the theme of perspectives. Students stated that learning occurred through being exposed to different ways of seeing provided by their peers, which in turn facilitated a change of their own perception of spaces and ideas. This collaborative exchange and mutual learning is illustrated in the following quotes from three students interviewed.

> I had a certain idea in my head that the other person might not see. And it was very difficult to interpret that in words. But when we put together the collage, and when we put the character into the other person's environment, the other person could really understand what I was trying to say. (M1)
>
> Seeing my own being changed at the very end to what <student name> produced was kind of eye-opening, seeing it change and how each person adapted to the space. I guess that's a way to see how other people think. (F2)
>
> An interior architecture student was very sensitive to the landscape that I had produced. She actually discussed with me what my intention was of my scene, and when I spoke to her very briefly about it, she actually produced an incredibly beautiful landscape experience. (F3)

The exchange between students went beyond verbal discussions by embracing the visual medium of the game environment, allowing for student interpretations and reinterpretations. The process is illustrative of Schön (1983) and Lawson's (2005) view of design as a reflective

conversation. The feedback mechanism designed into the game was through a questioning and a discussion stage between levels, aiming to promote conversation. This occurred to some degree as related by F2. She stated that feedback from peers added another dimension to her gameplay process and forced a shared consideration of the output. The other students interviewed suggested varying degrees of verbal discussions with their fellow players about the spaces they produced. In the Moodle game forum students' written descriptions and discussions were concise. While the verbal or written discussions were one form of feedback, the spatial images the students produced that represented the design drawings of the game, provided for a visual conversation about their ideas. Through this system, the students developed new appreciations of their own spatial creations by how their peers reinterpreted and reframed their spaces for the next game level. An example of this visual exchange is reflected in Figures 8.2 and 8.3. Figure 8.2 represents a space designed by a Landscape Architecture student F3, corresponding to the emotion of entrapment where there is an attempt to escape from an enclosure. Figure 8.3 represents the space extended by an Interior Architecture student, who picked up on the theme of the landscape student and transformed it from an indoor to an outdoor space. This provided a strong sense of visual feedback to the players in the team, becoming discussion points well after the game was complete. The game allowed for these students to move out of their disciplinary perspective and embrace those of their peers.

The iterative sharing of individual interpretations of spatial designs through the game helped students develop a deeper understanding of both the nature of space as well as the way people behave and think. F2 reinforced this in her interview. She came to realise that spatial meaning can vary significantly between different people, and individuals can get locked into a narrow viewpoint when not challenged by others.

> Each person has an idea and a way of thinking, which is something that you don't get when you're focused on your own work, or when you're doing group work and someone's the leader. When you only surround yourself with likeminded or within the same discipline, there is a chance that your knowledge is limited. (F2)

F2 reflected that even group work does not ensure broadening of perspectives. She developed her awareness that the exposure to different perspectives expands one's own understanding since it is easy for people to often get constrained by their own world view.

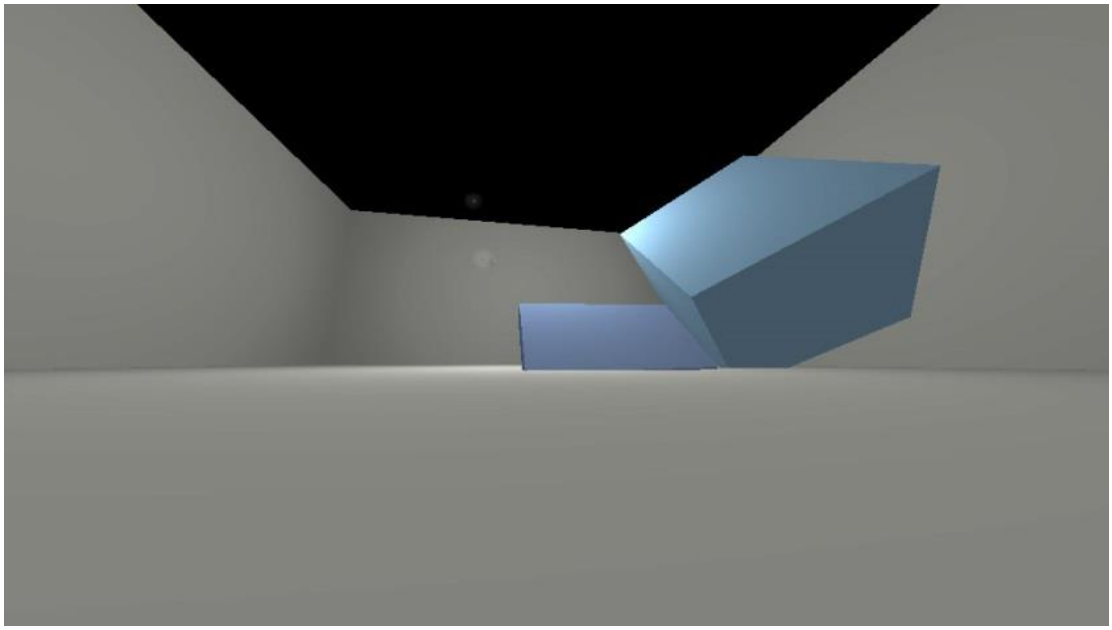

Figure 8.2: Landscape Architecture student space representing confinement

Figure 8.3: Interior Architecture student reinterpretation to an outdoor space

The interviews uncovered the way the game enabled effective collaboration. F2 suggested that the success of the collaboration was due to game rules, where there was a definite task for each member. This structure forced every person to play their part rather than sitting on the sideline, which can often be the experience with group work. F2 reflected that within her group assignment, which was made up of the same people as her game team, this did happen due to unclear delineation of roles and a lack policing to do the work. F1 reiterated the importance of

the structure suggesting the sequencing cycle of the game was meaningful where the outcomes produced through the process resulted in personal satisfaction. F3 also commented on the game rules as facilitating collaboration, stating that having a deadline to move on to the next level encouraged gameplay. The game analytics, as discussed in the last chapter, revealed high level of activity across most of the students. While the survey and interviews suggested some students felt unsure or unenthusiastic about the game, this did not translate into significant inactivity. One possible reason is that there was a level of expectation in regards to the contribution of fellow players and they would apply pressure on their peers to perform. This was the case in at least one situation revealed by a student's comment that a degree of nagging was required. The game thereby became an informally policed activity where the peer obligations minimised the approach of taking a passive role to the teamwork.

Ideas and Creative Thinking

The theme of ideas and creative thinking received a number of comments (4) in the survey. These overlapped with other themes of design and space (15 survey comments) as well as collaboration and team building (8 survey comments). This was reiterated in the interviews with all students commenting in some form that the game facilitated creative thought and idea formation. F3 described the gameplay experience as a "generator of ideas." The students also reflected on how the game developed ideas that could be transferred into assessment work, as discussed in the following section.

Preparation for Assessment

The first assessment in the *Cinematic Space* course was a short film with a theme of 'emotion is emotion'. This theme was deliberately chosen to align with the engagement that took place in the game. The subsequent assignment was themed around space, place and time, which was also introduced in the game. A number of comments (5) in the survey question on how the game helped with learning in the course mentioned that it was useful as preparation for the assessments. These comments ranged from identifying specific ideas, such as the use of fog as a tool for revealing, to more theoretical understandings, such as the use of framing and motion. Two students commented that it helped them in the formation the team for the major assignment as well as understanding the dynamics of collaborative work. Another student simply stated the game as a way to "prepare my mind for what the course was to offer." These views were reiterated in the interviews where students identified the game as providing a foundation for the course learning outcomes.

F1 corresponded to survey comments of other students in identifying specific elements and techniques of the spatial design within the game that she could transfer and develop into her film assignments. This included the colour, lighting, camera angles and sequencing, which were important in the creation of a story. For F1, the game was "like a simulation of film making." The lessons of the game were directly applied to the assignments as a subconscious understanding, where the connections were only realised through reflection. For F1, the game changed her approach and way of seeing design problems. She discussed a design competition entered after the course where she has applied her new way of framing and sequencing for the building proposal.

F3, like F1, drew on specific techniques in the game to draw into her assignment work. In addition, the development of her alter-ego, described as an 'eco-warrior', became a catalyst for her to articulate and express her personal beliefs and values. The game allowed her to "address the landscape architectural elements as having a character of their own." For F3, the game provided opportunities to deeply consider the nature of space, the elements that define it and give it character. In this way, it provided scaffolding for her subsequent assessments. It also provided a way of approaching her discipline of landscape architecture as reflected in her comment:

> The layering of experiential phenomena, as experienced in the levels of the game, even in terms of materiality, and lighting could provide a generator for ideas for landscape.

For F3, the game activity impacted on her 'way of seeing'. It facilitated the creation of characters that responded to a designed environment and allowed for deep consideration of scenarios that could translate to the real world.

For F2, the collaborative nature of the game provided insight into group dynamics and individual thinking processes, which was useful when beginning the team assignment. While F2 found this type of game-generated lesson valuable, she related that her assignment group still reverted to traditional methods of delegating roles and managing contributions. The game thereby did not significantly guide group workflow for the assessment task but rather provided a reference for reflection and comparison.

M1 elaborated on the view that the game prepared students for what was to come in the course, achieved by introducing key themes of the subject. He mentioned that a deeper understanding was developed once he engaged with critical reflection of the process. M1, like F3, found the

saw the game as a building block that scaffolded subsequent work through the all assignments. This is reflected in his comment:

> You learn something, and you don't want to let it go completely, but you want to use some, a part of it that you learn in what you're doing.

As an avid gamer, M1 developed a game-based way of thinking to his assignments described as 'thinking in levels' that became 'automatic' when approaching the assessment tasks. He reflected that the design of the film projects closely aligned to a game system where challenges were faced and strategies developed in order to progress. In this way, a game-based view of design and practice could be applied more broadly into his future profession of architecture.

M2 reiterated points raised by F1 and F3 about the colours and lighting elements of the game feeding into the interpretation and design of the emotional character within first assignment. A key take-away for M2 was the how to create a space that expresses a particular message, which included his character, history and emotions. He also described a similar connection to M1 in relation to the workflow of the assignment as being very game-like. The team film was characterised as having multiple levels. The process of creating his film assignment involved creating a character, a world, the views of the space, and the insertion of lighting. All these considerations reinforced the meaning of the experiences in the game. M2 reflected:

> I think this was a very good lead up to it because, it made you think about all those different things, the angle, and what kind of mood you want to set, and all that kind of stuff.

The game thereby facilitated an experience and an opportunity to think deeply about issues that would be important at a later stage. The experience of making the films extended his understanding of design:

> For me, it was very eye opening because the fact that just by looking through a lens, the whole perception is actually changed.

M2 initially described his approach to the architectural design process as 'old fashioned' that would unlikely change from the game and course. However, through the interview a deeper reflection was drawn out. M2 experienced moment of sudden realisation that on a subconscious level, multiple lessons from the game had fed into his design thinking. He stated:

> It is something that would go into the design process, even if I don't explicitly know.

This corresponds to M1 who used the term ‘automatic’ for how his thinking from the game transferred to thinking about the assignments. For both students, the game resonated strongly in their way they would work in the future. It produced a way of thinking that could be likened to driving a car where the skills are so embedded in the process they occur naturally without second thought. .

Design-based Learning and the Theme of Time

Developing design thinking encapsulating the theme of time and lived experience was a core learning objective for the students through their gameplay. The theme of ‘time’ was addressed in two ways, (1) movement through space, (2) and the changing of space over time.

For most of the students, their change in thinking culminated in the final level of the game where they were required to create a sequence of images that told a story. In earlier levels, the images they produced were generally representations of different views of the spaces they created. An example of this approach is illustrated in Figure 8.4. By the final level, greater consideration was given to the journey through the spaces and their meaning. Figure 8.5 is indicative of this approach. The image sequence produced by the students shows the journey of a central character through the space. The camera angles change across images from looking up at the character to looking down on the word, reflecting a change of the character from being heroic and powerful to insignificant. The movement through space is not simply a character walking between two points but the camera moving to change the perception of the world and the characters within it. Figure 8.6 illustrates the approach of time represented by an evolving space. The game group created a final level that they tiled ‘The Six Days of Creation’. The images represent an abstracted view of a world being created in layers with minimal form and light in the early days to a highly textured space with multiple forms of life in the last parts. The sequence also embraces the journey the students went through with their design iterations and celebrates it as an achievement of the creation of a world.

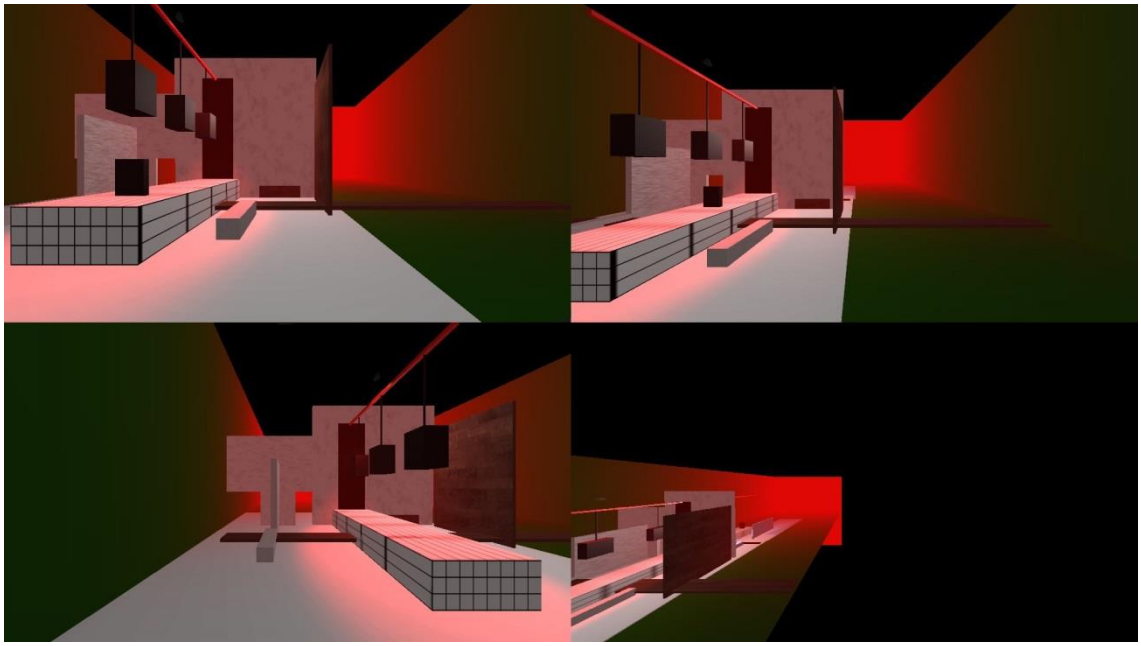

Figure 8.4: Images of game space seen from different angles

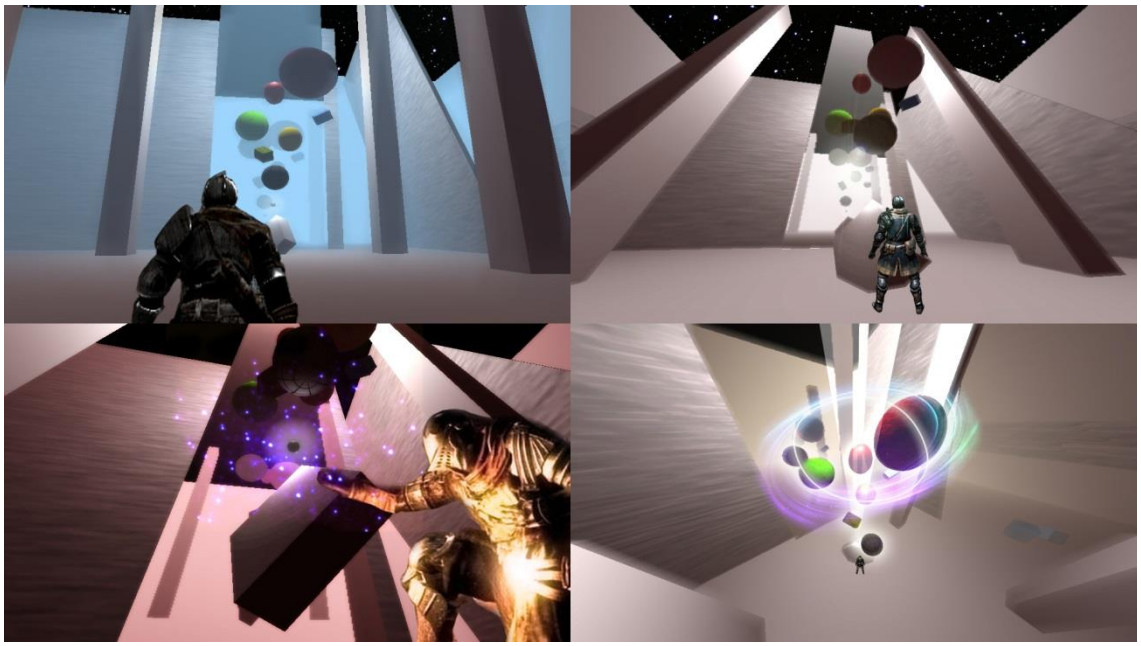

Figure 8.5: Images of game space illustrating movement and journey

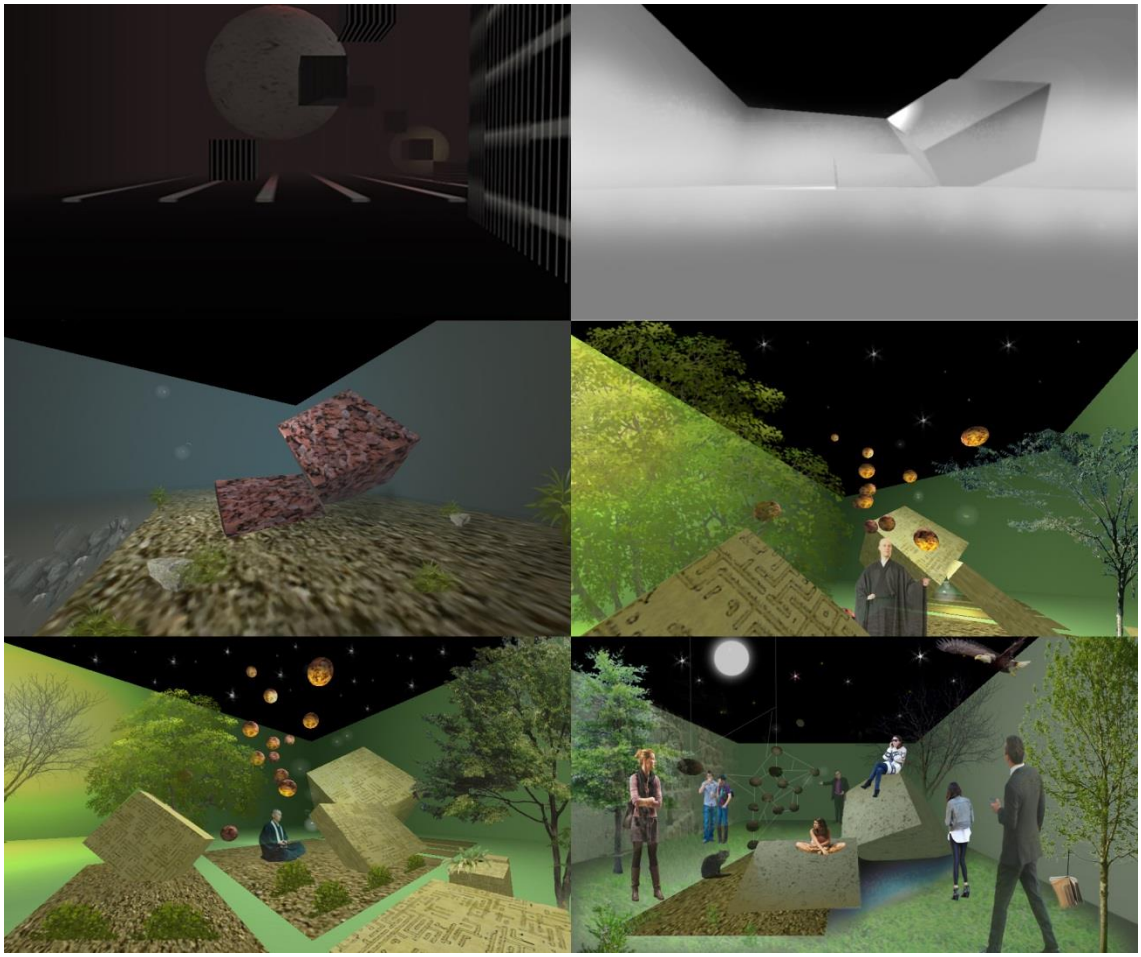

Figure 8.6: Images of game space evolving over time titled The Six Days of Creation

Influence of Prior Digital and Gameplay Experience

All of the five students interviewed were digital savvy having smart phones and using different mobile apps for communication and Internet access. Their experience with technology and social networking platforms did not appear to provide natural scaffolding for the game. The only possible advantage was that they were open to the use of new technology for a collaborative activity. However, familiarity with other 3D tools was raised as useful prior knowledge for some (like M2) but not vital for others (like F3).

In terms of digital gameplay experience, there were wide differences amongst the group of five. The three females interviewed had little to no prior digital game experience and the two males had vast experience. One student's lack of interest in digital games was due to a concern of too much exposure to electromagnetic radiation. Another student stated she suffers from motion sickness when playing video games. The third simply stated she has minimal interest in games.

Two of the female students related that they play puzzle games on their mobile or tablet. The two male students were at the other end of the spectrum of gameplay being highly experienced gamers. Both stated that games were important parts of their childhood.

> Gaming started to become a huge part of my life ever since I was in eighth grade. (M1)
>
> Games were a big part of growing up for me. (M2)

For both M1 and M2, much of their leisure time had been consumed by immersive video games. It is not surprising that the two students experienced in video games used that knowledge as a reference point when discussing their views on the *Space Place Play* game. On the other side, the students that played puzzle games as individual activities made no connections (F1 and F2).

> I felt it was more like a journey of a character from start to the end. And that's how every game is at the end of the day. Like, you have a protagonist, right. You have one in every single game and it's his transition from level one to level ten. Or like from one stage to the other stage. Obviously there weren't any boss battles. But I guess the boss battles in this case would be the challenges that actually came up - collaborating with different people. (M1)

M1 explained his affiliation with video games through the ability of becoming a character and being taken on an interactive journey that felt like a movie experience. For him, the games stimulated his mind through the development of strategies that brought about different experiences and outcomes each time they were played. He expressed his enthusiasm for games saying he had made a list of the ones he completed and it numbered 147. M1 was very positive about the educational value of games expressing how skills that people develop in video games would be valuable in later life. In terms of the *Space Place Play* game, M1 found it challenging due to the collaborative approach, which differed from games he had played. He compared *Space Place Play to* the prior games saying:

> A huge factor of almost all games is the ability to use the environment around you.

For M1, entering the *Space Place Play* game came with a level of expectations. His approach on what to do in the game and what should happen took into account his prior video games. However, he did not simply behave as he would in the other video games but rather he adapted and found ways to use prior game knowledge and skills as scaffolding for his new experience. He reiterated this point saying:

> Probably since I gamed a lot before that, I could understand or I could correlate to that.

M2's game prior experience was very much focused around the social side. For him, the socialisation in games was not simply the multi-player component of the games but in playing with people he knew to create shared experiences and build or extend friendships. The social side also extended into forums to engage with the wider game community. With this rich social approach to games, it would be expected that the level of engagement with his team players would have been high. However, M2 related that the interaction was relatively lower than other groups. The reason was due to the availability of the various students. His fellow players had to budget the game play time with their jobs and therefore were often only available for discussions late at night. This led to M3 adapting and focusing on his own component. The group still interacted online and in person although in a limited way. M2's discussion on his game-based learning experience clearly showed that his knowledge, skills and modes of thinking gained through playing the *Space Place Play* game scaffolded for approaches for assessment tasks. His prior game experience also provided a level of scaffolding in terms of allowing an easy way to adapt to the challenge of the specific scenario. It aided his progress despite the perceived limitations, which in his case were team communication issues.

Hindrances to Learning

Three main themes were uncovered through the survey and interviews on how the game hindered learning. In response to the survey question on this point, the comments focussed on: (1) bugs and technical issues (7 comments of 18 responses), (2) usability and tool limitations (5 comments) and (3) working with others (6 comments). There were two comments indicating that there was no hindrance to learning, and one student who said the only problem was that it took too long. Issues of collaboration have been covered in the previous chapter. This section will focus on the technical and usability issues.

Platform bugs and technical issues were the highest commented concern communicated in the survey. It is clear that the technical issues or limitations caused the greatest frustration with students using words like 'annoying', 'quite troublesome' and 'temperamental' to describe the tool. These issues were reiterated in the interviews, with three of the five raising this in response to a question on the challenges of the game. Of these three interviews, two students laughed while mentioning the issue. While, it was clear they were frustrated and inconvenienced by the technical problems, they realised, particularly in hindsight, that it was not a debilitating problem. The technical problems included files not saving properly in some situations and instances where

the application froze. In the forum, a student posted the statement, “feel depressed” with an explanation that the web application crashed unexpectedly resulting in him losing his work. The strong emotional impact reflects the deep investment, ownership and personal loss to the student. This student managed to overcome the initial setback and produced quality outcomes in subsequent levels, of which he was proud. While the problems were not severe to the final game outcome, the reflections through the survey, interviews as well as online forum, suggest that students see technical challenges as significant barriers to learning.

The useability issues included things like passing scenes on to someone else or the manipulation of architectural objects. In the survey question on what could be improved in the game to aid learning, a number of students (4) identified the saving and transfer of scenes, with a further three commenting on control of the program, which covered flexibility and usability. Three comments suggested the use of other tools for greater functionality and familiarity. Students clearly felt that a smooth workflow would minimise frustration and thereby facilitate a richer and more effective learning experience.

The technical and usability issues of the experience were picked up me as well during the class game playing sessions and in comments in the forum. To address this concern, I provided as much support as possible through the gameplay process to alleviate the problem. In addition, I recorded information on the issues for future improvement. Some students felt the tool was limited in capability and suggested other possible commercial application replacements such as Sketchup (a 3D modelling tool) or Crysis (a game engine). While existing game engines or 3D modelling tools may have served the requirements of the game activity, it is likely they would pose a steep learning curve for some students that would have resulted in a different type of frustration. In the design and development of the game, prior student knowledge and skills were key considerations. The game tool was developed specifically for the course to maximise accessibility. The survey results of students’ digital confidence in 3D modelling tools and 3D game engines were generally low and therefore the decision to employ a simpler tool was the better option. However, while the students did not appear to struggle in learning and using the game tool, it did have some teething issues.

The concerns raised by students in relation to the technical and usability issues clearly impacted satisfaction at some points of the game. Delwiche (2006), through his study on the use of MMOs in teaching two courses, one on research methods and the other on game design, identified student frustration with the learning curve of the game environment as a key factor in their

learning experience. In his study, the students had prior experience using game consoles at home but few were unable to quickly master the complicated interface of the *Everquest* game environment. Delwiche's (2006, p. 165) key finding from his study was that "game accessibility is crucial to learning."

The limited functionality of the game tool was highlighted by some students (4) in the survey question of how the game could be improved. These limitations were a deliberate design approach to provide fewer options to students and thereby encourage greater creativity and innovation with what was available. The interviews revealed that there was some confusion about how to use the tool, which was related more to the task than the functionality. These problems suggest that the experience could be enhanced by not only improving the product's ease of use, but clarifying expectations so students understand the reasons for any perceived limitations. This would go towards addressing the following student comment in suggesting improvements to the game:

> I guess the lecturer could elaborate bit more on the instruction of the game part, as there were some confusions at the beginning for me which might make the game less enjoyable.

The findings indicate the intrinsic nature of the game is strong but aspects of collaboration and technical functionality can be improved. The previous chapter has suggested changes in terms of collaboration and feedback. Instruction and other content that feeds into the game can be modified to avoid confusion in relation to how the tool can be used, why it is being employed as well as what is hoped to be achieved. This material could also more strongly address connections to film, storyboarding and critical thinking that were rated well (77% agreement) but lower than other aspects of learning. By enhancing these aspects of the game, it would be likely that negative perceptions would be minimised and views on relevance and satisfaction would increase, further facilitating deep learning.

Conclusion

The data collected in this research study identified strengths and weaknesses in the DGBL experience. The strengths include positive perceptions of learning, particularly in the area of spatial design, benefits of collaborative design, personalised learning, and meaningful experiences. Weaknesses included some aspects of collaboration and technical issues that obstructed progress at times and frustrated players. A key impact of the game was the personal

meaning it facilitated, achieved through engaging in cycles of reflection, identity formation and product development.

The findings identified collaboration as both positive and troublesome. The clear expectations to roles and tasks facilitated effective collaboration for many and provided an internal system of rules for participants to follow. The game structured and guided participation together with shared perspectives and visual conversation. However, it also demanded communal responsibilities, which resulted in a level of conflict in situations where players' expectations of each other were not met. The challenge of interacting and responding to other players became both enriching and provocative.

The game activity achieved success in being autotelic, personalised and generative. It was autotelic in that the creative activity had an end and purpose in itself, tied to an intrinsic reward as a dimension of flow (Csikszentmihalyi, 1990) as well as the situated nature of the learning experience. The purpose was directed by the students themselves and how they perceived its value beyond the game. It was personalised in how the players designed their own gameplay identity through their alter-ego and the spaces it informed. It was generative by the design product and forum discussions. This learning provided meaningful scaffolding for subsequent course work as well as perceived professional applications.

The second research question of this study asks how the digital game facilitates learning and what outcomes are produced. The chapter has found qualities of collaboration, personalisation, technical challenge, role determination and communal responsibilities, generative output, as well as the clear and internal purpose, were contributing elements. Outcomes include creative output, deeper consideration of the nature of space and the theme of time, as well as rewarding and meaningful learning for the students. The *Cinematic Space* digital game-based learning experience gave students the opportunity to engage with other disciplines of the built environment and insert themselves in their design creations. This was done metaphorically through their alter-ego and its associated emotions, desires and memories. The game allowed students to directly experience the 'lived space' concept discussed by Pallasmaa (2001) transferring their theoretical reading into a concrete action. Pallasmaa (2001, p. 22) asserts that experiencing space is a dialogue with architecture, "I place myself in the space and the space settles in me." The experience of the game appeared to impact many in this way where the spatial dialogue was personally absorbing and social, allowing meaning to be drawn out from engagement of the events of the virtual world.

Chapter Nine: Conclusion

Introduction

> "From the learner's perspective, games offer not only the opportunity for a more compelling, rich and exciting experience but also offer the opportunity for a more individualized experience and efficient learning." (Epper et al., 2012, p. 7)

This research study included two significant components; (1) the design and development of an educational game and (2) its implementation and testing within a course for senior undergraduate and postgraduate students studying disciplines within the Faculty of Built Environment. Through this investigation, logistics of production and design have been uncovered as well as the learner's perspective of how the game impacts the student experience. This chapter gives a summary and conclusions drawn from the research findings. In addition, it covers biases, limitations, contributions and recommendations for theory, practice and further research.

Summary and Conclusions

Educational Game Design and Development

Games are complex activities with intricate layers that engage, motivate and stimulate players in achieving their goals. The design of games, particularly those with an educational objective, is a highly challenging task. Educational game development frameworks, such as Annetta's (2010) Six "I"'s, De Freitas' et al. (2010) Four Dimensional Framework and Gee's (2003, 2004a) learning principles, provide valuable guidelines and considerations for creating games for learning. These cover themes of identity, immersion, interactivity, pedagogy and the broader learning context. In addition, they point to an examination of learning theories, which are critical to define the nature of the experience and plan the type of learning outcomes. While educational game design frameworks provide a foundation for the planning and development, they are not a total solution for designing good games (Björk & Holopainen, 2005). Beyond the frameworks, this research drew on evaluations of other games, including *Minecraft* and *Armadillo Run*, design processes employed in software development, as well as pedagogical practices.

The game production process was limited in resources of time and budget. Design in professional practice is generally a collaborative activity, drawing on a range of expertise and ideas. The combination of specialised knowledge and skills results in a stronger end product. The team in the development of the educational game, *Space Place Play*, included myself as the primary designer and content expert, a programmer and colleagues from both academic and professional circles, who provided advice. In addition, three past students were available to test the game. Time proved to be the biggest limitation, which restricted the length of the testing stage and discovery of technical issues. However, the game was successfully integrated into a higher education course and facilitated learning in an architectural design context. It thereby acted as a strong proof of concept and uncovered considerations for both game design as well as digital game-based learning.

Key lessons drawn from the creation of *Space Place Play* relate to management of the process, resources as well as expectations. This is particularly important within an educational context where budgets tend to be tight. An iterative design process can result in a better end product where each version improves and addresses problems of the previous. However, the implications of such an approach include increased development time and expense. In order to minimise problems in the game execution, adequate planning, resources and support is vital, processes that were carefully considered in the development of the game for this project.

The comprehensive process of producing *Space Place Play* addressed the first part of the research question of this study. It uncovered a range of factors that influence game design as well as key considerations necessary to maximise positive outcomes within an architectural design course context.

Digital Game-Based Learning Outcomes

This research study aimed to explore if digital games can be effective for learning in an architectural design discipline and explain the impact. The second part of the research question covered how the digital design game facilitates learning for the course context and the outcomes it produced. These questions were addressed by collecting evidence through a mixed method approach that included a student survey, interviews, online discussions, LMS logs, game products, informal observations and reflective notes. Through quantitative analysis of themes of student perceptions of satisfaction, relevance, collaboration and learning, as well as qualitative data coding, the outcomes elicited were largely positive.

The *Space Place Play* game proved to be effective for learning within the *Cinematic Space* course with the majority of students expressing positive outcomes from their DGBL experience. The most highly rated area in the student survey was that the game was effective in learning about spatial design with a 96% level of consensus. The other areas that were rated positively included design with the consideration of 'time' (88%), creative and design thinking (81%), storyboarding in design (77%), use of film for spatial understanding (77%), critical thinking and problem solving (77%). These student perceptions of learning were reinforced in the interviews.

The perceptions of the game experience were similar when comparing different subgroups within the class. The female group were more favourable in all areas of satisfaction, relevance, collaboration and learning. Drawing on other research, a possible explanation for the difference is that females are more process aware and engage stronger with social factors while males focus more on technology use (Ong & Lai, 2006; Venkatesh & Morris, 2000). Comparing students aged 24 and older to those younger, the results were similar in most themes with the main difference in the area of relevance, which the older group scored more favourably. The explanation proposed was that a level of maturity and life experience allowed the older group to see broader applications and learning connections.

The research found that collaboration was both a strength and weakness. An identified strength was that the game clearly defined roles and tasks for players, facilitating collaboration and providing an internal system of rules for participants to follow. This encouraged engagement through peer pressure and responsibility, minimising the taking of a passive role to the team activity. The collaboration was successful in the sharing of different perspectives and in challenging students in their own thinking. However, it also created difficulties in the management of the dynamics of the team. As a design learning exercise where collaboration is vital to the process, the game produced challenges for some students in the way they interacted with their peers. Examples of these challenges included pressuring others to deliver their component promptly as well inadequate communication. This collaborative issue itself was an educational opportunity for the students. However, some saw the collaborative challenges as an obstacle. As such, future considerations are required for the facilitation of the game, communication processes and management of expectations.

Beyond the challenge of collaborative interaction, technical problems were identified as a significant obstacle. It resulted in a degree of frustration and disappointment. While the platform bugs and technical issues added an obstruction to the game experience, students

persevered and did not give up on the gameplay. However, it was clear that students saw technical challenges as a barrier to learning.

The participants in the interviews revealed the strong personal impact of the game. For these students, the 3D environment and collaborative activity provided an avenue to explore spatial design and the insertion of personality and emotion. Both male and female students in the interview group discussed how the game was highly personalised through the alter-ego identity and the ownership of the worlds they created. The interviews expanded on points raised in the surveys suggesting that the game provided valuable scaffolding and preparation for assessment work in the course. For some students, prior game experiences also acted as scaffolding, allowing for a game-based way of thinking to be easily transferred into action both within the game as well as through other course tasks.

The game encompassed a collaborative design activity in order to facilitate design thinking and practice. Students reported success in reaching these learning outcomes, achieved as a result of the situated learning experience through the collaborative design interaction where they developed a strong game identity and emotional connection to their alter-ego character. The process facilitated reflective practice aligning to Schön's (1983) theory as well as Gee's (2003) probing principle, which reinforced students' understanding and increased the personal impact. The design and implementation of the game was successful due the theoretical framework employed, which positioned learning as situated in an authentic context that is meaningful and directly relevant to learning outcomes.

Biases and Limitations

All studies have a degree of bias and limitation. In this study, I was both researcher and teacher. This potentially adds a level of bias to the data through a personal degree of subjectivity as well as influence over the students. This bias was alleviated through benchmarking with other researchers, in particular the primary supervisor for this study. From planning through to analysis, all data and interpretations were shared, ensuring an objective treatment of the findings.

Through the ethics approval process, the panel identified the issue of the teacher-student relationship and requested a greater arm's length approach to the collection of information from the students. This was to avoid coercion and potential distortion of data where students

may feel obliged to give a specific answer in fear of an impact on their grades. With this in mind, the survey and interviews were conducted once all assessable work was graded and final course results were available to students. At this point, it would be clear that all communication through the survey and interviews would have no impact on course results. In addition, signed consent forms filled in by students were given to a third party and only passed on to myself once the course was over.

The survey and interviews occurred over the period from March to April 2013. The game had taken place in the second week of January 2013, with the course continuing into late February. The delay in collecting data potentially impacted on students' recollections of some of the details of their experiences. This was addressed by asking students to reflect regularly and keep notes on their learning and experiences, which could become a reference for later research communication.

The study is limited by the small size and therefore findings are not empirically generalised. *Cinematic Space* was a relatively small course with 29 students. A significant representative data set was collected through the survey with 26 survey responses. The qualitative questions posed in this context received brief answers with minimal deep discussion by students of their experience regardless of whether they were positive or negative. This is a limitation of surveys and the interviews aimed to elicit and explore the student experience at a deeper level. Five students were available to be interviewed. These students were amongst the most diligent of the class, being highly enthusiastic and engaged. The data collected from this group thereby suffers from selection bias. The stories, feelings and perspectives of those who felt less engaged in the game activity were not fully captured as their voice was limited to the brief comments in the survey. As a result, a degree of speculation was required to understand the problems faced by some of these students. However, the surveys revealed only a very small component of student disengagement.

Besides the limitations of data collection, the game itself as a key research instrument was limited by the resources available to its creation. As discussed earlier, digital games are complex endeavours that often require a large team and substantial budget. Since this was not available to the *Space Place Play* development, the game was limited in features. In particular, an analytics engine for full and detailed tracking of the activity and decision-making of players in the game was not available. The tracking was restricted to how often students accessed the LMS tied to the game. A more detailed capture of student game-based interactions can reveal

insight into player successes and failures as well as collaboration preferences, learning styles and learning issues (Epper et al., 2012).

Recommendations

Recommendations for Educational Practice

Digital games can be valuable tools for learning to sit alongside other technologies such as online forums, blogs and learning management systems. They can be complex to design and build. The recommendation coming out of this research is that for digital game-based learning to be a long term sustainable option, suitable institutional support is required. This would help staff initiate their game implementations as well as aid teachers and students through the delivery where technical challenges are likely to be faced.

In design-based learning contexts, games that allow for situated learning through authentic collaborative activity can be effective. In order to maximise the collaborative benefits, participants need to have clarity around the objective and roles they will play. In addition, opportunities for personalisation and self-expression facilitate engaging and meaning experiences. Since design and epistemic games deal with situations that do not have standardised answers, consideration is required to the feedback mechanisms both within the game and broader learning experience.

Recommendations for Theory and Design

The design of games requires a framework that considers the process, gameplay and appropriate learning theory. Game design frameworks are effective tools but cannot provide a complete formula to success. It is recommended that a framework or set of principles be employed to support the design of the game alongside a process model that guides the development. The process model ensures time and resource management are as efficient as possible. The educational game design framework should consider identity, immersion, flow, interactivity, pedagogy and context. In addition, games for design-based learning should consider the experience of exploration, discovery, freedom and management of choice.

Recommendations for Further Research

The study was extensive in engaging with game design, implementation and evaluation. The investigation on the DGBL experience focussed on students' perceptions of their learning. Future research could explore and measure the transfer of design skills and understanding from a DGBL scenario into architectural design assessments. In chapter one, the challenge of design-based learning was identified within architectural design studio courses. A logical extension to the research of this study would be to implement a DGBL approach within a design studio course as an intervention to help students with complex concepts. A research question could be, "what are the behavioural changes and learning outcomes within large class learning for architectural design studio projects?"

The future research could involve an empirical comparison of groups in a design studio with greater focus on behavioural approaches by the students. An analytics system could facilitate the research question by providing observational data of player behaviour, such as time spent in building content, number of changes made before finalising the students' designs, colour choices and changes. The game of this study was limited in the feedback mechanisms within the game. The game can be extended to allow internal feedback on choice of colour, their emotional meaning suitability alongside each other, amount of objects inserted, as well as compositional rules. Through the additional game-based direction, measures could be taken on how players changes their thinking and practice from one level of the game to the next through to the design studio project.

Contributions to New Knowledge

This study explored spatial design through a collaborative game. It contributes to the understanding of collaborative game-based interactions for spatial design learning. In addition, it provides new information that uncovers factors and considerations for the planning and development of a digital game for learning spatial design using a situated learning theoretical framework. Epper et al. (2012) argue that digital games can not only can be more compelling but also more individualised and efficient for students' learning. These attributes can be realised through studies like this one that inform strategies and best practice in digital game-based learning.

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Appendix 1: Participant Information Statement and Consent Form

Approval No 12155

The University of New South Wales

PARTICIPANT INFORMATION STATEMENT AND CONSENT FORM

Project Title: Digital game-based learning in architecture and spatial design

This research study is being done by Dean Utian, Postgraduate Research Student in the MPhil (HE), School of Education, The University of New South Wales, Sydney, Australia.

Participant selection and purpose of study

You are invited to participate in a study of digital game-based learning within Architecture. I, the research investigator, hope to learn about the factors that influence a digital game-based learning approach within an Architectural context in Higher Education. This includes how a game-based approach influences student behaviour and learning, perceptions, motivation, understanding of the subject, as well as performance quality in assessment. You are selected as a possible participant in this study because you have been a student in BENV6722 Cinematic Space 2013.

Description of study and risks

If you decide to participate, you will be asked to take part in an interview of approximately 30-40 minutes to be conducted once the course has concluded and results released. The interview will take place at The University of New South Wales.

The interview will be audio-recorded for transcription purposes only with your consent.

Confidentiality and disclosure of information

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission, except as required by law. If you give your permission by signing this document, I plan to publish the results in a thesis for the MPhil (HE). In addition, the study may be presented at academic conferences in the field of education or games with results published in journals of this type. In any publications, information will be provided in such a way that you cannot be identified.

Complaints may be directed to the Ethics Secretariat, The University of New South Wales, SYDNEY 2052 AUSTRALIA (phone 9385 4234, fax 9385 6648, email ethics.sec@unsw.edu.au). Any complaints you make will be investigated promptly and you will be informed of the outcome.

Feedback to participants

A summary of the research findings will be offered to research participants at the completion of the study, provided via email.

Your consent

Your decision whether or not to participate will not prejudice your future relations with The University of New South Wales. If you decide to participate, you are free to withdraw your consent and to discontinue participation at any time without prejudice by filling in the withdrawal form and sending it to me.

Additional Questions

If you have any questions now or later, please feel free to ask. Dean Utian will be happy to answer them. Contact details are d.utian@unsw.edu.au or 0416 250133.

You can also contact the research supervisors:
Supervisor: A/Professor Wan Ng - w.ng@unsw.edu.au or 0418 178387

Co-Supervisor: Dr Malcolm Ryan - malcolmr@cse.unsw.edu.au

You will be given a copy of this form to keep.

Thanking you
Dean Utian

The University of New South Wales

PARTICIPANT INFORMATION STATEMENT AND CONSENT FORM (continued)

Project Title: Digital game-based learning in architecture and spatial design

You are making a decision whether or not to participate. Your signature indicates that, having read the information provided above, you have decided to participate.

☐ I agree to be interviewed with recording

☐ I agree to be interviewed without recording

…… ……

Signature of Research Participant Signature of Witness

…… ……

(Please PRINT name) (Please PRINT name)

…… ……

Date Nature of Witness

PARTICIPANT INFORMATION STATEMENT AND CONSENT FORM (continued)

REVOCATION OF CONSENT

Project Title: Digital game-based learning in architecture and spatial design

I hereby wish to **WITHDRAW** my consent to participate in the research proposal described above and understand that such withdrawal **WILL NOT** jeopardise any treatment or my relationship with The University of New South Wales.

…… ……

Signature Date

……

Please PRINT Name

The section for Revocation of Consent should be forwarded to Dean Utian via email (d.utian@unsw.edu.au) or mailed to

Dean Utian
Built Environment
The University of New South Wales
Sydney NSW 2052

Appendix 2: *Cinematic Space* Survey

Thank you for taking time to complete this questionnaire. Please answer each question as best as you can. Your thoughtfulness and candid responses will be greatly appreciated. Your individual name or identification number will not at any time be associated with your responses. Your responses will be kept completely confidential.

PART A. Background Information

* 1. What is your gender?

- Female
- Male

* 2. Which category below includes your age?

- 18 - 23
- 24 - 29
- 30 - 35
- 36 or older

* 3. Which of the following degrees is your current program of study?

- Bachelor of Architectural Studies
- Master of Architecture
- Bachelor of Architectural Computing
- Bachelor of Interior Architecture
- Bachelor of Landscape Architecture
- Bachelor of Town Planning
- Bachelor of Industrial Design
- Other (please specify)

PART B. Digital Literacy and Games Played

* 4. Please indicate how proficient you are with using the following (i.e. how skilled and confident you are with the tools).

	Very Proficient	Proficient	Somewhat Proficient	Not Proficient
Writing documents (e.g. Word)	○	○	○	○
Editing/manipulating images (e.g. Photoshop)	○	○	○	○
3D modeling and animation (e.g. 3DS Max)	○	○	○	○
Use of 3D game engines (e.g. Unity, Crysis)	○	○	○	○
Authoring of multimedia presentations (e.g. Director, Flash, Prezi)	○	○	○	○
Comments (if any)				

* 5. Approximately how many hours per week do you use web platforms for work, study, hobbies and other purposes?

- ○ Less than 10 hours
- ○ 10 to 19 hours
- ○ 20 to 29 hours
- ○ More than 30 hours

* 6. What types of digital games do you most often play? Select all that apply.

- ☐ Single player games
- ☐ Online using a computer
- ☐ Mobile games
- ☐ I do not play digital games
- ☐ Multi-player games
- ☐ Offline games
- ☐ Game console games (Xbox, Wii)

* 7. What genre of games do you most often play? Select all that apply.

- ☐ Action
- ☐ Adventure
- ☐ Fighting
- ☐ Puzzle
- ☐ Role-playing
- ☐ Simulations
- ☐ Sports
- ☐ Strategy
- ☐ Other (please specify)

* 8. Approximately how many hours per week do you play digital games?

- Less than 10 hours
- 10 to 19 hours
- 20 to 29 hours
- More than 30 hours

Part C. Views on the Course Game-Based Learning

* 9. Please rate your level of agreement with the following statements.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
The game-based approach (includes online game and associated activities) was engaging and interesting and I was enthusiastically involved.					
The game-based approach enhanced my analytical and critical thinking ability for problem solving.					
The game-based approach was helpful in my understanding of spatial design.					
The game was a valuable tool in developing my creative and design thinking.					
The game increased my motivation in the subject.					
I was proud and satisfied by what was produced through the game activity.					
My learning through the game aided the development of my assessment tasks (provided scaffolding for subsequent learning).					
Working collaboratively and discussing the game with classmates developed my understanding and learning.					
I would have preferred if the game was an individual activity.					
The feedback I received from my peers in the game activity had little/no influence on my learning.					
I think working within teams in this type of design game was a good way to learn.					
The game clearly illustrated how films can be used as references / case studies for understanding the emotion spaces can evoke.					
The game was effective in illustrating the value of a storyboarding approach to spatial design.					
The game gave me a better appreciation of designing with a consideration of time and human experience.					
I could see a direct connection of the game to real world applications to that I could apply in my future profession.					
I think more courses should use digital games in learning.					
Comments (if any)					

*10. Overall, how do you rate your learning experience with the game-based approach in the course?

Excellent	Very good	Good	Average	Poor
○	○	○	○	○
Comments (if any)				

Part E. Personal Experience

Please complete this section by writing your responses in the boxes.

11. In what ways, if any, did the game help your learning within this course? Here you can identify particular parts that were valuable and why.

12. In what ways, if any, did the game hinder your learning within this course? Here you can identify aspects of the game that were troublesome / unhelpful and why.

13. What do you feel could be improved in this game to aid your learning?

14. Any other comments that you would like to make on use of the game-based approach to learning? Here you could add what you liked the best or disliked the most.

Thank you very much for your time.

You are invited to participate in a short interview to elaborate on your learning experience. If you are happy to participate, please contact Dean Utian by email - d.utian@unsw.edu.au.

Appendix 3: Questions for Semi-structured Interviews

1. Tell me about some of your experiences in the use of games during your day to day life.

2. What tools/technologies do you engage with (e.g. Facebook, mobile) and how often?

3. Describe your individual experience with the Cinematic Space game approach. How did you make the experience your own and create/define the nature of that experience? What did you do beyond the 'rules of the game'?

4. Describe your feelings during the playing of the game, including the challenges you faced.

5. In what ways, if any, did the game provide stimulus for learning and the way you approached your assessments? Was the game used substantially outside of class time? How did it keep you engaged/not engaged?

6. How did you interact with your class mates through the game experience (such as discussions and comparison of results)?

7. How did you apply lessons from the game into your assessment tasks?

8. What connections do you see from your game experience to the way you would work in your professional practice?

9. What other thoughts do you have on the effectiveness of this type of game in your learning of design and creative thinking?

Thank you very much for your time.