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# Using an instructional video game to support geography outcomes, motivate learning and support critical thinking of students in Stage Two primary classroom

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**School of Education  
Faculty of Social Sciences**

**Using an instructional video game to support geography outcomes,  
motivate learning and support critical thinking of students in Stage  
Two primary classroom**

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BEd (Geography); MEd (ICT in Education and Training)

**This thesis is presented in fulfilment of the requirements for the  
award of the Degree of**

**Doctor of Education**

**from**

**The University of Wollongong**

**July, 2015**

## **ABSTRACT**

Research suggests that young people are motivated to play popular video games that involve learning (Eglesz, Fekete, Kiss & Izsó 2005). Educational video games with sound pedagogical principles have been shown to motivate and enhance learning more than traditional education methods (e.g. Blunt 2007; Michael & Chen 2005). However, research generally has not provided an understanding of the design principles incorporated into effective games, taking into account the variables of age, educational goals, specific learning outcomes and subject matter.

This research aims to identify how an instructional video game based on best practice design principles supports students to achieve the Stage Two (Year Three and Four) geography outcomes specified by the New South Wales Board of Studies Human Society and Its Environment (HSIE) syllabus. Importantly, this research also investigates how the use of a video game motivates learning and supports critical thinking as a method of instruction.

Constructivism, social constructivism and critical pedagogy are the theoretical frameworks that guide this research study and inform the video game design, research design, and data collection and analysis techniques. These theories recognise that knowledge is critically and collectively built over time, and in a social, economic and historical context.

The research involved four phases. In the first phase a video game was designed based on a review of literature and supported by the theoretical framework. In the second phase the methods of data collection and analysis were developed. In the third phase the video game and data collection and analysis techniques were tested in a pilot study, to determine game functionality and ensure the data collection captured the information required to answer to the research. Finally, in the fourth phase the research design was implemented in the classroom: the game was introduced and used weekly for four weeks in a Stage Two primary geography class at an Illawarra school. The purpose of the last phase was to answer the research questions.

This study drew on existing research to: first, develop a comprehensive understanding of best practice video game design principles based on the work of research in the field to support students' learning of Stage Two HSIE syllabus outcomes, critical thinking and motivation to learn. Second, design a video game based on these design principles that have a strong theoretical basis and build on the work of research in the field. Third, provide a tool that teachers may use that aims to help students learn stated syllabus outcomes, motivate learning and increase critical thinking of students. Fourth, test both the design principles and video game, providing a contribution to the literature on educational video game design. Fifth, provide a video game for further testing in other classrooms and/or adaptation for testing in other disciplines or age groups, to ascertain general and discipline or age specific principles.

Findings showed that *GeoCity*, the video game designed for this research, supported Stage Two students to achieve the geography outcomes specified by the NSW syllabus. They also showed that *GeoCity* supported motivation to learn and critical thinking. This was underpinned by the combination of best practice design principles identified in the review of literature.

The principles of respecting cognitive load and teacher involvement were found to chiefly underpin support for syllabus outcomes, complimented by the other principles. For both motivation to learn and critical thinking, teacher involvement and access to related resources, and a lack of technical problems, were found to be a requirement of participation and accessing the support provided by the game. Both also required a clear context, including a complex, immersive and realistic environment and situated meaning. To support motivation to learn, it was found that the game had to be perceived to be useful, achievable and challenging and respect cognitive load. Finally, support for critical thinking was predicated on the greatest number of principles. In addition to those already mentioned, collaboration, in which content can be reflected upon in discussion with others, appeared foundational. So too did opportunities for self-paced student inquiry, learning by doing and problem solving; and regular feedback, particularly actions having consequences.

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# 1 INTRODUCTION

## 1.1 Background to the study

Research suggests that young people are motivated to play video games (Eglesz, Fekete, Kiss & Izsó 2005); with video game-playing the fastest growing type of human recreation (Ryan, Rigby & Przybylski 2006). The most popular video game worldwide, *League of Legends* (Gaudiosi 2013; Tassi 2014), has 27 million players a day and 67 million players each month (Tassi 2014). The Australian Communications and Media Authority (2008) estimates that people aged 8-17 in Australia spend about 40 minutes a day playing computer and video games, and more than 94% of people aged 6-15 are involved in regular game-playing (Brand 2012). This involves more than play, often facilitating skills such as critical thinking, learning, social interaction and technology use (Shaffer, Squire, Halverson & Gee 2005). Video games offer many possibilities for progressing knowledge and learning practices (El-Nasr, Aghabeigi, Milam, Erfani, Lameman, Maygoli & Mah 2010), including increasing motivation to learn (Blunt 2007; Michael & Chen 2005; Villalta, Gajardo, Nussbaum, Andreu, Echeverría & Plass 2011) and enhancing critical thinking (Adams 1998; An & Bonk 2009; Dittmer 2010; Gaber 2007; Gee 2010; Prensky 2002; Smith 2011). Gee (2005a) states that despite being challenging, time consuming and complex, the best recreational video games assist motivation, critical thinking and learning.

A study of Information and Communication Technology (ICT) use in Britain, by the Department for Education and Skills (2002), found:

When the meaning of ‘games’ is probed, it is clear that much learning is taking place through [the] use of ICT for leisure pursuits, including learning of factual knowledge and conceptual understanding (p. 61).

Video games require learning, as one cannot play a game without learning how to play it (Gee 2003, 2005b; Rice 2007). In fact, it is suggested that gameplay can trigger deep learning that is itself an enjoyable part of the game (Gee 2005b).

Research has established that video games may produce better learning conditions than many classrooms because many young people voluntarily engage in video game

activities that are difficult, long and complex, yet still enjoy the experience. Comparative studies have indicated significant improvements in student motivation and learning when instructional video games, rather than traditional classroom instructions, are used (Blunt 2007; Egenfeldt-Nielsen 2007; Habgood, Ainsworth & Benford 2005; Ke 2008; Michael & Chen 2005; Tay & Lim 2010). Video games have also been found to support problem-solving (Beavis, Muspratt & Thompson 2015) and enhance critical thinking (Adams 1998; An & Bonk 2009; Dittmer 2010; Gaber 2007; Gee 2010; Prensky 2002; Smith 2011). The development of critical-thinking skills is vital to children becoming independent learners (Leicester & Taylor 2010), engaging with questions and knowledge, and being the creators of solutions for the world as it is today (Daniel & Gagnon 2011). This is in contrast to many classroom routines that principally aim to improve standardised test scores, which can undermine important skills such as critical thinking (Freire 1972, 1982, 1998; Giroux 2011; Kincheloe 2005; McLaren 2001, 2005).

## **1.2 Statement of problem**

There has been much written about how video games assist learning, motivation to learn and critical thinking; however, it is also evident that not all video games enhance learning equally (Tennyson & Jorczak 2008). In terms of testing the relationship between design features and particular learning outcomes, attainment of curricular outcomes, how the age of users affects best practice design principles, there appears to be a significant gap in the research. The first gap, the relationship between design features and particular learning outcomes, the implementation of design that brings together lessons from video game experiences is still pending (Squire 2003; Villalta et al. 2011). Research into the relationship between particular design features and specific learning outcomes, and the mediating variables, is limited (Rosario & Widemeyer 2009; Tennyson & Jorczak 2008; Turkay, Hoffman, Kinzer, Pantiphar, Chantes & Vicari 2014; Wilson, Bedwell, Lazzara, Salas, Burke, Estock, Orvis & Conkey 2009). Perrotta, Featherstone, Aston and Houghton (2013) note:

Efforts are needed to articulate clear relations between game elements and a range of outcome from a broad level (e.g. platform on which the game runs, single player, multi-player, and so forth), gradually narrowing down to specific gameplay mechanics (p. iii).

For the second gap, the relationship between design features and meeting anticipated curricular outcomes, much has been written about the benefits of video games for learning, but there are few studies that report on attainment of curricular outcomes (Miller & Robertson 2011). Papastergiou (2009, p. 2) identifies a significant gap in research on the “effectiveness of games for concrete educational purposes” and Perrotta et al. (2013) explain that there is an absence of research that accounts for the realities of school. For the third gap, how the age of users affects best practice design principles, very little research looks specifically at how age affects video game use and usefulness in the classroom (Wilson et al. 2009). Many of the general principles for the design of instructional video games do not take into account the variable of age, and are primarily based on research involving high school or university students (Tan & McWilliam 2008).

### **1.3 The research aims**

This research aims to identify how an instructional video game based on best practice design principles supports students to achieve the Stage Two (Years Three and Four) geography outcomes specified by the New South Wales (NSW) Board of Studies Human Society and Its Environment (HSIE) syllabus. The research also investigates how the use of a video game motivates learning and supports critical thinking as a method of instruction.

### **1.4 The research questions**

Q1. In what ways does an instructional video game based on best practice design principles support Stage Two students to achieve the geography outcomes specified by the NSW syllabus?

Q2. How does the use of a video game motivate learning and support critical thinking as a method of instruction?

### **1.5 The significance of the study**

This research aims to:

- Develop a comprehensive understanding of best practice video game design principles to support Stage Two HSIE syllabus outcomes, critical thinking and motivation to learn, based on research.
- Design a video game based on the above design principles that has a strong theoretical basis and build on the work of research in the field.
- Provide a tool that teachers may use to help students learn stated syllabus outcomes, motivate learning and increase critical thinking of participants.
- Test the design principles and video game in the classroom, providing a contribution to the literature on educational video game design in a school environment.
- Provide a video game for further testing in other classrooms and/or adaptation for testing in other disciplines or with different age groups, to ascertain general and discipline or age specific principles.

## 1.6 Definitions of terms

To clarify and limit the scope of inquiry, this section provides definitions for the following terms used in this study: video game, motivate, learning, instruction, critical thinking, Stage Two geography and best practice. The definitions that will apply in this study are:

- ‘Video game’ denotes a “structured activity whose components are rules, goals, challenges and interactivity” (Neill 2009, p. 12) that is played on a computer or console. This includes simulation video games of real world situations that have elements like performance rating, challenge and reward.
- ‘Motivate’ refers to the desire to participate, in this case in the instructional task (Fetherston 2007), due to performance goals, mastery goals, social goals (Whitton, Sinclair, Barker, Nonholy & Nosworthy 2004) or fun prompting engagement with instruction.
- ‘Learning’ refers to categories referred to outcomes outlined by the University of Warwick (2006): adoption of subject specific knowledge or skills; cognitive skills such as understanding methodologies, synthesis, evaluation or critical analysis; and key skills, or skills that are transferable to other contexts, such as communication or teamwork.
- ‘Instruction’ denotes the act of guiding learners (Killen 2003).

- ‘Critical thinking’ refers to the process of identifying questions about knowledge, contextualising them, and engaging in cycles of understanding, testing, evaluation and reflection (Freire 1972). It is “not the intellectual reproduction of what already exists” (Adorno 1998, pp. 291-292), but is situated in dialogue and the construction of new knowledge (Daniel & Gagnon 2011).
- ‘Stage Two geography’ refers to that which is outlined in current NSW Board of Studies (1999) syllabus for Years Three and Four Human Society and Its Environment (HSIE) students.
- ‘Best practice’ refers to that which has consistently proven superior to date, at delivering a particular outcome.

## **1.7 Limitations**

The design and scope of this study have potential limitations in relation to:

1. Generalisability
2. Researcher interpretation
3. Research environment
4. Budget for video game
5. Technological developments

### **1.7.1 GENERALISABILITY**

A common criticism of qualitative case study research, which this thesis utilises, is that it occurs in a specific context which leads to limitations to generalising the findings of the study (Merriam 1998; Yin 2003). This study was limited to a Stage Two HSIE class at an independent school in the Illawarra in NSW, Australia; it is therefore acknowledged that the research findings are not necessarily transferable to other environments or populations.

### **1.7.2 RESEARCHER INTERPRETATION**

Qualitative case studies also position the researcher as interpreter. This assists the collection of meaningful information and adaptation to the research context, but it also means the research findings are innately subjective (Merriam 1998; Tellis 1997).

As such, it is acknowledged that this study represents a single interpretation of the outcomes and experiences of implementation, though it includes techniques to ensure trustworthiness: persistent observation, thick description, triangulation and movement between data and conclusions, and member checks.

### **1.7.3 RESEARCH ENVIRONMENT**

The research was performed in the context of a school classroom. As such, allowances had to be made for participant absences, computer lab availability, technical issues and school timetables.

### **1.7.4 BUDGET FOR VIDEO GAME**

The budget for the build of the video game constrained the quality of game graphics and the number of interactions available; that is, it prevented the game from having the graphics and animation quality of mass-produced contemporary popular video games, and limited player choice and the complexity of the game environment. However, the graphics, animations and interactions in the video game are commensurate with the budget provided.

### **1.7.5 TECHNOLOGICAL DEVELOPMENTS**

The use of a video game in the Stage Two HSIE classroom is explored in this study. It is predicted that the findings will provide new understandings to assist future use of video games in primary and geography classrooms to enhance learning syllabus outcomes, motivation to learn and critical thinking. However, it is recognised that developments in technology will alter the speed, access to and design of video games and that new research questions and issues may emerge as a result.

## **1.8 Structure of thesis**

This chapter has outlined the background to the study, research aims and questions to be explored, as well as an overview of the investigation, including significance and limitations. The following chapters expand on this in more detail.

Chapter Two provides a review of the relevant literature and outlines the theoretical framework employed, both of which guide the research and inform the video game design, research design, and data collection and analysis. The literature review focuses on the design features of popular video games that support and motivate learning and support critical thinking; and the design features of video games that support syllabus aims, motivation to learn and critical thinking for primary students and geography students. The outline of the theoretical framework details the learning theories of constructivism, social constructivism and critical pedagogy, and the rationale for their use to guide the research study.

Chapter Three details the research methodology, including the design, approach and strategy, as well as the four phases of the research. The chapter details the design of *GeoCity* – Phase One of the research – an online multiplayer immersive virtual world, and how it incorporates NSW Stage Two HSIE syllabus outcomes, motivation to learn and critical thinking skills based on best practice design principles, and sits in line with the theoretical framework for the research. It discusses Phase Two of the research, outlining the data collection and analysis methods necessary to evaluate students across the categories of learning of Stage Two HSIE syllabus outcomes, motivation to learn and critical thinking skills. Trustworthiness and ethical considerations of the research methods are also addressed here. The chapter describes and discusses Phase Three: the implementation and findings of the pilot study – conducted to test that the video game functions as intended and that data collection and analysis captures the information required to answer the research questions – and the resulting changes to improve the research design. Finally, the chapter provides a description of the school context, including the preliminary organisation at the school, classroom implementation, data sources and technical problems.

Chapter Four presents the findings from individual data collection instruments in relation to the two research questions, and outlines the performance of the video game design and technical problems experienced during implementation.

Chapter Five presents synthesis and discussion of findings in relation to the two research questions. The chapter also includes the conclusions of the study and recommendations for further research.

Supporting documents are included in the appendices at the end of this thesis.

## **2 LITERATURE REVIEW AND THEORETICAL FRAMEWORK**

### **Overview**

The purpose of this Chapter is to review literature that relates to the research questions and discuss the theories that underpin the research study. These inform the research design, including the design of *GeoCity*.

### **2.1 Literature review**

This literature review examines the three major areas of the research problem. First, the review seeks to identify the combination of design features present in video games that are popular with young people, which aid and motivate learning and support critical thinking. The instructional approach underlying these design features is explored. Second, the literature review investigates how game design principles have been practically applied in primary classrooms, with respect to syllabus outcomes, motivation to learn and critical thinking. Finally, the review explores how these principles have been applied specifically in geography classrooms, with respect to syllabus outcomes, motivation to learn and critical thinking. The synthesis of this information is the gap in the research. It informs best practice design principles for the development of a video game for Stage Two geography students.

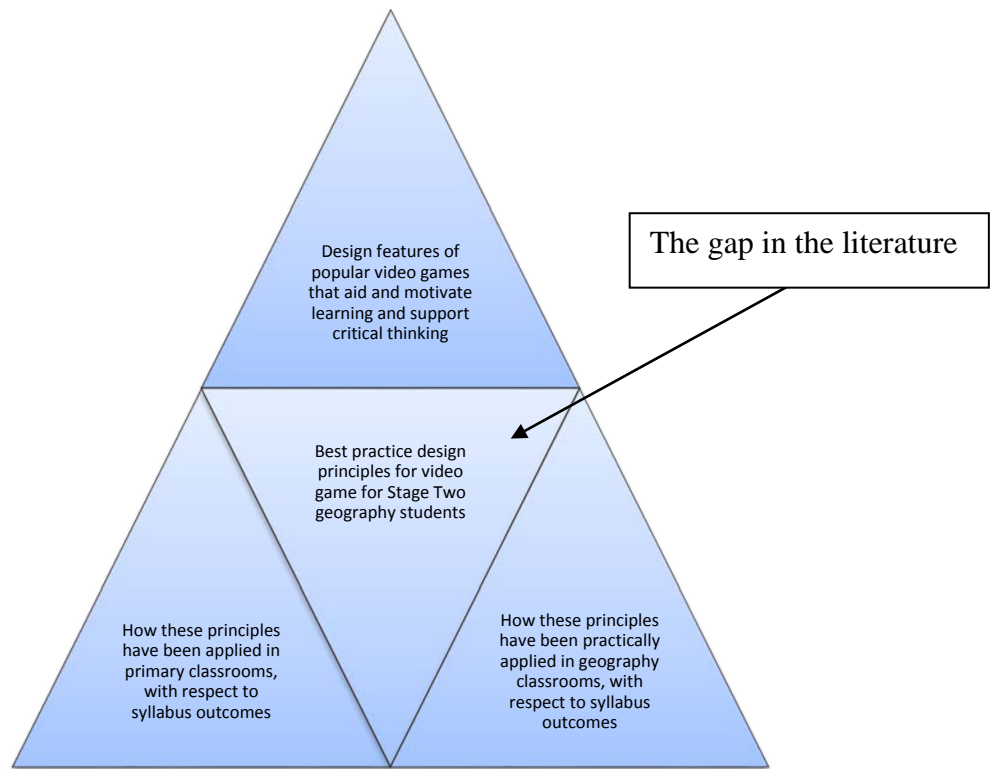


Figure 2:1: The gap in the literature

### 2.1.1 DESIGN FEATURES OF POPULAR VIDEO GAMES THAT AID AND MOTIVATE LEARNING AND SUPPORT CRITICAL THINKING

Research has broadly investigated the design features present in video games that aid and motivate learning and support critical thinking, often using different terms to describe similar things. Common findings in the literature are grouped below into six design feature categories that are strongly supported in the literature, including:

- Perceived to be useful, achievable and challenging
- Learning is part of game flow
- Play involves collaboration
- Players have identity and agency
- Game play situates meaning
- Design respects cognitive load

#### 2.1.1.1 Perceived to be useful, achievable and challenging

There is widespread agreement that facilitating learning through various forms of ICT requires perceived usefulness and ease of use (Brosnan 1999; Castleford 1998;

Davis 1989; Rosario & Widmeyer 2009). In simple terms, this means that technology designed to enhance learning must lead to meaningful outcomes (Wilson et al. 2009) and seem to require no significant effort by the user (Tan & McWilliam 2008).

Davis (1989) proposed a model for technology adoption called the Technology Acceptance Model (TAM). This model provides an important contribution to the literature, asserting that usefulness and ease of use has a positive impact on the intention to use a technology and usage behaviour. Davis defined perceived usefulness as the extent to which the user believes that the technology enhances their work or learning, and perceived ease of use as free of effort. Based on Ajzen and Fishbein's theory of reasoned action (1975) it is suggested that an explicit definition of attitude is required for the development of any measurement procedures. Therefore, TAM is one of the most theoretically and empirically supported frameworks used to assess the factors influencing the acceptance and use of technology (Ngai, Poon & Chan 2007; Tan & McWilliam 2008; Venkatesh & Davis 2000; Venkatesh, Morris, Davis & Davis 2003). Indeed, empirical studies support the validity of TAM as a reliable and predictive instrument of technology adoption (Hendrickson, Massey & Cronan 1993; Szajna 1994).

More recent studies confirm the concept that to enhance motivation to use a video game, it must be seen as useful. This further develops the TAM framework. Roblyer, Edwards and Havriluk (1997) said content must seem to be useful beyond the task itself to enhance critical thinking; Wilson et al. (2009, p. 233) explained that learning is enhanced when players connect actions to meaningful outcomes, namely "through three forms of assessments: completion assessment, in-process assessment, and teacher evaluation"; and Rogers (1995) drew on more than 6000 field tests and research studies to conclude that the number of people using a technology increases when it is perceived as superior to other existing technologies or modes of practice. Venkatesh and Davis (2000) developed and tested an extended version of TAM, known as TAM2, which added several factors that influence perceived usefulness: subjective norm, image, job relevance, output quality, result demonstrability and experience. In both mandatory and voluntary environments, these factors were found

to significantly influence user acceptance, accounting for 40-60% of difference in the perception of usefulness and 34-52% of difference in usage intentions.

In practical terms, the researcher is interested in games that require the user to learn skills and values in the game's universe – that is, to first gain and then apply useful knowledge and critical thinking methods. Based on examples, Prensky (2002) identified the elements of video gameplay that meet these criteria. These elements required the user to learn:

- how to affect the game world and discover the skills to do so;
- what to do in the game and why;
- that these things happen in a cultural and environmental context with embedded values; and
- how to evaluate these values with respect to real life.

This understanding is consistent with Bourgonjon, Valcke, Soetaert and Schellens (2010), who tested TAM and other factors as a model for predicting the acceptance of video games as learning tools. The study, which involved 858 students between the ages of 12 and 20, confirmed the predictive capacity of TAM. It also showed that clarity of learning opportunities, and experience with video games in general, positively affects both motivation to play video games and perceived usefulness.

The second key determinant in TAM – ease of use – has also been explored in research literature. Davis (1989, p. 320) argued that motivation to learn using a particular technology is enhanced when “a person believes that using a particular system would be free of effort”. Castleford (1998) explained that it is the growing collection of user-friendly software that has led to the widespread uptake of computer use. Tan and McWilliam (2008) expanded on this to suggest that it is the learners' perceived belief that a game has a low level of complexity that leads to the belief that no great effort is required; and it is this perceived feeling of ease and usability that is crucial to student engagement with digital learning.

However, research into popular video games also shows that motivation to learn requires challenge (DiSessa 2000; Gee 2003, 2005a, 2005b; Habgood, Ainsworth &

Benford 2005), a seemingly contrasting notion. Gee (2005a) and DiSessa (2000) explain that some frustration is highly motivating for learners, when game content seems challenging. Likewise, via an empirical investigation of motivation during digital learning, Eseryel, Law, Ifenthaler, Ge and Miller (2014) found that games that provide complexity and attainable challenge support motivation to learn. Further research confirms that popular games motivate learning when the object of the game is complex, holistic and challenging, not simply easy to use (Bourgonjon et al. 2010).

Theorists reconcile this need for challenge with perceived ease of use by advocating video game design that seems achievable, not simply easy to use, to enhance motivation (An & Bonk 2009; Gee 2003; Habgood, Ainsworth & Benford 2005; Reigeluth 1999; Squire 2005; Tan & McWilliam 2008). A recent study of student perception of video game use in the classroom concluded “games that are too easy or too hard will put students off” (Bourgonjon et al. 2010, p. 1147). Rosario and Widmeyer (2009, p. 292) explained that systems should be easy to navigate, to minimise player frustration, and have a non-intrusive interface otherwise the “game’s sense of urgency and realism diminishes”. Delwiche (2006) explains that the ideal interface flows from functionality, so is not unnecessarily complex. In other words, video game controls and interface should maximise access to game content. Thus, in addition to usefulness, motivating video game use requires the perception of challenge and achievability (An & Bonk 2009; Bourgonjon et al. 2010; Gee 2003, 2005a, 2005b; Habgood, Ainsworth & Benford 2005; Reigeluth 1999; Squire 2005).

Students take control and will evaluate their learning through a process. Self-regulation is the process where this can take place. In motivation students will take control or be autonomous in their actions, whereas self-regulation requires the students to have or exhibit some form of choice. That is, students will intentionally select or choose strategies to achieve a particular goal or behaviour. According to Pintrich and De Groot (1990), there are a variety of definitions of self-regulated learning which includes student’s metacognitive strategies for planning, monitoring and modifying their cognition (Zimmerman & Pons, 1986, 1988). Different cognitive strategies have been found to foster active cognitive engagement in learning such as rehearsal, elaboration, and organizational strategies. These strategies result in higher

levels of achievement (Weinstein & Mayer, 1986)

Given that people find different things useful, achievable and challenging, learner control is promoted by the literature to achieve these goals (Carter 1993; Kinzie & Joseph 2008; Shin, Sutherland, Norris & Soloway 2012). Research on learner control has consistently yielded positive results with respect to learning and motivation (Cordova & Lepper 1996; Eck 2006; Morrison, Ross & Baldwin 1992; Shin et al. 2012). Quintana, Shin, Norris and Soloway (2006) observe that learner control enables players to regulate learning activities based on their learning style, previous experience and knowledge; Blumenfeld, Kempler and Krajcik (2006) assert that it is an important aspect of subject matter mastery, and motivation to play and learn; and Kahveci and Imamoglu (2007) think the individualised learning environment enhances student learning. Gee (2005a) examined video games that incorporate good learning principles to advocate several design features. He proposed that players should be able to customise their playing and learning styles, via different player attributes and characters and by enabling multiple ways to solve problems.

#### **2.1.1.2 Learning is part of game flow**

A common criticism of educational video games is that many fail to integrate learning curriculum content into the mechanics of gameplay (Baek 2008; Habgood, Ainsworth & Benford 2005; Kirriemuir & McFarlane 2004; Squire 2003; Villalta et al. 2011). A study by Villalta et al. (2011) evaluated the design of a multiplayer online educational game in a shared classroom space. The study found that an unclear relationship between curriculum content and game actions, and a lack of coordination between gameplay mechanics and instructional aspects of the game, had a negative impact on understanding and identification. Likewise, a review of fantasy and learning in video games by Habgood, Ainsworth and Benford (2005) found that most educational video games either interrupt the flow of gameplay for learning content or keep learning separate from the game experience, with negative impacts on motivation.

Villalta et al. (2011) believe popular video games — such as the *Age of Empire* series, the *Total War* series and the *Civilization* series — avoid this problem because they make understanding content conditional to success in the game. Ke (2008) said this flow triggers metacognitive awareness of the learning process by integrating the game mechanism with learning content; players in Ke's study were more likely to self-regulate and analyse their own learning if it was contingent to winning. Further, Aldinger, Kopf, Scheele and Effelsberg (2005) demonstrated that living the events in a story can lead players to make decisions and understand complex events. Villalta et al. (2011) supported these ideas by suggesting an important guideline for educational game design: that curricular content must be embedded in game play such that the game play requires understanding learning content. In other words, researchers advocate that learning content be reinforced through action in the game, rather than simply asking questions about learning content. Likewise, Habgood, Ainsworth and Benford (2005) asserted that:

- learning content should be delivered through the most fun parts of the game to play; and
- learning material should be imbedded in the player's interaction with the game world.

However, they also cautioned that beyond this, personality, taste and mood impact the degree to which different players experience game flow; and noted that the diversity of popular video games provides evidence of this (pp. 492-493).

#### **2.1.1.3 Play involves collaboration**

Gee (2005a) explained that interaction, in which player actions and decisions prompt a response, is a key component of popular video games. He asserted that good video games put play in the context of an interactive relationship between the player, the world and other people. Similarly, in a literature review of motivational aspects of video games Felicia (2012) explained that game based learning can promote interaction within and between players, that can result in a more engaging experience than traditional classroom instruction. Further, Ally (2004) claimed that interactive and collaborative learning promotes an environment in which people are critically aware of how and why they understand things, and in which people are more willing

to learn new things because they feel supported to test, confirm and apply them. Research broadly shows that learning improves when people collaborate and become an essential part of a social group (Fisher & Baird 2005; Salmon 2000; Steel 2009; Vygotsky 1978). For example, through a review of studies of network-based learning communities, particularly communities formed for collaborative projects, Levin and Cervantes (2001) concluded that collaboration that changes over time improves productivity. Likewise, Fisher and Baird (2005), observed masters level education technology students using online dialogue and social media to support their learning, and found that collaboration enhanced motivation, support, ownership, understanding and retention rates. Further, they noted that knowledge construction was gained specifically between community members, in this case, groups across four different courses, and that with the deepening of personal understanding, participants were motivated to contribute to the collective understanding and receive positive feedback.

A review of popular games shows that collaboration is a common, and critical, feature. For example, massive multiplayer online games (MMOGs), which include *World of Warcraft*, *The Lord of the Rings Online: Shadow of Angmar* and *Second Life*, connect hundreds or thousands of players in persistent online worlds (Nardi & Harris 2006); *League of Legends*, *Warcraft III: Reign of Chaos*, *Left 4 Dead 2* and *Stronghold Legends* involve or permit online collaboration; and popular single player games – such as *Half-Life 2*, *The Sims 3* and *RollerCoaster Tycoon*, have online websites and forums for collaboration (Gee 2003; Steinkuehler 2008).

Nakasone, Prendinger, Holland, Miura, Hut and Makino (2009, p. 71) explain that virtual worlds and online computer games are “at the forefront of interaction and collaboration”, as they provide interesting and unique ways to interact with the virtual world and other avatars. Bourke (2009) explains that the rich environment for social networking provided by *Second Life* generates engagement and creates collaborative learning experiences, an environment that Nakasone et al. (2009) attributes to synchronous communication and collaboration, including textual chat, gesturing and voice transmission. Further, an analysis of *World of Warcraft* by Nardi and Harris (2006) found that the community is a resource for learning, as players

observe successful play, ask questions, gain advice and information, and receive mutual benefit from collaboration.

Additionally, in studies of video game flow, researchers found that not only collaboration, but collaboration that is part of the mechanics of game play, assists motivation (El-Nasr et al. 2010; Habgood, Ainsworth & Benford 2005; Villalta et al. 2011). Through a study of the perceptions of players on the learning impact of MMOGs, Voulgari, Komis and Sampson (2014) found that difficulty and complexity supported collaboration. Villalta et al. (2011, pp. 2044-2045) puts forward the following guideline for educational video design: “collaboration must be embedded in the game’s functioning mechanics, so that its success is conditional to having worked collaboratively”. A number of methods are advocated to achieve this: the interactive building of narrative (Carbonaro, Cutumisu, Duff, Gillis, Onuczko & Siegel 2008), needing to solve tasks in collaboration with peers in order to achieve game goals (Amory 2007; El-Nasr et al. 2010; Hamalainen 2008; Voulgari, Komis & Sampson 2014), and that achieving team goals requires different collaborative options from which individual players choose (Dillenbourg 2002).

#### **2.1.1.4 Players have identity and agency**

Bruner (1991) thought that an integral part of collaboration and the interpretations offered by others is their powerful effect on identity. Research shows that playing out identity in social scenes helps test and develop a sense of self as an agent (Holland, Lachiocotte, Skinner & Cain 1998). According to Gee (2005a), identity and agency are requirements of deep learning, as players become committed to the video game world through having a place and a voice in it. This understanding is supported by other research: Lombard and Ditton (1997) agreed that identity or presence is vital for intrinsic motivation, or motivation derived from finding the action itself satisfying; and Ryan, Rigby and Przybylski (2006) concluded that presence – the sense of being within the game world, as if the game medium were not there – assists intrinsic motivation. Furthermore, McBride (2014) explained that active participation in the construction of reality is important to support critical thinking.

Further research shows that identity is boosted by the inclusion of avatars, and characters having distinctive traits, as these features assist identity, recognition, teamwork, immersion and differentiation (Amory 2007; Cheng & Yeh 2009; Dickey 2007; Sundar, Xu & Bellur 2010; Villalta et al. 2011). Reflecting on research by Leotti et al. (2010), Turkay et al. (2014) stated that:

... the opportunity to choose even seemingly low-level items such as icons, names representing the player, and in-game opponents made the game personally meaningful to participants and influenced their learning (p. 11).

Gee (2005b) examined popular video games that motivate and support learning and asserted that games can offer players identities that trigger investment on the part of the player. He explains that *Metal Gear Solid* offers an intriguing protagonist, which attracts players by letting them project through a character. In other words, it supports identity by offering intriguing characters that players want to inhabit and project their desires, fantasies and pleasures through. Alternatively, Gee notes that video games such as *Animal Crossing* and *The Elder Scrolls: Morrowind* offer avatars that players can build in a detailed and consequential way. So another way games can offer identity is to offer blank-slate characters, whose qualities the player must determine (pp. 7-8). Villalta et al. (2011) tested a networked multiplayer game in a Year Six classroom, evaluated the game, created guidelines to help overcome problems and tested these guidelines in a re-design of the game. They found that emotional proximity between avatars and the player controlling them improves when distinctive traits are chosen by the player – as in *Super Smash Brothers Brawl* and *The Sims*. In addressing why this is the case, Gee (2005b) says that without the context of identity in action, facts are hard to learn and retain; but with it facts come free, learned as part of being a distinct person who needs to do purposeful things.

Research reflects that it is not only identity, but identities taking meaningful action, that assists learning (Gee 2005a; McLeod & Lin 2010; Naik & Teelock 2006; Rigby & Przybylski 2009; Ryan & Deci 2000; Thomas 2006). Wilson et al. (2009) explain that students invest more and attempt more complex strategies when they feel control over their learning. This is reflected in an analysis of *World of Warcraft* (WoW) by Thomas (2009):

The most significant part of the game comes from the player base itself. Games like WoW evolve as a direct result of the actions of the players within the world. Players discover or create new uses for items, uncover synergies among skills or player talents, and continually test new styles of play and techniques to be more successful in overcoming the challenges of the game (p. 37).

Gee (2005a) supports this by asserting that in effective games players are producers who co-design games through their actions. Hsiao (2007) and Thompson (2002) note the presence of identity and agency, and that players co-design the game through their actions in *The Sims*.

#### **2.1.1.5 Game play situates meaning**

Research broadly shows that identity and agency within the game world is enhanced when meaning is situated in an authentic context (An & Bonk 2009; Gee 2005a; Greeno & Moore 1993; Squire 2005; Shaffer et al. 2005). Based on interviews with leading video game designers, Squire (2008) argued that learning through video games requires a shift in focus, away from content towards designing experiences that stimulate thinking, acting, and being in the game world; or creating situated and embodied learning experiences. McBride (2014) explained that video games can deliver content in a hands-on and authentic way, to support players integrating information to solve a problem, a critical part of higher-order thinking. Villalta et al. (2011) asserted that learning content should be embedded in a situation that is uncovered through interactive game play. Likewise, according to Aldinger et al. (2005), living the phenomena of a story through a game leads players to understand complex events and make decisions. Gee (2005b, p. 12) used the metaphor of children playing in a sandbox to explain how good games motivate and support learning: “sandboxes are good for learning: if learners are put into a situation that feels like the real thing, but with risks and dangers greatly mitigated, they can learn well and still feel a sense of authenticity and accomplishment”. An and Bonk (2009, p. 45) wrote that “context is more important than content”, and Squire (2005) argued that learning is a process of developing abilities to participate in the world.

McRae (2001, p. 12) advocated including related prior knowledge in video game design, on which new knowledge can be built. He described this – akin to more

traditional contexts – as “the single most powerful influence in mediating subsequent learning”, stating that “knowledge is best integrated when unfamiliar concepts can be related to those which are familiar”. In other words, this general principle also applies to video game design. Research broadly shows that learning, immersion and engagement improve when video games support the construction of knowledge (Castleford 1998; Dede 2009; Gee 2005a; Inal & Cagiltay, 2007; Lemberg & Stoltman 1999; McNail 1987; Schraw 1998; Steel 2009; Villalta et al. 2011). For example, Villalta et al. (2011) tested a video game in the classroom, evaluated it, created guidelines to help overcome problems and tested these guidelines in a re-design of the game; they found that games must build on existing knowledge, involve tasks that are more challenging than previous accomplishments, and offer precise, timely and constant feedback that guides toward learning goals. Likewise, Abrams (2009) conducted research with three academically underperforming students who struggled with motivation to learn in traditional settings. The students played a video game to support their understanding of World War II. The results showed the video game helped them remember and understand concepts because the game made the learning material 'accessible, useful and relevant' by providing a meaningful context and an interactive representation.

In addition, principles advanced by Gee (2003, 2004, 2005a, 2005b) declare that good video games not only situate play, but encourage risk-taking and exploration, treat failure as a way to gain feedback and adjust, present challenges that must be solved until solutions become automatic, and order challenges “so that the earlier ones are well built to lead players to form hypotheses that work well for later, harder problems” (2005a, p. 36). Research broadly shows that video games are engaging when they support the critical construction of knowledge (Castleford 1998; Gee 2005a; Lemberg & Stoltman 1999; McNail 1987; Rosario & Widemeyer 2009; Schraw 1998; Steel 2009). An and Bonk (2009) created a framework for supporting learning via video game design on common principles in simulation and game-based learning literature. It specifies the need for exploration, learning through doing, learning through failure and adaptivity, to enhance learning. This is further confirmed by a review of game attributes and learning outcomes by Wilson et al. (2009, p. 233) who found that “in order for players to improve performance and even

enhance learning, it is critical that they see the connection between their actions and the outcomes”. This provision of consistent feedback allows players to “reflect on strategy and to re-evaluate their decision making” (Turkay et al. 2014, p. 9), which facilitates critical thinking.

Furthermore, research shows that this construction of situated knowledge is enhanced when students learn the metacognitive skills of identifying goals and monitoring, questioning and assessing oneself (Lemberg & Stoltman 1999; McNail 1987; Savery 1998; Schraw 1998). In other words, motivation and learning are assisted by design that requires critical thinking. Research by Rosario and Widmeyer (2009) shows that popular MMOGs allow learners to hypothesise, test and adjust their ideas in cycles, to build knowledge. In practical terms, research shows that video game goals and rules need to be clear to support organisational skills, abstract thinking and learning performance (Garris, Ahlers & Driskell 2002; Shin et al. 2012), and forming and testing hypotheses (Shin et al. 2012, p. 542).

#### **2.1.1.6 Design respects cognitive load**

Cognitive load theory (CLT), an instructional design theory by Sweller (1988), suggests that for effective and efficient learning, the cognitive architecture of learners should be taken into account when designing instructions (Van Merriënboer & Ayres 2005). The theory is based on the understanding that working memory has a limited capacity over which different “loads” compete and that if a learner’s working memory is overloaded, very little will be learned (Paas, Renkl & Sweller 2003; Sweller 1988). Sweller, Van Merriënboer and Paas (1998) explain that people can hold only seven, plus or minus two, pieces of information in their working memory and outline two competing “loads on working memory”: intrinsic load, or the load imposed by the elements that must be understood together for the student to make sense of the task; and extraneous load, or irrelevant or superfluous detail often caused by the design of instructions. Sweller (1988) warned that if the content requires a high load on working memory, then the tool itself must have a low extraneous load while it is being learned and understood.

This initial hypothesis conflicted with the ideas of the constructivist theory of problem-based learning, particularly the understanding that challenging and open-ended problems enhance learning. Critical constructivism has been criticised by some cognitive load theorists (Kirschner, Sweller & Clark 2006; Mayer 2004), particularly when considering novice learners. They argue that empirical data does not support using the constructivist teaching technique of pure discovery (Mayer 2004) and that novices do not possess schemas necessary for “learning by doing” (Kirschner, Sweller & Clark 2006).

However, these criticisms do not weaken the core of constructivism, which is the theory that learning is an active process and that knowledge should be built dynamically with respect to the learner and context. Rather, CLT points to the critical need to implement this learning theory with regard for students’ prior learning experiences, providing scaffolding, or sufficient support, when new concepts and skills are being introduced to students. Contemporary CLT theorists put forward two additions to CLT, recognising that discovery and learning by doing could be useful *when they assist learning*. The first addition was the concept of germane cognitive load advanced by Sweller, Van Merriënboer and Paas (1998). Germane load is the mental effort undertaken by the student in addition to understanding the instructional content. Sweller, Van Merriënboer and Paas (1998) theorised that germane load imposes a positive load on working memory that assists learning through schema construction. For example, their research found that using worked examples in a mathematics course “improved schema construction and the ability to solve new algebra problems more than conventional problem solving” (p. 274). That is, by providing students with the steps to solve mathematic problems, the instructional load was part of building new learning schema. The second related addition was contrasting the requirements of working memory with those of long-term memory. Theorists explained that long-term memory consists of “a large store of schemas that integrate multiple pieces of information into a single element” (Paas, Renkl & Sweller 2003); these schemas, in concert with the virtually unlimited capacity of long-term memory, have the potential to expand the capacity of working memory (Ericsson & Kintsch 1995; Paas & Van Gog 2006; Van Merriënboer & Ayres 2005). Thus, when instructional design helps “chunk” pieces of information together, it is

useful. Hasler, Kersten and Sweller (2007) and Sweller (2010), now argue that situating learning in an authentic environment is important to support the learner to utilise relevant schemas and chunk information together meaningfully, so as to build long-term memory and enhance germane cognitive load.

In practical terms, Mayrath (2009) pointed out that, when using simulations, players generally require training before a simulation can be used to its full potential. As such, he advocates tutorials to combat cognitive overload, and the restriction of functionality and extraneous elements within a novice user's interface. Ang, Zaphiris and Mahmood (2007) demonstrate that multiple social interactions, social interactions at the same time as play, tracking the game user interface and keeping track of constructed identities can all contribute to cognitive overload. Ang, Zaphiris and Mahmood (2007) suggest that including spaces in the game with no present danger, using collaboration to ask for help or announce activity, forming social groups, filtering between essential and non-essential tasks and information, and communication shortcuts, all help to reduce cognitive load. Turkay et al. (2014, p. 7) note that a game that "overwhelms or underwhelms the cognitive resources of its players likely will result in a negative experience" and suggest that this can be circumvented with user-based flexibility and, relating specifically to educational games, offering players choices and control that matches their abilities and skill, and not overload their learning experience. Gee (2005a, p. 36) posits that good games provide information only when "the player feels a need for it, wants it, is ready for it, and can make good use of it".

In addition, flowing from a review of literature and popular video games, Villalta et al. (2011) proposed a number of guidelines that relate to cognitive load. Pointing to *Final Fantasy X*, *Final Fantasy XIII* and *Mass Effect 2*, they offer two guidelines to reduce cognitive load from language: that on screen text be clear, concise and easy to read, and facilitate comprehension of the scene; and that, in the case of a complex scenario, spoken text be favoured over written text as it causes less cognitive load. Furthermore, citing *Super Smash Brothers Brawl* and *The Sims* series, they advocate two things to reduce cognitive load from spatial distribution: that characters and

activities be spread around the map, to take advantage of available space; and that distribution should relate embedded knowledge to the real world.

#### **2.1.1.7 Summary**

Research on the design features of popular video games that aid and motivate learning and support critical thinking provides general principles that can be applied when designing educational games. These principles include: perceived to be useful, achievable and challenging; learning is part of game flow; play involves collaboration; players have identity and agency; game play situates meaning; and design respects cognitive load. These six principles will be incorporated into the design of the video game for Stage Two primary classroom focusing on geography. However, it is recognised that these principles do not offer age or subject specific information about enhancing learning in a video game environment.

#### **2.1.2 THE DESIGN OF VIDEO GAMES TO SUPPORT SYLLABUS AIMS, MOTIVATION TO LEARN AND CRITICAL THINKING FOR PRIMARY STUDENTS**

Research on the design features of video games that support syllabus aims, motivation to learn and critical thinking for primary students provides vital information when designing a game for primary students with these aims. Video games that have been tested in the primary classroom with implications for these aims include *Dr Kawashima's Brain Training*, *Active Worlds* and *Quest Atlantis*, which are examined here.

*Dr Kawashima's Brain Training* is a commercial video game involving mathematics, word and memory puzzles. The British *Daily Telegraph* (21 October 2010) explains the design of *Dr Kawashima's Brain Training* as one that drills and tests memory, maths and perception skills, or one's "brain age", using a Nintendo DS. The article explains that questions must be answered via a stylus, touch screen or microphone, with challenges marked for speed and accuracy, and results recorded over time. Miller and Robertson (2011) and Main and O'Rourke (2011) investigated changes in primary school students' mental computation performance and self-perceptions as a result of using *Dr Kawashima's Brain Training*. Lorant-Royer, Munch, Mescl   and

Lieury (2010) examined changes in primary school students' visual attention, manual dexterity and visuospatial memory as a result of using *Dr Kawashima's Brain Training*. None of these examined the impact of *Dr Kawashima's Brain Training* on critical thinking.

Miller and Robertson's (2011) research compared the mental computation performance and self-perceptions of two groups: an experimental group that used *Dr Kawashima's Brain Training* for 20 minutes each day in class, and a control group that continued normal classes. Participants comprised 634 primary school students aged 10 and 11, from 32 schools in Scotland. Schools were randomly assigned experimental or control status and the treatment period was nine weeks. In terms of syllabus outcomes, the students showed significant improvements in accuracy and speed of computation in both groups, though the rate of improvement varied significantly. The experimental group improved at a faster rate than the control group for accuracy, demonstrating a gain of more than 50% over the controls. Similarly, the experimental group improved speed of computation by twice that of the control group. Miller and Robertson (2011) also tested mathematics and academic self-concept, or self-perception, and attitude to school, factors affecting motivation to learn (Guay, Larose, Marsh & Dowson 2005). They found that students' self-concept did not change significantly for either the experimental or control group. However, they found that the experimental group showed significant improvements in their attitude to school, whereas the control group did not.

Main and O'Rourke's (2011) similar though smaller study affirms some of the above findings. It compared speed, accuracy and self-concept in mathematics in two Year Four classes – one using *Dr Kawashima's Brain Training* and the other having traditional classroom mathematics lessons – over 10 weeks. As with Miller and Robertson (2011), the results showed small improvements in speed and accuracy from the control group, and large improvements in speed and accuracy from the experimental group. However, unlike Miller and Robertson (2011), Main and O'Rourke (2011) found a significant improvement in self-concept for the experimental group that did not take place for the control group.

A study by Lorant-Royer et al. (2010) examined visual attention, manual dexterity and visuospatial memory, comparing results for students using *Dr Kawashima's Brain Training*, *New Super Mario Bros*, paper-pencil games and a control group that did not participate in training. Eighty-eight students with an average age of 10 were divided into four groups and evaluated before and after 11 training sessions. The results showed that *Dr Kawashima's Brain Training* had a weak positive effect on right hand dexterity, but no significant impact on visual attention or visuospatial memory. They also concluded that recreational training is not sufficiently specific or long enough to develop cognitive abilities.

Miller and Robertson (2011) noted that the game design is consistent with traditional drill and test methods, and that they tested the impacts of game console use rather than specific design features. Main and O'Rourke (2011) and Lorant-Royer et al. (2010) said similar: their purpose was to test how drill and practice was delivered via game console compared with other methods, rather than evaluate particular design features. However, students showed small to no improvement in learning and motivation to learn across various researches (Lorant-Royer et al. 2010; Main & O'Rourke 2011; Miller & Robertson 2011). Main and O'Rourke (2011) and Miller and Robertson (2011) found stronger improvements in computation than traditional classroom methods. Main and O'Rourke (2011) noted that students' self-concept, which affects perception of their ability to complete a given task, was assisted and improved via game play; that is, students who used consoles in class held a deeper understanding of their own learning ability. However, Miller and Robertson (2011) found no significant change in students' self-concept as a result of playing the game, though a significant improvement in their attitude to school.

Furthermore, the elements of *Dr Kawashima's Brain Training* that enhance learning and motivation have been assessed as part of general video game research. In a discussion of game-based learning with mobile devices, Santamarina, Moreno-Gor, Torrente and Manjón (2010) said the game is an effective learning tool because it offered challenge, including a diversity of exercises, clear rules and objectives and a short feedback cycle. Lorant-Royer et al. (2010) also note that the design of *Dr Kawashima's Brain Training*, incorporated practice, with students doing tasks and

problem solving; and player agency, with students free to choose the exercises in which they participate.

Another example of a video game that has been successfully used in primary schools is a three-dimensional (3D) Virtual Learning Environment called *Active Worlds* (Ang & Wang 2006). Virtual Learning Environments are network-based computer programs that involve interaction (Dickey 2005) and a high degree of immersion (Trindade, Fiolhais & Almeida 2002).

Ang and Wang (2006) conducted a study to test the impact of playing *Active Worlds* on primary students' motivation to learn and syllabus outcomes. Participants were 10 Year Five students in Singapore, who had demonstrated difficulty in learning science. These students used a learning task of building a solar world using *Active Worlds* in eight sessions of two hours each, and were evaluated against syllabus outcomes and for motivation to learn. Using observation, interviews and work assessment, Ang and Wang (2006) found that students were more engaged, motivated and excited by the video game than by traditional classroom instructions. Further, the research found that these formerly underachieving students mastered the scientific concepts of the course through using the video game tool. However, notable limitations of the study included: the short time period of the research, which could give rise to novelty impacting results; the small number of participants; and that the results could not be generalised to dissimilar contexts that do not focus on underachieving students or the discipline of science.

Merchant (2009, 2010) evaluated the design, implementation and impact on syllabus outcomes of a game to raise achievement in literacy in the *Active Worlds Educational Universe* called *Barnsborough*. Over 18 months, Year Five and Year Six students at 10 schools in Britain played in-class *Barnsborough*, a game designed by advisers, consultants and teachers working in primary schools in the north of England. As with Ang and Wang's (2006) study, students showed significant improvements in syllabus outcomes and motivation to learn as a result of playing *Barnsborough*. The research data, including observations, planning meetings, chat logs, and interviews and questionnaires with teachers and students, showed an

improvement in student motivation and written work; teachers noted a higher quality of speaking and listening, and improved levels of concentration, interest, discussion, cooperation and purpose (Merchant 2009, 2010).

Merchant (2010) identified a number of limitations of this study. The first was the tension that exists between creative design and curriculum planning (pp. 140-142). Implicit in the design of *Barnsborough* was a view that learning would happen actively via exploration, motivated by an interest in problem solving in an immersive environment (Merchant 2010). This he contrasts with classroom practice that often counters this, involving direction and focussed instruction, constrained by institutional norms and routines. In particular Merchant (2010) identified the constraints placed on implementation posed by narrow and official definitions of literacy, such as those of Britain's Primary National Strategy (Department for Education and Skills 2006), that valued print literacy over texting and chat. Second, he noted that the dominant view of teachers was to use the game as a means to enrich standardised literacy learning. Merchant (2010) thought that this could turn interest-driven exploratory learning into a means to achieve print-based literacy. In other words, it narrows the purpose and definition of learning. For example, Merchant (2010, p. 146) quotes a student who says: "The virtual world is good and not good. I enjoy looking around for clues, I don't enjoy writing about the world when I come out though".

Merchant (2009, 2010) did not include an assessment of critical thinking in the evaluation of *Barnsborough*. However, the above study does support the widely held criticism that when narrow curriculums and routines – in particular, standardised testing – are the goal of education, critical thinking is seen to be undermined (Darder 1995; Freire 1972, 1982, 1998; Giroux 2011; Guevara 2003; Hooks 1994; Kincheloe 2005; McLaren 2001, 2005). Merchant's exploration of the tension between routine practices and video game learning, by deliberately intervening in the former to implement the latter, offers valuable information about carrying out video game-based learning with respect to supporting critical thinking.

*Active Worlds*, found to support syllabus outcomes and motivation to learn (Ang & Wang 2006; Merchant 2009, 2010), is a server-based game, played by multiple players via browsers with built in navigational and communication tools (Merchant 2009). The virtual learning environment in *Active Worlds* is explored via avatar-based game play (Dovey & Kennedy 2006); players can move around in virtual spaces that are complex and immersive (such as streets and buildings), engage in synchronous written conversations, and inquire and solve problems in response to clues and information (Merchant 2009). Ang and Wang (2006) explained that *Active Worlds* is designed based on principles of situated meaning, social presence and collaborative learning, with the additional dimensions of an immersive environment and opportunities for self-paced student inquiry and the construction of knowledge – significant to consider when developing best practice game design for primary classrooms.

A similar example of a video game that has been tested in the primary classroom with positive results is *Quest Atlantis* (Anderson 2008; Barab, Thomas, Dodge, Carteaux & Tüzün 2005; Gerstein 2009; Smith 2011; Tay & Lim 2010; Tüzün, Yilmaz-Soylu, Karakus, Inal & Kizilkaya 2009).

Tüzün et al. (2009) used a quasi-experimental design to assess student and teacher perspectives of *Quest Atlantis*, with 24 Year Four and Five students at a school in Turkey. The results showed that students made learning gains about world continents and countries through the game, the difference between pre and post achievement tests being statistically significant. Tüzün et al. (2009) also measured the game's effect on motivation by both quantitative and qualitative methods. The results showed increased intrinsic motivation (motivation from within the individual such as enjoyment) and decreased extrinsic motivation (motivation from external pressure such as grades). However, Miller and Robertson (2011) note that the study did not include controls; that students were selected by school authorities for their above average ability and motivation levels; that three teachers worked with the group throughout the research period; and that quantitative data was only collected for 13 participants. That said, further testing of *Quest Atlantis* with academically at-risk primary students (Tay & Lim 2010) and gifted elementary students (Gerstein 2009)

also produced positive results. Furthermore, the developers of *Quest Atlantis* (Barab et al. 2005) conducted a long-term study of 153 primary students, and found significant increases in learning and retention levels over time and that the game was more enjoyable than any other learning activity they were involved in.

Similarly, Anderson (2008) used a mixed model research strategy to assess how *Quest Atlantis* supported knowledge building and syllabus outcomes for 18 Year Five students across two schools. Assessment of knowledge growth and meeting syllabus outcomes was measured by performance on standardised tests. Anderson (2008) also looked at how learning unfolded, in which motivation and engagement was central. Science, specifically water quality and ecosystems, was the learning content. The standardised pre/post written and content interviews showed significant learning growth, and engagement with *Quest Atlantis* and motivation to progress through the activities. However, a small decrease in learning outcomes was recorded in standardised pre/post multiple-choice tests. Anderson (2008) lists some possible reasons for the latter result and noted that further research was needed to examine trends in multiple choice questions elsewhere. Reasons for the drop in outcomes included: the large number of English-language learners taking part in the research; the fact that there is often less technical science vocabulary for students to engage with in open-response assessments than multiple choice; that multiple choice questions have distracters which may be similar to the correct response, creating doubt for students with newly gained knowledge; and that students only have the opportunity to explain their answers in open-response questions and to demonstrate knowledge even if unable to zero in on a particular answer.

In another study, Smith (2011) reaffirmed the positive impact *Quest Atlantis* had on student motivation to learn, and drew similar conclusions about the effect on critical thinking. Smith (2011) used quantitative and qualitative data to assess student engagement and growth of competency in critical thinking while using *Quest Atlantis*. Eighteen American teachers who were experienced in *Quest Atlantis* were interviewed and asked about their observations of elementary students using the game in the classroom. Additional to the interviews, Smith evaluated existing pre/post test data from engagement surveys of 15 Year Four students who used *Quest*

*Atlantis*. For this, the mission students embarked on was about genetics; students assumed the identities of scientists working to breed specific genetic designs of dragonflies. In response to an open-ended question about the benefit teachers see from students working in *Quest Atlantis*, 5 of the 18 teachers interviewed named critical thinking. This ranked third behind student engagement (7 of 18 teachers) and collaboration (6 of 18 teachers). Indeed, 87% of teachers agreed or strongly agreed that using *Quest Atlantis* led to competency in critical thinking. In terms of student engagement, it was the most common benefit of *Quest Atlantis* noted by teachers, and 90.2% of students reported being engaged while using the game.

Tüzün et al. (2009) explain that *Quest Atlantis* includes a 3D Multi-User Virtual Environment (3D MUVE), in which the user can construct a sense of self – an avatar – that can interact with others and construct personally meaningful structures and places. They then engage in challenge via personalised quests and move through levels. At the same time, learners have access to a complex two-dimensional environment, presenting a back-story, clues and information, a chat area, a menu and a toolbar. Anderson (2008, pp. 92-93) explains that players encounter spinning disks that indicate quests they must complete; interact with the world by clicking on objects, people and structures; that the game is also accessible to multiple users in real time, involving self-paced student inquiry and problem solving; and that players can choose to view the 3D window in either first or third person, connecting their character visually to the 3D space.

### **2.1.2.1 Summary**

Testing of *Dr Kawashima's Brain Training*, *Active Worlds* and *Quest Atlantis* in the primary classroom provides an understanding about the design features of video games that support syllabus aims, motivation to learn and critical thinking for primary students. Testing of *Dr Kawashima's Brain Training*, a drill and test design, provided mixed results. Students showed small to no improvement in learning and motivation to learn across various research (Lorant-Royer et al. 2010; Main & O'Rourke 2011; Miller & Robertson 2011). However, the design features included that were found to support these outcomes included: challenge, clear rules and objectives, a diversity of exercises, feedback, problem-solving opportunities, and

player agency (Lorant-Royer et al. 2010; Santamarina et al. 2010). Testing of *Active Worlds* showed that the game supported syllabus outcomes and motivation to learn (Ang & Wang 2006; Merchant 2009, 2010). The design features found to support these outcomes include: avatars, a complex and immersive environment, synchronous written conversations, social presence and collaboration, situated meaning, an immersive environment, self-paced student inquiry and problem solving, and the construction of knowledge (Ang & Wang 2006; Merchant 2009). Testing of *Quest Atlantis* showed that the game supports syllabus outcomes, motivation to learn and critical thinking (Anderson 2008; Barab et al. 2005; Gerstein 2009; Smith 2011; Tay & Lim 2010; Tüzün, et al. 2009). The design features noted include: a 3D immersive and complex environment, avatars that can interact with others and construct personally meaningful structures and places, challenge, chat, accessibility to multiple users in real time, and self-paced student inquiry and problem solving (Anderson 2008; Tüzün, et al. 2009).

### **2.1.3 THE DESIGN OF VIDEO GAMES TO SUPPORT SYLLABUS AIMS, MOTIVATION TO LEARN AND CRITICAL THINKING FOR STUDENTS STUDYING GEOGRAPHY**

In designing an effective video game for a Stage Two primary classroom focusing on geography, it is important to not only understand best practice video games design for primary students, but also take into account the specific teaching discipline. This section will discuss research and examine the design features of video games used to teach geography, the content area of this research study. Sacramento and Munhoz (2011) note the need to address the clear gap between optimal game design in the content area of geography, as there have been few discipline-specific studies published. However, the available literature does indicate some important information about the design of video games to support syllabus aims, motivation to learn and critical thinking for geography students.

The types of video games tested in the geography classroom discussed in the literature focus on *virtual field trips* or *immersive virtual worlds* or realities (Dittmer 2010; Inoue 1999; Woerner 1999). *Virtual field trips* involve a virtual, rather than physical, engagement with a real site (Litherland & Stott 2012); and *immersive virtual worlds* simulate bodies in a simulated environment (Dittmer 2010). Research

broadly suggests that video games of this type are ideal for the study of geography, because they can teach students how to use geographical resources and tools, help them develop critical thinking skills and make lessons more dynamic (An & Bonk 2009; Gee 2010; Prensky 2002). Sacramento and Munhoz (2011) explain that a key criterion in teaching geography is to create conditions so that students can understand the geographical phenomena-taking place around them. Shaffer et al. (2005) explain that virtual environments enhance learning by integrating knowing with doing.

Stumpf II, Douglass and Dorn (2008) tested the effectiveness of a *virtual field trip* for teaching university level introductory physical geography, specifically desert geomorphology. Access to the video game was via the Internet, where the field trip was presented as a series of web pages in three tiers: index, field trip stop-offs and concepts. The game started with a brief history of the location, the index and an aerial photo of the site on which stop-offs were marked. The aerial photograph had a built in navigational system and students simply clicked on a stop-off on the photograph to visit the site, viewed as panoramic photographs, and accessed key concepts relevant to it. By clicking on concepts, students could then access further specific subject matter, close-up images, video footage and graphical models of geomorphic features. In other words, navigation in the game was directed by student inquiry. The research involved a statistical analysis of pre and post-test results of syllabus outcomes, a qualitative analysis of essays, and a comparison of the results of undergraduate students who took *virtual field trips* and students who took physical field trips. Comparing pre/post aggregate data, Stumpf II, Douglass and Dorn (2008) found no statistical difference in test scores when comparing those of students who experienced only the *virtual field trip*, to those who experienced only the physical field trip, or participated both virtually and in the field. Even when this data was disaggregated by student background, there were no significant score differences for virtual-only or field-only learning. However, when data was disaggregated by individual questions, the data showed that for more difficult concepts, or where linking term or concept to location was required, virtual-only students were less likely to answer correctly. Stumpf II, Douglass and Dorn (2008) also found major differences in how students appreciated place and connected to the subject, possible factors affecting motivation, with much stronger improvements among students who

participated in a physical field trip. In conclusion, Stumpf II, Douglass and Dorn (2008) remarked that *virtual field trips* can enhance or give students access to locations, provide a cost effective alternative to physical field trips, and support students to learn basic geography concepts.

Research generally suggests that *virtual field trips* avoid some limitations of physical field trips, such as logistical problems, unacceptable risks, timing, weather, cost, and sites providing too much information to be learned on a single trip (Bellan & Scheurman 1998; Dittmer 2010; Woerner 1999). However, research by Barta-Smith and Hathaway (2000) showed that students can struggle to know how pictures, facts and figures relate to one another in *virtual field trips*. For this reason, Barta-Smith and Hathaway (2000) and Stumpf II, Douglass and Dorn (2008) noted the importance of providing maps or aerial photos when material is presented virtually. Furthermore, Woerner (1999) asserted that *virtual field trips* should include scaffolding to respect cognitive load which includes clear objectives, orientation and debriefing, rich context, easy access to related resources, a clear relationship to course objectives and offline activities, and facilitation of independent investigation and cooperative work. Woerner (1999) also advocated that in *virtual field trips* students should be able to interact and use multiple sensory modalities, access experts, observe, collect and analyse data, discuss this data with peers and experts to construct their own explanations, and select what they find meaningful to engage with at their own pace. Research broadly recognises that learning improves when complex environments are supported by reciprocal or mutual understandings (McRae 2001; Papert 1991; Taylor 1998), and when students learn the metacognitive skills of identifying goals and monitoring, questioning and assessing oneself (Castleford 1998; Lemberg & Stoltman 1999; McNail 1987; Schraw 1998).

Research into an *immersive virtual world* by Tüzün et al. (2009) shows primary students experience learning gains and higher motivation while using *Quest Atlantis* in class, as discussed above. The study's quasi-experimental design also specifically assessed primary student and teacher perspectives on *Quest Atlantis* in regard to learning geography. Tüzün et al. (2009) tested a version of *Quest Atlantis* that involved a 3D MUVE and interactive avatars that participated in levels or quests.

The content involved information about world continents and countries; the 24 students in Years Four and Five at a Turkey school played a version of the game based on a real world event, relevant to the lives of the learners. The back-story of the game was National Sovereignty and Children's Day in Turkey on which an annual international children's festival takes place. As such, the game's design was consistent with advice from constructivists Roblyer, Edwards and Havriluk (1997), that virtual game settings seem real beyond school culture, offering an immersive, realistic and complex environment. Also important is that the game required learners to critique and improve themselves and the virtual world. Other noted design features include: avatars that can interact with others and construct personally meaningful structures and places, challenge, chat, accessibility to multiple users in real time, and self-paced student inquiry and problem solving (Anderson 2008; Tüzün, et al. 2009).

A paper by Dittmer (2010) found that using *immersive virtual worlds*, specifically *Second Life*: an MMOG with no built-in narrative and players represented by avatars which are central to all interactions (Dittmer 2010; Gordon 2008), enables human geography students to:

- compare and test representations of particular places;
- use critical thinking to recognise the construction of meaning;
- situate meaning to enable the construction of knowledge; and
- find a site for fostering effective responses.

Dittmer (2010) reviewed literature on traditional e-learning strategies, and cited their formality and subsequent poor interactivity as weaknesses in producing constructivist-learning outcomes. He also reviewed literature related to video games and learning, specifically *Second Life*. Dittmer (2010) found that *Second Life* helped students to comprehend and develop three key human geography concepts: representation, narrativity, where new information fits in relation to what is already known, and affect. Representation of gender, for example, could be seen in avatar behaviour, which Yee, Bailenson, Urbanek, Chang and Merget (2007) said parallels real-world conventions, specifically that female avatars tend to stand closer than males. Dittmer (2010) noted that game play is affective because player decisions and interaction actively affect outcomes, providing immediate feedback and requiring

students to remain critically engaged. Overall, Dittmer (2010) said the design features of *Second Life* offer representations of human geography that are built by its users, which are considered by the collective and allow competing visions to be reflected; Dittmer considered these features core to constructivist learning.

Several studies investigated using the immersive virtual world *SimCity* to teach geography (Adams 1998; Gaber 2007; Ruiz-Tagle 2007). Adams (1998) explained that *SimCity* is a single-player game in which users become the mayor of an imaginary town that they design and build. The landscape can be computer generated or custom designed, and players must zone land, build power plants, roads and power lines, and take further action to enhance the city. Players can build infrastructure and structures, and shape land. Residents of *SimCity* also build structures based on zoning, the power grid and infrastructure. Friedman (1999) explained the dynamic nature of development in *SimCity* that gives players constant feedback about their performance:

[Players] can't make the zones develop into thriving homes or businesses; that's determined by the simulation, on the basis of a range of interconnected factors including crime rate, pollution, economic conditions, power supply, and the accessibility of other zones. If you've set up conditions right, an empty residential zone will quickly blossom into a high-rise apartment complex, raising land values, adding tax money to the city's coffers, and increasing the population of the city. If the zone isn't well-integrated into the city, it may stay undeveloped, or degenerate into a crime-ridden slum (n.p.).

Adams (1998) stated that *SimCity* presents a complex system of patterns and processes. This includes a simplified version of the simultaneous demands facing urban planners, such as budgetary constraints, municipal service provision and commerce and industry.

Adams (1998) evaluated the role *SimCity 2000* played in an undergraduate class of urban geography students, compared with other methods of learning, over a period of one week. He evaluated student preference for the *SimCity* project against nine other related projects of similar duration and difficulty and found that it was the favourite project for 48% of students. He also found that students' major area of study affected whether they liked the game. Results from the study showed that 60% of geography, planning or urban studies majors liked *SimCity* without qualification, whereas 89%

of other majors liked the program without qualification. Adams (1998) noted that this critical response from students has meaning for motivation, but not necessarily learning; it may simply show an advanced ability to critique the program. The evaluation of student preference had implications for motivation; Adams (1998) found that students are highly motivated to use the software because it is game-like, and gain a greater appreciation of the role of urban planners, designers, and policy-makers as a result of playing *SimCity*. Furthermore, the results of essay evaluation showed that *SimCity* enhanced computer literacy, geographical knowledge, and critical skills; that is, syllabus outcomes and critical engagement. So, an immersive virtual world, in which the player was central to activity and learnt by doing while receiving constant feedback from the game, motivated students to learn and enhanced geography outcomes and critical thinking. This said, Egenfeldt-Nielsen (2007) notes that the study did not evaluate learning with a control group or test knowledge before and after implementation; and states that, as such, it does not compare learning via *SimCity* with other pedagogical methods.

A study by Gaber (2007) explored the learning objectives and pedagogical limitations of *SimCity*, examined its implementation in the classroom and surveyed students about their experiences with the game. Gaber (2007) drew on his experiences in teaching undergraduate and graduate students with the game over a 13-year period. He evaluated geography, planning and urban studies learning, as well as implications for critical engagement and student experiences, including motivation to learn. He reviewed related literature and concluded that computer simulation leads to two cognitive learning outcomes: holistic understanding and adaptive critical reasoning. He connected these outcomes to three objectives obtained by teaching with *SimCity*. First, seeing a situation embedded in the context of interconnected variables, where actions have consequences, moved students towards systems thinking. Second, when students worked with *SimCity* they had to identify and analyse problems and develop immediate and long-term solutions in response; in other words, they had to develop procedural knowledge. Third, the game provided the opportunity to develop their skills as students planned, developed and reflected on feedback from their simulated city. To surmise, Gaber (2007) shows that *SimCity* supports holistic understanding and adaptive critical reasoning because play involves

feedback, an immersive and complex environment, and problem-based learning. These findings affirm those of Adams (1998), but provide analysis for two-thirds of a semester, rather than only one week.

Gaber's (2007) survey results also offer valuable information in terms of the implications of using *SimCity* for learning, critical thinking and motivation to learn. The findings were self-reported and so had implications for motivation, as they show levels of student support and perceived usefulness. He reported that 100% of planning students and 75% of undergraduate and non-planning graduate students learnt about the complexities of cities. Here Gaber (2007) noted a difference between his study and that of Adams (1998). Adams found more support for the game among non-planning students than planning students – the opposite of Gaber (2007) – which he attributed to the longer implementation period of his study. It should also be noted that Adams (1998) tested an earlier version of the game. Gaber (2007) also found that 42% of undergraduate students said the game definitely changed their understanding of city planning, while 75% of planning and graduate students said the same. Here he suggested that undergraduate students were less likely to identify more than one or two causal factors and could benefit from the teacher explaining, in class, the systems approach presented in *SimCity*. In terms of procedural knowledge and problem solving skills, 62% of graduate students overall and 75% of planning students said the game definitely improved these. Finally, Gaber (2007) reported that less than 50% of students in any category reported learning the craft of planning via the game; an outcome he attributed to the earlier stated limitations of the game.

By way of pedagogical limitations, Gaber (2007) identified that the game is a poor approximation of reality, as planners do not start cities from scratch, plan entirely for economic reasons, or have as much control as they do in the game. That the game can trivialise major decisions as a result, is a criticism shared by Adams (1998) and Gaber (2007). Further Gaber (2007) criticised *SimCity* for relegating planning decisions to decisions about aesthetics rather than people, a misrepresentation and simplification of actual planning. As such, he warned that teachers must be clear about what *SimCity* offers and what it does not; pair game play with student

reflection, analysis and other learning instruments; and include clear objectives and active teacher involvement in game play.

Furthermore, *Minecraft* is a popular video game now being used and tested in the classroom (Short 2012). In a survey of 270 Year Four to Nine students, Beavis, Muspratt and Thompson (2015) found that *Minecraft* was the most popular out-of-school game identified by students; and Hanghøj, Hautopp, Jessen and Denning (2014) and List and Bryant (2014), explored use of *Minecraft* in the geography classroom.

Hanghøj et al. (2014) studied *Minecraft* as a platform to build important places and structures that can help them survive on a fictional desert island; testing this in two Year Three classes at one school and three Year Two classes at another. The study posited that the open-world and free-choice format of *Minecraft* could be redesigned for specific pedagogical approaches. The curricular aims of the course set out to encourage collaboration and promote students to learn to communicate and argue for what to build and how to operate. The scenario was flexible enough to allow teachers to design lesson plans, meaning there were “a multitude of options for re-designing the game as a learning resource in formal education” (Hanghøj et al. 2014, p. 182). The study also found that via cooperative gameplay and challenging problem-solving, students situated the meaning of the game in terms of their “everyday understanding of what it meant to survive” (p. 187). However, the authors believed that teachers need to be sufficiently versed in game literacy, choose relevant pedagogical approaches, “and provide just-in-time lessons to promote students reflection”, suggesting that a game designed specifically for a classroom requires teacher involvement of a particular kind.

Similarly, List and Bryant (2014) assessed the use of *Minecraft* in a Year Seven US classroom, in which geography concepts such as human-environment interaction, movement and resource management were taught through actions in the virtual world. In small groups, students learned the mechanics of the game world to survive for one in-game day, migrate across land, build a defensible colony and trade with other colonies of students. They then had to document their actions and choices, and

explain what elements in the game allowed them to survive. The study focused on five of Gee's (2005a) principles of effective educational video games: interaction, customisation, agency, situated meanings, and exploration and problem solving (List and Bryant 2014). Once surviving for a full in-game day, students explained the geographical features that they used for survival, such as trees for shelter or mountains for high ground. The study was still in early stages and data processing was ongoing, but List and Bryant (2014) believed that because *Minecraft* allows students to attempt one solution, then rethink and retry another solution, they were likely to think laterally, rethink strategies and goals and use the context of the game to “develop understandings or situated meanings” (p. 2378).

Tromba (2013) explains that *Minecraft* offers a 3D immersive virtual world that allows for multiple players; and points specifically to collaboration, creativity, a complex environment that is built to scale, and problem solving and decision making, as features supporting learning. List and Bryant (2014) explain that players must collect materials to build tools to access resources in a world with a variety of geographical regions. They note that beyond this, players choose how to participate in *Minecraft*, though the game provides feedback that is situated. Hanghøj et al. (2014) explain that the game allows students to explore and inquire as they see fit. This said, Hanghøj et al. (2014) also explain that while *Minecraft* offers an open-world as a resource in formal education, the best pedagogical approach to support learning using *Minecraft* is one in which students are “allowed to explore, experiment, and argue in favour of the meaning of their design choices” (p. 189).

Finally, a study by Pee, Blanchfield and King (2010) designed and tested a video game called *GeoEmission* for effectiveness as a supplementary teaching tool for geography at a British school. The video game was based on the Key Stage Three (Years Seven-Nine) geography curriculum and *SimCity*. *GeoEmission* is a networked role-play and adventure game, in which players must achieve specific goals and complete challenges or mini games to unlock items or actions. The aim of the game is to reduce greenhouse gas contamination and gain reward cards for temperature, money, energy and carbon emissions.

An empirical study was carried out by Pee, Blanchfield and King (2010) to assess *GeoEmissions*'s capacity to promote collaborative and cooperative behaviour, with implications for learning and motivation. Two groups of 10 Year Eight geography students played the game. The first group comprised the 10 students with the highest standardised achievement scores, and the second group comprised the 10 students with the lowest standardised achievement scores. Further, the game was played during the normal teaching sequence during a one-hour class.

Players were divided into teams of two for game play. Data was collected through structured observation and discussion across a range of categories which included: motivation, clarity, achievability, control, immersion, interest, purpose and communication. Pee, Blanchfield and King (2010) observed that players interacted almost continuously while playing the game, both within and beyond paired teams, and collaborated in order to win the game. All students demonstrated improved subject knowledge, and greater willingness to share what they had learned. Moreover, Pee, Blanchfield and King (2010) found a significant improvement in interaction and enthusiasm by the low-achievers group, who asked more questions and tried to understand concepts when game playing. This said, the researchers noted that the short implementation period means novelty could have contributed to these outcomes. By way of rebuttal they offered evidence from further research they were conducting at the time of writing that compared students playing *GeoEmission* to a control group using the Internet to find information. This experiment showed that *GeoEmission* led to interaction and collaboration whereas Internet searches did not, suggesting that it is not the novelty of a technology-based lesson that lead to interaction, but rather the structure of the game-play itself.

In *GeoEmission* players choose their actions, design and build a city, and learn by doing (Pee, Blanchfield & King 2010). Players advance in the realistic and complex game environment by evaluating and navigating the results of decisions and actions. For example, Pee, Blanchfield and King (2010) describe one action and some possible consequences:

Shutting down a heavy polluting industry... tends to have knock-on effects such as causing people to lose their jobs. When people become jobless, this

will have an impact on their quality of life and therefore their political response (p. 441).

Complex relationships are thus simulated by the game in response to player's actions. Further, during the game, players are able to take on a number of roles such as Greenpeace activist, mayor or scientist, who can each take particular actions. The game also involves a non-player character for the teacher, who can send messages to players, add realistic responses to actions, and pause the game.

#### **2.1.4 SUMMARY**

Testing of video games that support syllabus aims, motivation to learn and critical thinking in the geography classroom focuses on *virtual field* trips and *immersive virtual* worlds. These designs are suited to the study of geography because they allow immersion in the environment being studied (Sacramento & Munhoz 2011) and integrate knowing with doing (Shaffer et al. 2005). The results were not uniform across all research, but *virtual field trip* testing suggested that games should include the following: self-paced student inquiry and problem solving, access to experts and related resources, scaffolding to respect cognitive load, clear rules and objectives, rich context, a clear relationship to course objectives, collaboration and independent investigation and cooperative work (Stumpf II, Douglass & Dorn 2008; Woerner 1999). Furthermore, testing of *immersive virtual worlds* suggested that design features that supported syllabus learning, motivation to learn and critical thinking included: avatars having identity and agency, requiring players to critique and improve themselves and the game world; an immersive, realistic and complex environment; challenge; collaboration, including a chat facility and access for multiple users in real time; situated meaning; feedback, including player actions actively affecting outcomes; self-paced student inquiry, learning by doing and problem solving; and teacher involvement in the game, including explanations and reflections on what a video game offers and what it does not (Adams 1998; Gaber 2007; Pee, Blanchfield & King 2010).

#### **2.1.5 SYNTHESIS OF REVIEWED LITERATURE**

Best practice design principles for a video game for Stage Two geography students, to support syllabus learning, motivation to learn and critical thinking, can be

extrapolated from the findings of the literature review. The design features present in video games that motivate learning and support critical thinking, and that support syllabus aims, motivation to learn and critical thinking for primary students and students studying geography are:

1. Perceived to be useful, achievable and challenging
2. Learning is part of game flow
3. Play involves collaboration
4. Players have identity and agency
5. Game play situates meaning
6. Design respects cognitive load
7. Offers an immersive, realistic and complex environment
8. Involves self-paced student inquiry, learning by doing and problem solving
9. Design supports teacher involvement and access to related resources
10. Play includes clear rules and objectives
11. Play involves feedback

## **2.2 Theoretical framework**

This section discusses the theories that underpin the research study and inform the video game design, research design, and data collection and analysis.

Consistent with the findings of the literature review – that popular video games and effective instructional video games facilitate the construction of knowledge and include both critical and collaborative dimensions (Castleford 1998; Gee 2005a; Jong, Shang, Lee & Lee 2010; Lemberg & Stolman 1999; McNail 1987; McRae 2001; Rosario & Widemeyer 2009; Schraw 1998; Steel 2009) – the most suitable instructional theories appropriate for this study are constructivism, social constructivism and critical pedagogy. These theories recognise that knowledge is critically and collectively built over time in a social, economic and historical context. Critical pedagogy, in particular, is also underpinned by the value that education should support democratic action: knowing the world and one's power to transform it (Taylor 1993). Discussion of each of the central theories to this research is discussed below.

### 2.2.1 CONSTRUCTIVISM

The foundation of constructivism was pioneered by Piaget (1953, 1962). Through observing thousands of children of different ages, Piaget developed the theory that all children develop intellectually and psychologically through distinct cycles of knowledge construction, and should be taught according to their developmental level (1953). Piaget posited that children's self-directed play is critical to their cognitive development, recognising that people learn through doing and are participants in their own development (1962). Fosnot (1989) provides a summary of four main assumptions of Piaget's theory:

- Previous constructs are the foundation of new knowledge.
- Assimilation and accommodation comprise knowledge.
- Learning is not mechanical, but a process of organic invention.
- Complete levels of understanding occur as cognitive conflict is reconciled through reflection and resolution.

As such, Piaget's theory of cognitive development defines learning as an active process and surmises that knowledge should be built dynamically with respect to the learner and context. These ideas challenge traditional understandings that assume knowledge is fixed and can be passed from educator to learner (St. Pierre Hirtle 1996), as well as the notion that tests and other forms of objective performance can provide a full measure of learning (Adams 2006; Easen & Bolden 2005).

Two important additions to constructivist theory were made by Vygotsky. The first was the understanding that children learn step by step through action, often by completing tasks slightly above their capabilities (Vygotsky 1978, pp. 85-86). Vygotsky asserted that learning designs must take into account students' Zone of Proximal Development, that is: the distance between the current level of development (defined by independent problem solving) and the potential development (defined by guided or collaborative problem solving). As such, Vygotsky recommended that education should supply scaffolding that affords the necessary level of support at any given time (Goodman 2007), and that the learning experiences are within a person's Zone of Proximal Development (Berk & Winsler 1995).

Vygotsky's (1978) second important addition to Piaget's notion of constructivism was the understanding that development happens in a social context. In other words, education happens in the context of broader historically constituted social and economic relations, and that people learn through interaction with one another. Further, education is a process in which people participate. Vygotsky (1978) asserted that learners build knowledge in the context of, and as participants in, society; this context must be recognised to understand or shape development. The implications of this for pedagogy was termed social constructivism and investigated by social constructivists.

### **2.2.2 SOCIAL CONSTRUCTIVISM**

Social constructivists assert that knowledge about the world is socially built (Eggen & Kauchak 2004; Holt & Willard-Holt 2000; Wheatley 1991; Yager 1991), as learners compare their understandings with that of others, to arrive at new socially tested understandings (Kukla 2000). Further, social constructivists focus on:

- learning as a production process, not memorising validated truths;
- guidance rather than instruction;
- engagement having implicit worth; and
- assessment being an active process whereby shared understandings are uncovered (Adams 2006).

The development of such learning communities may enhance deep learning (Chapman, Ramondt & Smiley 2005; Hardwick 2000; Lukinbeal & Allen 2007), critical thinking (Deloach & Greenlaw 2005; Francescato, Porcelli, Mebane, Cuddetta, Klobas & Renzi 2006; Lukinbeal & Allen 2007) and student collaboration (Gokhale 1995; Francescato et al. 2006; Lukinbeal & Allen 2007).

The study of social constructivism involves a breadth of ontological positions that take in an active and pragmatic approach to learning and recognition of the importance of the social context. It is active and pragmatic, in that it values an ongoing process of learning from practice. It also recognises the social context of education, including other actors in knowledge and community development, history

and economy. While social constructivism broadly recognises that learning is the product of social contexts (Adams 2006), it also positions the learner not only as a product of social contexts, but as a creative actor in social contexts. Freire called this *praxis*, which he defines as “reflection and action upon the world in order to transform it” (1998, p. 36). In practical terms this means engaging in cycles of ideas, application, evaluation and reflection, to build knowledge and create change. Freire (1972) argued that thought only has meaning when built through action in the world. Implementation of this notion requires a range of practices advanced by critical pedagogues.

### 2.2.3 CRITICAL PEDAGOGY

Critical pedagogy – as advanced by Darder (1995), Freire (1972, 1982, 1998), Giroux (2011), Guevara (2003), Hooks (1994), Kincheloe (2005) and McLaren (2001, 2005) – developed the understanding that learning must recognise not only the social but:

- the full context in which it occurs, exploring how knowledge is deemed valid or invalid;
- the need to situate learning in the lived experience of participants;
- the need to engage students and involve them in creating knowledge;
- that it is not distinct from power that exists in every other aspect of life; and
- knowledge is constructed through the shared participation and interpretation of people, who are also shaped by society.

Furthermore, critical pedagogy is also underpinned by the value that education should support democratic action: knowing the world and one’s power to transform it (Taylor 1993). Indeed, in an exploration of education and socio-technical change, Facer (2012) notes “young people will have to live in the future with real consequences of decisions taken today about socio-technical developments” (p. 98) and advocates developing technology in schools that enable “young people’s informed engagement with possible futures” (p. 109). Recognising that learning and thought processes happen in a context that shapes them, and identifying the context and these processes, is essential to this goal (Darder 1995). Likewise, understanding

how knowledge is mediated and created is as important and active as knowledge itself (St. Pierre Hirtle 1996, p. 91). Finally, Giroux (2011) explains that citizenship involves individuals having responsibilities to others and that education must reflect on, and contribute to, both the production of self and the historically constituted social and economic context. Freire advances *dialogue* as an instructional method in which people work with one another to make a difference in the world (McLaren 2001). Freire (1972) advocates building knowledge about what is known and why through social participation.

#### **2.2.4 SUMMARY OF THEORETICAL FRAMEWORK**

The instructional theories informing this study are the tenets of constructivism, social constructivism and critical pedagogy, with an emphasis on democratic action, praxis and dialogue as defined by Freire (1972, 1998). The study, which uses a designed video game, aims to locate knowledge in the full context in which it is built, positioning students as democratic participants. In this study, learning is not defined as simply memorising a body of validated truths, but incorporating knowledge in the context of society and using it to co-create society. The study is designed on the assumption that knowledge should be situated in the lived experience of students and be built with regard to context; that students should learn actively, collaboratively and critically via praxis; and learning should bring the world into the classroom, be creative and involve dialogue and democratic experiences.



### **3 RESEARCH METHODOLOGY**

#### **Overview**

The first aim of this research is to identify in what ways an instructional video game based on best practice design principles supports Stage Two students to achieve geography outcomes specified by the NSW syllabus. The second aim is to investigate how the video game motivates learning and supports critical thinking.

To meet these aims and answer the research questions, this research adopted a qualitative case study approach with an integrated focus group and carried out the research in four phases. This chapter outlines the research design and details the four phases of research that were developed to answer the research questions. The first phase involved designing a video game based on the design principles determined by the review of literature and supported by the theoretical framework in Chapter Two. Phase Two developed the methods of data collection and analysis. Phase Three tested the video game and data collection and analysis in a pilot study, to determine game functionality and ensure the data collection captured the information required to answer to the research. Finally, Phase Four implemented the research design in the classroom.

#### **3.1 Research questions**

Two main questions govern this study:

- Q1. In what ways does an instructional video game based on best practice design principles support Stage Two students to achieve the geography outcomes specified by the NSW syllabus?
- Q2. How does the use of a video game motivate learning and support critical thinking as a method of instruction?

#### **3.2 Research design**

The research methodology for this study was designed to answer the research questions in line with the adopted theoretical framework. This research seeks to understand the underlying experience of an instructional method – that is, the designed video game. Therefore, the researcher adopted a qualitative approach.

Furthermore, the theoretical framework demanded recognition of contextual factors, so that the research would provide authentic answers. As such, this research undertakes a case study of a Stage Two geography class using a video game, a method well suited when the context of the situation is being explored (Bogdan & Biklen 1998; Creswell 2007; Yin 2003).

### **3.2.1 QUALITATIVE APPROACH**

This research asks “how” and “in what ways” a video game based on best practice design principles supports students to meet syllabus outcomes, develop critical thinking skills and motivate learning. As such, it focuses on the quality of student responses to instruction, and the goal is to discover and understand. Thus, a qualitative approach was used because it shares these goals (Merriam 1998). The rich description involved in data collection for a qualitative approach assists with in-depth understanding (Bogdan & Biklen 1998; Creswell 2007; Hancock & Algozzine 2006; Johnson & Christensen 2004; Yin 2003). In fact, using qualitative methods to investigate ICT use in education (Alrumaih 2004; Kim 2003) has enabled researchers to form the kind of understanding these research questions require.

A qualitative approach is also consistent with the theoretical framework outlined in Chapter Three. Research guided by critical pedagogy requires valuing the participation and perspective of all those involved, flexible design, rich description, and holistic and inductive analysis: all features of qualitative research (Merriam 1998).

Furthermore, qualitative research seeks to understand complex social problems in their natural setting (Creswell 2007; Kervin, Vialle, Herrington & Okely 2006; Merriam 1998), so development of the research design recognised the need to implement the study in the natural setting of the classroom. This enabled analysis of “the situated form, content, and experience of social action” (Lindlof & Taylor 2002); allowed the researcher to explore unexpected outcomes and gain a broader understanding of the context (Bogdan & Biklen 1998; Kervin et al. 2006); and enabled maximum recognition of complex contributing factors to answer the research questions.

As well as multiple qualitative instruments, additional quantitative instruments were incorporated into the research design to measure the change in Stage Two students' geography outcomes specified by the NSW syllabus, and their motivation to learn and critical thinking, before and after using the video game. Based on the results of these quantitative measurements, the researcher was then able to ask how and in what ways this change occurred, drawing further from the qualitative data sources.

### **3.2.2 CASE STUDY STRATEGY**

To understand the relationship between use of the video game and students meeting syllabus outcomes, thinking critically and being motivated to learn, recognition of contextual factors, the realities of school, was a requirement of the research design. For example, the design needed to detect the various factors impacting learning, motivation to learn and critical thinking in the classroom. As such, implementation in a Stage Two geography classroom was needed. Only one class was selected for implementation of the video game, due to financial and time constraints, and the need for overall analysis.

Moreover, only six of the students in the class were selected for comprehensive evaluation to minimise disruption to the class. There are many uncontrolled variables in a classroom, such as gender, academic achievement, socio-economic status, previous experience with video games, and the instructional approach of different teachers; therefore, a focus group of six students of mixed ability and gender would allow the researcher sufficient data to develop a deeper understanding of the case in the context of these variables. The researcher would ask the classroom teacher to identify six students (three girls and three boys) with different average school results in HSIE, to be focused on by the research.

Data collected within a defined system is a characteristic of case study research (Yin 2003). A case study can provide the means of answering “how” questions about a set of events in a natural setting (Yin 2003). It is a detailed examination of a specific person, place or thing – in this instance a video game supporting syllabus outcomes, critical thinking and motivation to learn – at a particular institution (Kervin et al.

2006; Merriam 1998). In fact, case studies are a suitable strategy for recognising a great breadth of causal factors and effects (Crowe, Cresswell, Robertson, Huby, Avery & Sheikh 2011; George & Bennett 2005). Even though definitions of case studies vary (Merriam 1998), the strategy that fits the research is based on the process outlined by Yin (2003, p. 13), who defines a case study as the investigation of “a contemporary phenomenon within its real-life context, especially when boundaries between phenomenon and context are not clearly evident”.

That said, qualitative case studies have well-identified and relevant potential weaknesses. First, they position the researcher as interpreter and are therefore innately subjective (Merriam 1998; Tellis 1997). Second, the narrow scope of selected data limits the ability to generalise the result (Kervin et al. 2006, p. 72; Merriam 1998; Yin 2003). Third, a case study’s ethical considerations may involve the potential abuse of power by the researcher over the research participants (MacDonald & Walker 1977; Merriam 1998, pp. 42-43; Yin 2003). Fourth, discrepancies between what people think, say, appear to do and do can arise (MacDonald & Walker 1977; Merriam 1998). However, to reduce the effect of these weaknesses on this case study’s validity and reliability, steps were taken to acquire trustworthiness. These are outlined in section 3.3.2.4.

### **3.3 The four phases of research**

There were four phases to this research – the first three phases developed the research approach and the fourth phase implemented and tested it in context. The first phase involved designing an educational video game for a Stage Two geography classroom. The second phase designed and developed appropriate data collection and analysis to evaluate student learning of syllabus outcomes, critical thinking and motivation to learn. The third phase involved conducting a pilot study to test and improve the video game, and data collection instruments and analysis. Once the video game, and data collection and analysis techniques were sufficiently refined via the pilot study to meet the needs of the research, the fourth phase involved implementing the video game in an authentic Stage Two geography classroom and collecting and analysing data. The four phases of this study are illustrated in Figure 3:1 below.

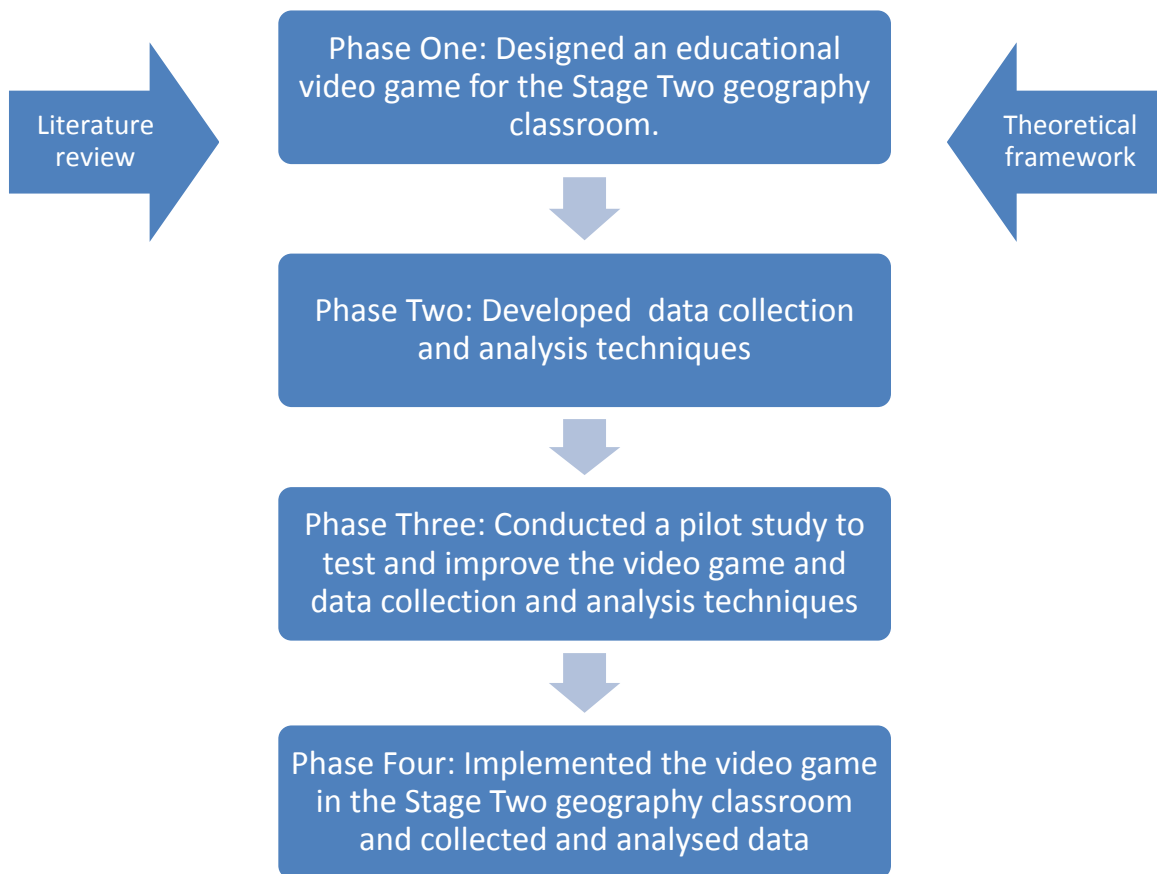


Figure 3:1: The four phases of the research

### 3.3.1 PHASE ONE: VIDEO GAME DESIGN

This section discusses the development of an educational video game, *GeoCity*, which was custom designed by the researcher of this study. *GeoCity* was designed to meet NSW Stage Two Human Society and Its Environment (HSIE) syllabus outcomes for the unit “Who Will Buy?” (see Appendix A). The video game aims to enhance students’ learning, motivation to learn and critical thinking skills in relation to HSIE. Design of the game was based on best practice instructional principles, as discussed in the literature review, in line with the theoretical framework overviewed in Chapter Two, and based on content from the NSW syllabus.

The game was designed by the researcher to be played for approximately five hours in total, generally spread over four 70-minute sessions. The allocated time was due to three practical considerations: first, the budget for building the game limited game length; second, to minimise disruption to ordinary classroom practices to ensure

school, student and teacher participation; and third, to fit the school time allocated for the study of this HSIE unit.

The following sections outline the main aspects of the game design and their relationship to best practice design principles:

1. Perceived to be useful, achievable and challenging
2. Learning is part of game flow
3. Play involves collaboration
4. Players have identity and agency
5. Game play situates meaning
6. Design respects cognitive load
7. Offers an immersive, realistic and complex environment
8. Involves self-paced student inquiry, learning by doing and problem solving
9. Design supports teacher involvement and access to related resources
10. Play includes clear rules and objectives
11. Play involves feedback

However, first this section will outline how the game design relates to the NSW HSIE syllabus. The sections are:

1. Video game format
2. Avatars and customisation
3. Playing the game
4. Syllabus and game objectives

### **3.3.1.1 Video game format**

*GeoCity* is an online multiplayer immersive virtual world where players explore a virtual city; interact with game objects such as shops, services and other players; investigate the production of goods and services; access, use and earn money; and buy goods and use services. The aim is to satisfy the needs and wants of avatars, and make responsible individual and collective choices about which goods and services to produce, buy and use.

The format of an online multiplayer immersive virtual world was chosen to support:

- immersion in the environment being studied, ideal for the study of geography;
- interaction and collaboration to enhance learning, motivation and critical thinking; and
- active engagement with the learning material.

The format is also consistent with the three theories that inform the framework for this research. Learning is embedded in acting in the game world, and with respect to social context, supporting the construction of knowledge. The social construction of knowledge is facilitated through the availability, and in some cases necessity, of collaboration as players are positioned as creative actors in this social context. Finally, to adopt a critical approach to pedagogy, citizenship in *GeoCity* involves social responsibility.

The structure of the game does not involve levels. This decision was made to:

- i. avoid having players on different levels and maximise the number of players interacting in a shared environment; and
- ii. enhance player choice in the game world.

The game world was designed to change and develop as a direct result of the actions of players. This aligns with geography learning and constructivism, as encounters with active outcomes offer students a way to engage with culture, learn via problem solving, and critically engage (Dittmer 2010). Furthermore, the game was designed so that players build knowledge through shared participation, action and responsibility to others, aligning game play with social constructivism (Kukla 2000) and critical pedagogy (Freire 1972, 1998; Giroux 2011). Challenge, usefulness and clear objectives were also incorporated via:

- i. individual and collective tasks;
- ii. diverse opportunities for self-paced student enquiry, learning by doing, and problem solving; and
- iii. players advancing by successfully completing tasks.

The text included in the game world was clear and concise. It was tested to ensure appropriateness for Year Three students by Readability-Score.com (n.d.): an online tool that tests readability using the Flesch-Kincaid, Gunning-Fog, Coleman-Liau, Simple Measure of Gobbledygook (SMOG) and Automated Readability scoring systems, and calculates the number of years of education a person needs to comprehend it. The tool does so based on character count, syllable count, word count, sentence count, characters per word, syllables per word and words per sentence. All text included in the game design was found to be appropriate for Year Three students.

Detailed usage reports of all players of the game were made part of the back-end of the game design. This enabled the researcher to view an administration portal and review usage information, including a log of time spent playing and engagement with particular learning tasks by each player, and full chat transcripts.

The graphics and animations used in *GeoCity* are commensurate with the budget provided. They are not high-definition 3D, as seen in many big budget commercial games. Two dimensional (2D) images were used for every aspect of *GeoCity*; however, use of 2D isometric images and animations give the game a 3D appearance. This technique uses angles and shadows to simulate a 3D environment and images.

### **3.3.1.2 Avatars and customisation**

Up to 40 players (students and their teacher) can take part in the game at any one time; each player is represented by unique avatars in the game world. The multiplayer environment was included for reasons discussed above, but player numbers were limited to 40 because the game was designed for use in one classroom. Avatars were included so that players have identity and agency, to assist learning and motivation.

At the start of the game players must select a unique avatar from a pool of 40 choices 20 male and 20 female. The avatar selected represents the player in the game world for the duration of game play. The use of personalised avatars was included in the

game design, with distinctive traits chosen by players, to support emotional proximity between an avatar and the player controlling them.

To promote identity in the game world each avatar is removed from the pool as players select them, to ensure no avatar exists in the game in more than one instance. Participants must also name their avatar. Screen shots of this process can be seen in Figure 3.2 and 3.3.

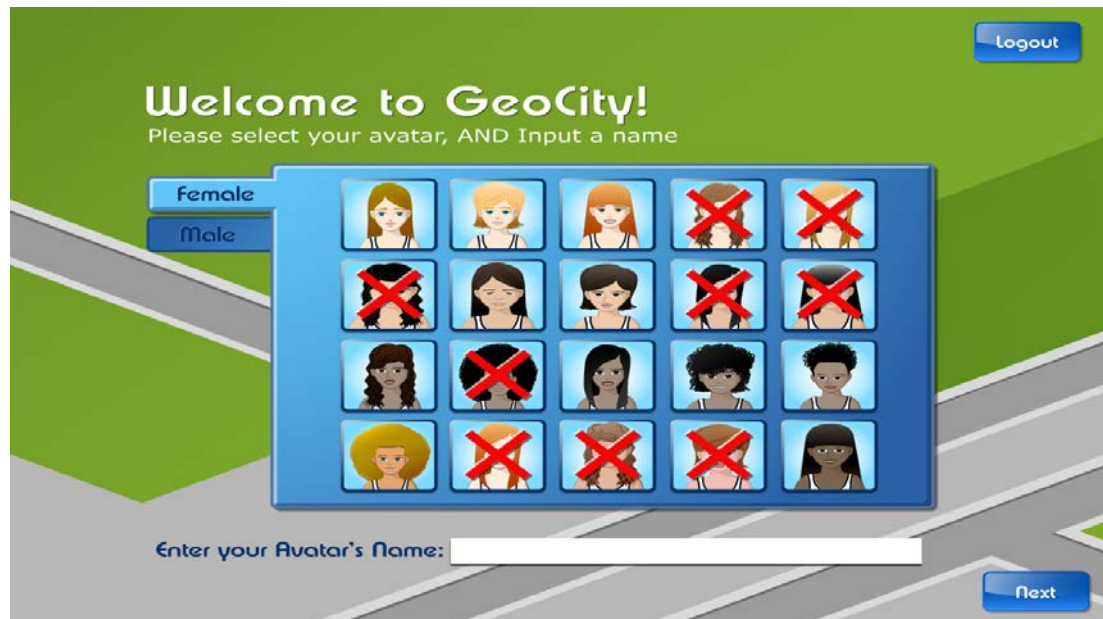


Figure 3:2: Selecting a female avatar



Figure 3:3: Selecting a male avatar

In *GeoCity*, choice is an important component. Choice is provided for players in the game beyond selecting a unique avatar. Each player must choose a block of land and one house from a choice of 10, as shown in Figure 3.4; they can then elect to buy clothing, food, furniture, pets, electrical goods and sporting equipment to individualise their avatar. These choices relate to syllabus content as outlined below.



Figure 3:4: Choosing a house

### 3.3.1.3 Playing the game

#### 3.3.1.3.1 Navigation and moods

In *GeoCity*, avatars are controlled by players; that is, avatars do not act independently of player direction. This supports player identity and agency in the game world. There are three exceptions to this, due to syllabus learning objectives and because game play was scheduled over a short period of time. First, there are three computer-controlled avatars present in the game: a bank manager named Jack Smith, a resident named Dina Ali, and a mayor named Jill Wallace. These avatars were included to prompt and facilitate some of the learning tasks. Second, some learning tasks are triggered in the game by time passing. Third, needs must be satisfied throughout game play. If an avatar's needs are not satisfied, avatar activity is limited to that which will help satisfy needs. Needs include:

- i. Hunger (buying and eating food satisfies this need)
- ii. Community (talking to others satisfies this need)
- iii. Shelter (having a house satisfies this need)
- iv. Clothing (buying and wearing clothes satisfies this need)

These needs are monitored for each avatar and add together to comprise their mood. Therefore, needs govern the overall moods of avatars in the game. Avatars complain via speech bubble if their needs are not being met. For example, if an avatar is not wearing warm clothing when it snows, they will say “I’m cold” via a speech bubble. The game also provides a tip on how to satisfy the most pressing need when this happens. For example, when an avatar is cold, an arrow points to the clothing shop and a tip appears: “Wear clothes in cold weather to satisfy your need for clothing.” If needs are not fulfilled, avatars become unwilling to obey player-directed commands unrelated to satisfying needs, constituting clear rules and objectives. These functions are similar to those included in popular video game *The Sims*, and ensure that learning is part of game flow, that the game situates meaning, and that play involves regular feedback.

For each player, a measurement of the satisfaction of each need of their avatar, as well as their overall mood, is displayed at the bottom of screen at all times during normal game play as can be seen in Figure 3.5.



Figure 3.5: Measurement of satisfaction of each need and overall mood of avatar

### 3.3.1.3.2 *Objects*

Game objects include the houses of all avatars, and shops and services related to the syllabus, such as a bank, a supermarket and a clothing shop. The full list can be viewed in Appendix B. These objects constitute an immersive, realistic and complex environment to be explored. Food, clothing, furniture, pets, electrical goods and sporting equipment are also included in the game, all of which can be bought in the game world. Some must be purchased to satisfy avatar needs, such as food and clothes, while others can be bought to fulfil wants, such as sports equipment and pets. All furniture, electrical goods and sporting equipment purchased are moveable objects, and the “cash”, “food” and “clothes” menu options show inventories of all items purchased by an avatar that can help satisfy needs. These can be opened – whereby players can view what is in them – or closed. They include cash withdrawn but not spent, purchased but uneaten food, and clothes owned as shown in Figures 3.6, 3.7 and 3.8.

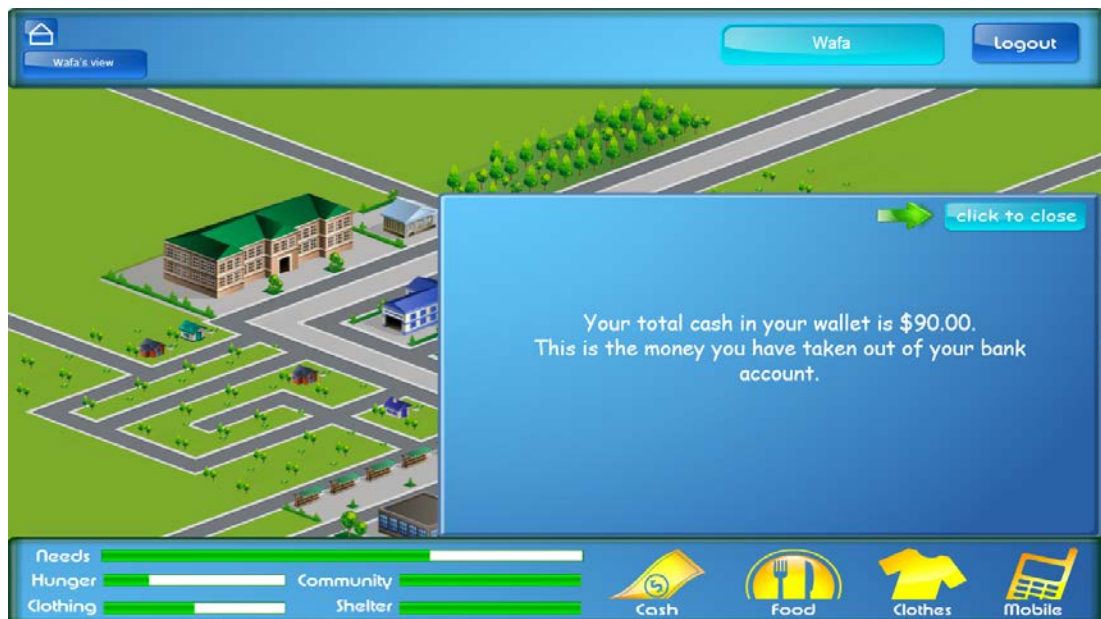


Figure 3:6: Cash inventory



Figure 3:7: Food inventory



Figure 3:8: Clothes inventory

Avatars can be directed by players to interact with many objects by clicking on them, such as using electrical equipment or going to the bank, so that the game experience situates meaning. This was included so that learning is part of game flow and because research shows that when players have identity and agency – in this instance

via the inclusion of identities that have the ability to undertake meaningful action in the game world – they are motivated to continue.

The names of each object is displayed when the cursor is held over it, so the game provides this information only when “the player feels a need for it, wants it, is ready for it, and can make good use of it” (Gee 2005a, p. 36). This function was included to reduce elements in a player’s interface, such that the design respects cognitive load by enabling access to information when needed. For all providers of goods and services, such as the supermarket and the bank, an explanation is also offered with the name, as shown in Figure 3.9. The names and explanations of all objects can be viewed in Appendix C. Furthermore, the names of all avatars and all avatar houses, for example, “Jill Wallace” and “Jill Wallace’s House”, are available in the same way, as shown in Figure 3.10.



Figure 3:9: Name and description of feature



Figure 3:10: Name of house

### 3.3.1.3.3 *Communication and collaboration*

Part of the onscreen menu is a mobile phone icon. When the mobile phone is clicked, a group chat opens that players communicate with each other via textual chat and scroll through the chat history, thus enabling discussion, collaboration, comments and feedback in the game world, and teacher involvement. This is shown in Figure 3.11. When anyone types into the group chat, it automatically opens for all players, although the view of chat on a player's screen can be closed at any time by that player. Avatars can also be prompted to chat by computer-controlled avatars, to ensure play involves collaboration and make cooperation possible. For example, computer-controlled avatar Jill Wallace opens chat to say: “Hunger is a need, so I should go to the supermarket to buy some food. What are some other needs and wants?”, as shown in Figure 3.12. This function has been included in the game to put play in the context of an interactive relationship between the player and the world, and other people.



Figure 3:11: Game chat



Figure 3:12: Computer-controlled avatars prompt chat

Interaction and collaboration are further facilitated by another design feature of the game. Players can see other avatars (see Figure 3.13) as they move around the game world and interact with game objects. For example, by clicking on any house, the

choice “Go here” appears on screen, allowing the player to enter the house of another avatar (see Figure 3.14), making the online community a resource for learning.



Figure 3.13: Students can see each other

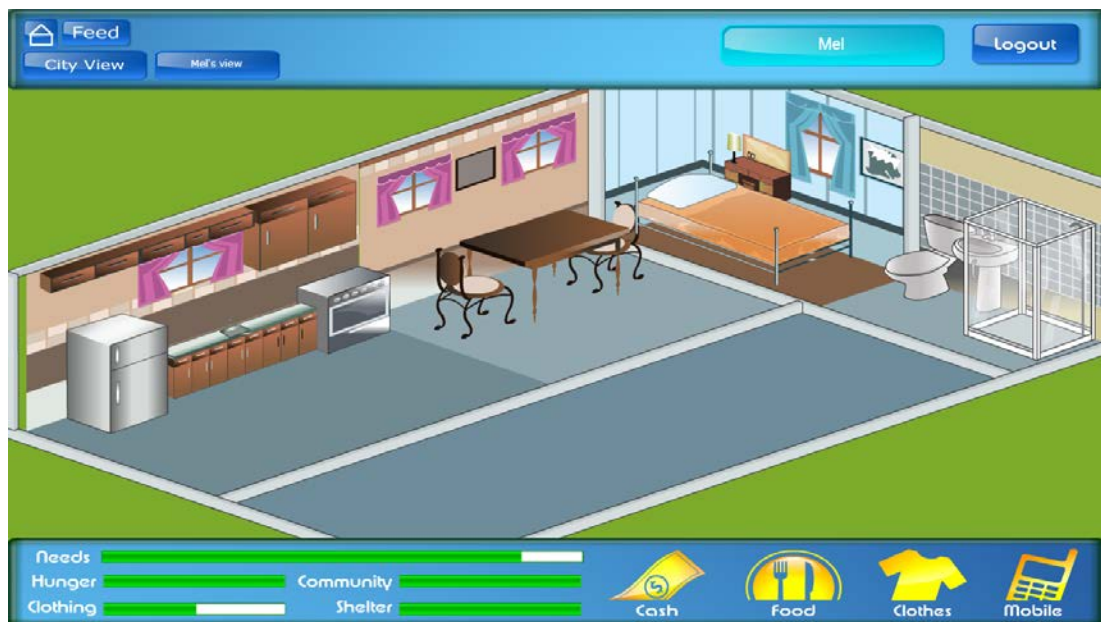


Figure 3.14: Students can enter houses

The game also allows players to toggle between two views at any given time: city view, or a bird's-eye view of *GeoCity*; and avatar view, or the view through the eyes of a player's avatar. Figure 3.15 shows the city view – with houses, roads, shops,

industries and services, as well as all avatars. It enables players to easily locate interactive features in *GeoCity*, and move to them. Figure 3.16 shows the avatar view, which enables players to view objects up close, through their avatar's eyes. These options assist navigation and experience, and personalise game play by offering choice; that is, they assist identity and agency.



Figure 3:15: City view of GeoCity

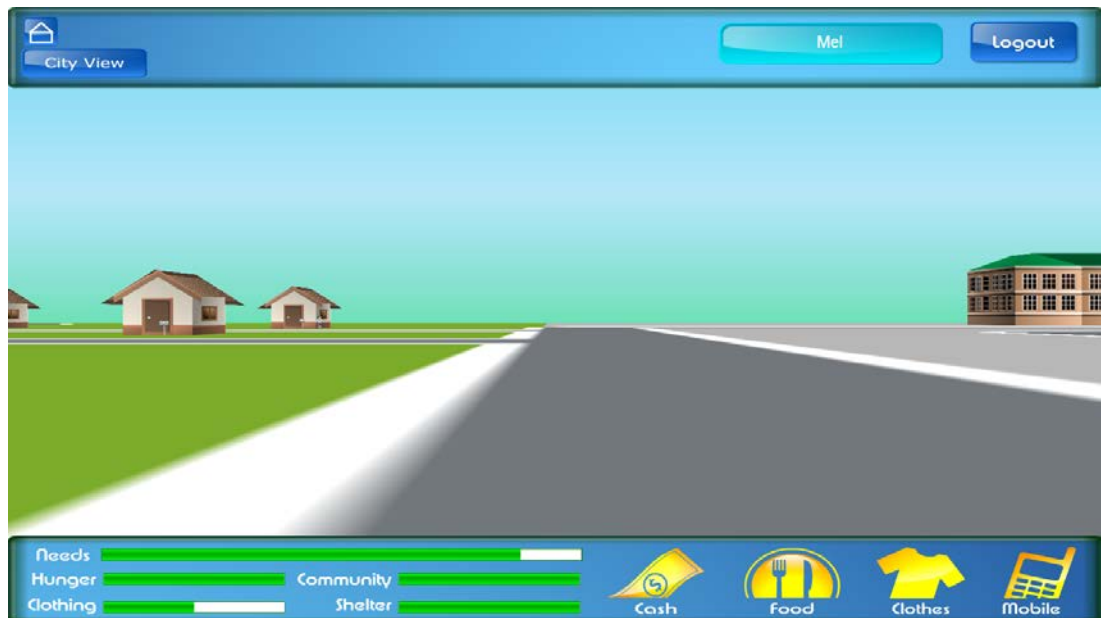


Figure 3:16: Avatar view of GeoCity

### 3.3.1.4 Syllabus and game objectives

The syllabus outcomes and indicators embedded in the video game design are for the HSIE unit “Who Will Buy?” (Board of Studies NSW 1999, see Appendix A) and are twofold. Upon successful completion of the unit a student should be able to:

1. “Describe how and why people and technologies interact to meet needs and explain the effects of these interactions on people and the environment” (p. 110).
2. “Investigate rights, responsibilities and decision-making processes in the school and community and demonstrate how participation can contribute to the quality of their school and community life” (p. 110).

As such, the objective of *GeoCity* is to satisfy the needs and wants of avatars, and make responsible individual and collective choices about which goods and services to use within *GeoCity*. The intention is that this be done in a context that aids and motivates learning and supports critical thinking. The full list of outcomes and indicators of the unit “Who Will Buy?” is presented in Table 3.1. *GeoCity* will address each of the outcomes and indicators, except points 3, 4 and 7. These three points are not included because they refer to change over time whereas the game happens in real time and is designed to be played over four weeks, to minimise disruption to the normal school schedule.

Syllabus outcomes and indicators of the unit “Who Will Buy?” included in <i>GeoCity</i>	Syllabus outcomes and indicators of the unit “Who Will Buy?” not included in <i>GeoCity</i>
1. Identifies the components of a system that provides goods and services and how the components need to interlink. 2. Examines a variety of systems that have been designed to meet needs in communities and identifies the advantages and disadvantages of their use, e.g. sewerage treatment works, postal system, electricity system. 5. Examines the goods and services provided within the community and by community organisations to meet needs. 6. Makes statements about the social and environmental responsibilities of producers and consumers. 8. Identifies the different technologies involved with monetary exchange. 9. Explain the processes involved in civic action within the community.	3. Examines possible consequences if a system changes in some way, e.g. if components are missing or break down, if technology improves. 4. Explain the changes to a system over time and the advantaged of these changes, e.g. shop, market garden. 7. Describes how changes in technology have affected lifestyles and the environment, e.g. media technologies.

Syllabus outcomes and indicators of the unit “Who Will Buy?” included in <i>GeoCity</i>	Syllabus outcomes and indicators of the unit “Who Will Buy?” not included in <i>GeoCity</i>
10. Investigates current community issues. 11. Investigates consumer rights and responsibilities.	

Table 3.1: Syllabus outcomes and indicators of the unit “Who Will Buy?” (Board of Studies NSW 1999, p. 110) included in *GeoCity*

The following sections outline the five main topics included in the game:

- Goods, services and needs
- Production and distribution
- Technologies involved with monetary exchange
- Consumer rights
- Coal or solar power

These sections outline the outcomes and indicators of each topic and task, and the particular design features included, as well as how these relate to syllabus content. The detail of the game and learning situations are summarised, including what students do, how they do it, what students learn through the activity, how this relates to syllabus outcomes, and how the activity incorporates best practice design principles, as discussed in the literature review. Each section concludes with a table summarising the design principles included in each task. Appendix D summarises the relationship between the five main topics of study and the eight syllabus outcomes and indicators included in the game.

#### **3.3.1.4.1 Goods, services and needs**

This topic includes three tasks:

1. Goods and services
2. Needs and services
3. Needs and wants

### 3.3.1.4.1.1 Goods and services

#### Syllabus outcomes addressed

5. “Examines the goods and services provided within the community and by community organisations to meet needs” (Board of Studies NSW 1999, p. 110).

#### Relevant activities undertaken

Players are presented with familiar providers of goods and services in *GeoCity* – such as a hospital, a supermarket and a clothing shop, which players can interact with through their avatars. This task provides definitions of goods and services and students are asked to sort providers into these the two categories. The task is reinforced via player access to these providers of goods and services throughout video game play. So it offers an immersive, realistic and complex environment.

Soon after avatars enter *GeoCity* and choose their house they hear “you’ve got mail” and the *GeoCity* postman tells them how to access it, shown in Figure 3.17. They receive the mail as shown in Figure 3.18.

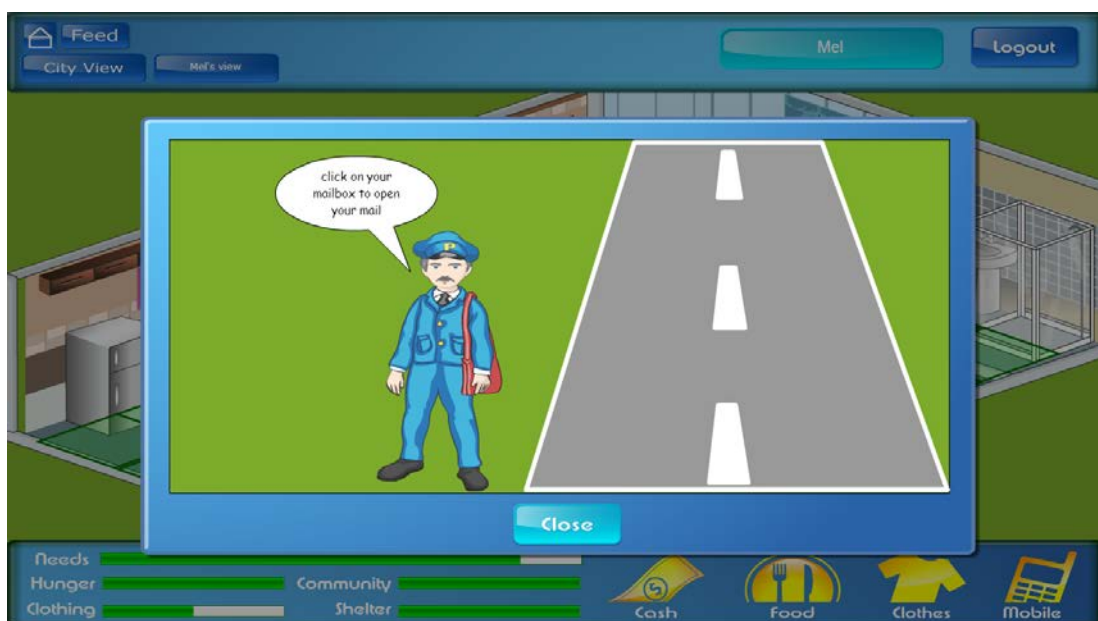


Figure 3:17: Postman instructs player to open mail

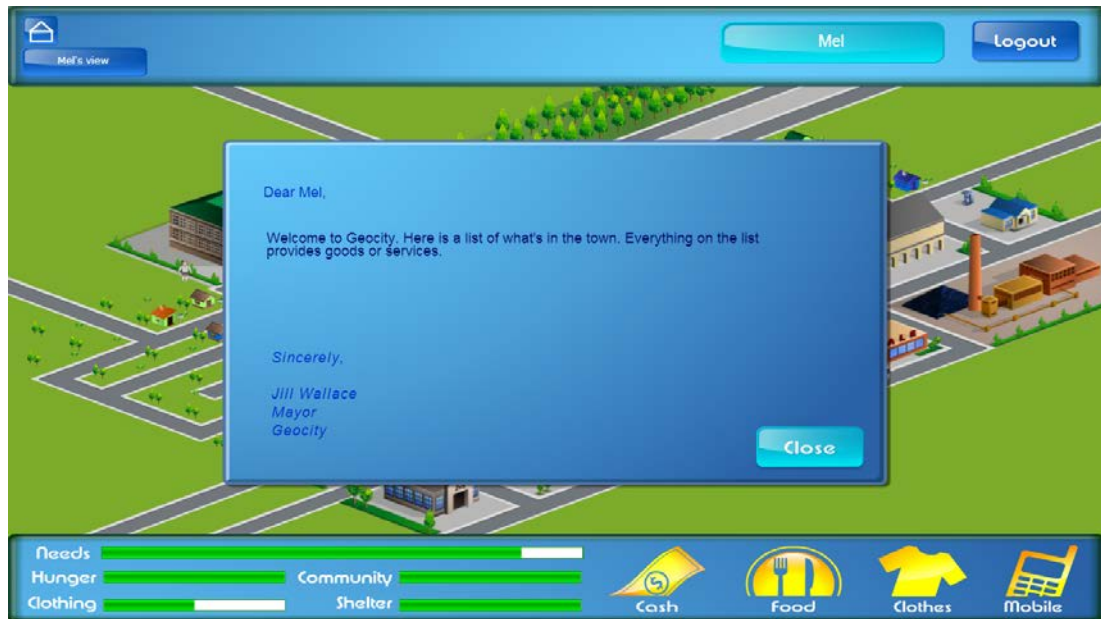


Figure 3:18: Mail for goods and services task

They receive a list of the goods and services in *GeoCity*. Each good or service provider is represented in the list by an image and, when hovered over, a corresponding name and description. The full list of features and descriptions can be viewed in Appendix C. At the same time, players are presented with definitions of “goods” and “services”. Jill Wallace appears on screen and, via speech bubble, says: “Goods are things you can see and touch. They are items such as apples, televisions and hats.” Jack Smith responds in the same manner: “Services are actions provided for you, such as teaching, banking and health care”. These interactions are shown in Figure 3.19. So the design of this task supports access related resources and prompts chat to involve collaboration. Players are able to chat and share their understandings, should they want or need it at any time during the task. Furthermore, the teacher is present as an avatar during the task, and can participate. So the design also supports teacher involvement.



Figure 3:19: Computer-controlled avatars give definitions of goods and services

Information about each provider is only present when a player seeks it – that is, hovers over it – so the design respects cognitive load. This is shown in Figure 3.20. A player needs only read an explanation of a provider, adding load, if they need it (do not know what it does).



Figure 3:20: Accessing information about a provider by hovering over it

To further reduce cognitive load during this learning task, the user interface is restricted to the task at hand and avatar needs are frozen throughout, in other words,

game design allows for students to focus on one aspect of the game, to support students' attention and perception of critical information.

Players must then label features in the city as providers of goods or services, by clicking the relevant box. Players are told this by an instructions message that appears on screen within the task itself, see Figure 3.21. Thus, for this task, play includes clear rules and objectives.



Figure 3.21: Instructions appear on screen throughout task

In line with the literature review, this task also situates meaning. Players must identify known features as providers of either goods or services; that is, they need to relate existing knowledge to new definitions. This task was designed so that new information about what defines a good and a service can be incorporated into existing knowledge about familiar providers of goods and services, consistent with a constructivist theoretical framework. It was included to take into account the learner's zone of proximal development, with existing knowledge included to form the foundation of new knowledge.

When players have labelled all features, correct answers are accepted and incorrect answers require re-labelling. Performance of this task treats failure as a way to receive feedback and try again, until providers are accurately defined and labelled. Players must identify and label all features correctly as providers of goods or services

to advance in the game, but building knowledge to complete this task is supported by treating failure as a way to receive feedback and try again. As such, play involves feedback.

When complete, the screen returns to a view of the city. The name and description of each feature is now available, when hovered over.

#### *3.3.1.4.1.2 Needs and services*

##### **Syllabus outcomes addressed**

5. “Examines the goods and services provided within the community and by community organisations to meet needs” (Board of Studies NSW 1999, p. 110).

##### **Relevant activities undertaken**

During game play a series of problems must be resolved by players: a fire breaks out, an avatar is injured, and an avatar has no food, shelter or money. During the needs and services task, players must identify the appropriate community services that can address the needs resulting from the situation. As such, learning is part of game flow.

After about four hours of game play, Jack Smith’s house catches fire. His neighbour – Dina Ali – tells all players via speech bubble “Jack’s house is on fire”, and asks “What should we do?” – as shown in Figure 3.22. As the question is asked in the context of a familiar and visible crisis, the task situates meaning. Chat is simultaneously opened for all players to encourage discussion, so that play involves collaboration. Furthermore, the fire intensifies until a player calls the fire station, after which players witness the fire brigade putting out the fire. As such, play involves feedback. This is shown in Figure 3.23.



Figure 3:22: Needs and services task 1-5



Figure 3:23: Needs and services task 2-5

As a result of the fire, Jack Smith has collapsed on the front lawn, and players are now told via speech bubble “Jack is injured” and asked “What should we do?” Jack remains on the front lawn until a player calls the hospital. When this happens, all players witness Jack being lifted into an ambulance that takes him to the hospital, see Figure 3.24.



Figure 3:24: Needs and services task 3-5

Finally, sometime later, Jack Smith leaves the hospital. He tells all players via speech bubble: “I have no food, shelter or money”, and asks “which services can give me free food?” A message appears on screen telling players to “click on the service that can help him” – see Figure 3.25 and Figure 3.26. All players must click on the soup kitchen. If this has not been done after one minute, further prompting happens via chat, informing the group which avatars still need to answer.

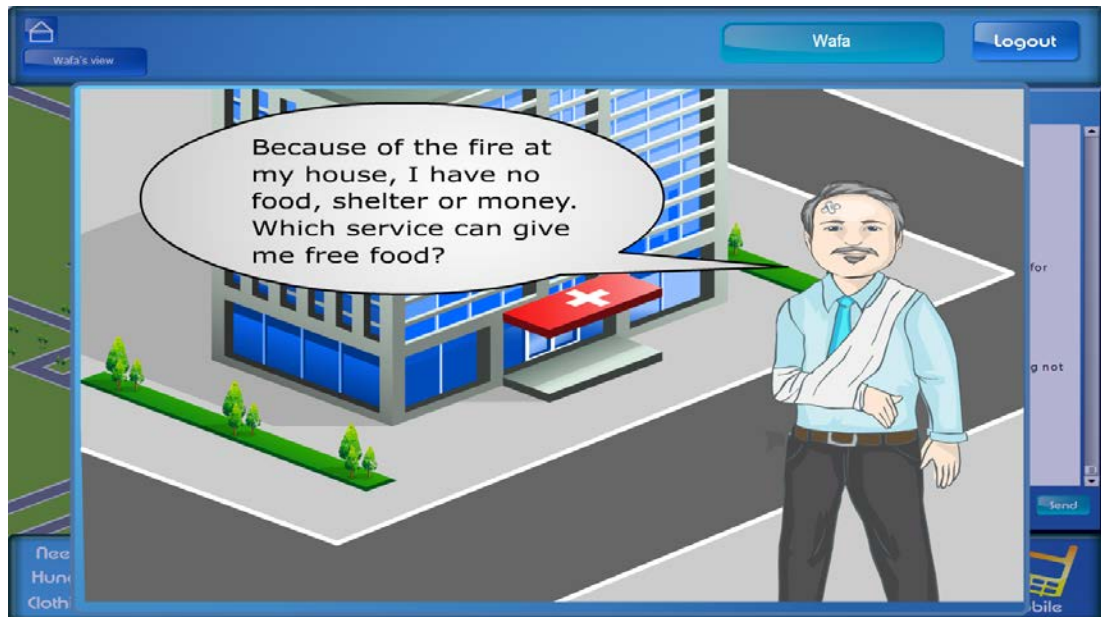


Figure 3:25: Needs and services task 4-5

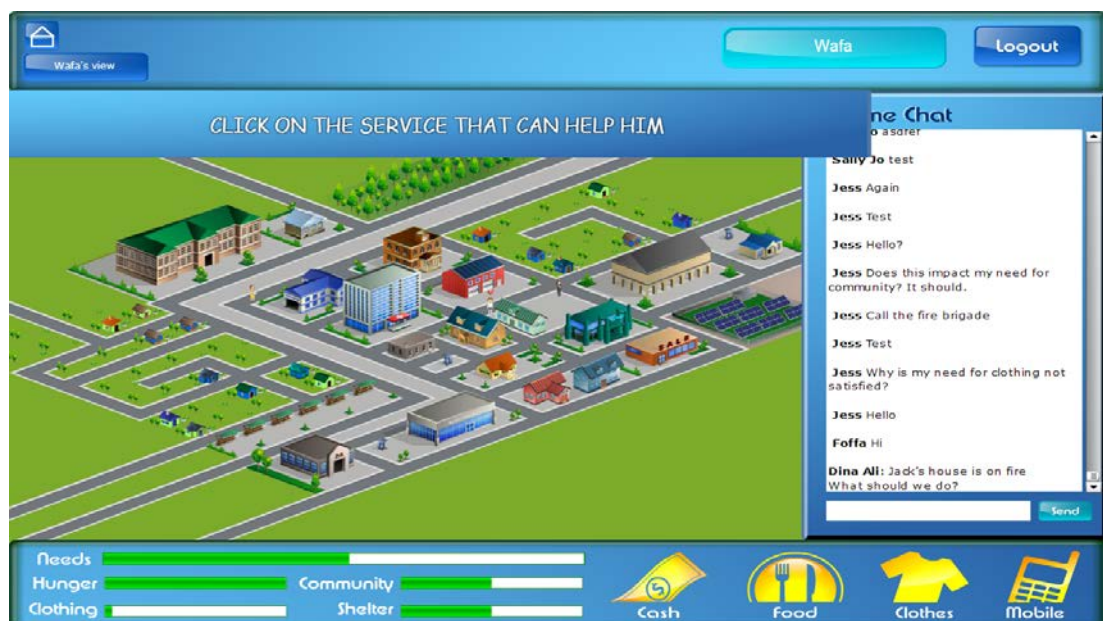


Figure 3:26: Needs and services task 5-5

When all avatars have clicked on the soup kitchen Jack says “Thank you! I am no longer hungry but still have no house”, and asks “Which service can give me shelter?” As with the soup kitchen, all players must click on the crisis housing. When this has happened, the task ends. The combination of engaging services to address needs, peer-to-peer support, clear instructions, and presentation of a series of crises to navigate, are designed to ensure this part of the game is perceived to be useful,

achievable and challenging. The chunking of information into each problem faced by Jack, discussion and action, also means the design of this task incorporates respect for cognitive load.

#### *3.3.1.4.1.3 Needs and wants*

##### **Syllabus outcomes addressed**

5. “Examines the goods and services provided within the community and by community organisations to meet needs” (Board of Studies NSW 1999, p. 110).

##### **Relevant activities undertaken**

At the start of the game, each player has \$800 in their bank account, enough to satisfy avatar needs and some wants in the early stages of game play, by making purchases in *GeoCity*. Players must examine goods and services in relation to needs and wants, and make choices about what to buy. Through these choices players have identity and agency, particularly via avatars. When purchased, sizeable furniture, electrical goods and sporting equipment are picked up at the store by a truck and delivered to avatars’ homes, as shown in Figure 3.27, to show how goods (the products bought) are connected to services (the delivery truck). These are components of a system providing goods and services and the activity shows users how the components interlink.



Figure 3:27: Delivering goods

Players are told what needs and wants are via computer controlled avatars. During game play Jack Smith asks “what are needs and what are wants? Jill Wallace replies: “a *need* is something that you have to have. A *want* is something you would like to have.” Jack Smith responds: “I want an Xbox but I don’t think I need one.” Jill Wallace replies: “Hunger is a need, so I should go to the supermarket to buy some food. What are some other needs and wants?” Screen shots of this process can be seen in Figures 3.28- 3.31.



Figure 3:28: Needs and wants task 1-4



Figure 3:29: Needs and wants task 2-4



Figure 3:30: Needs and wants task 3-4



Figure 3:31: Needs and wants task 4-4

As such, the design supports access to related resources and respects cognitive load, supporting achievability: the two computer-controlled characters are the resource, providing scaffolding by giving the player definitions and examples of needs and wants. This is consistent with both social constructivism and critical pedagogy. Players make choices about what to buy, and the conversation between computer-controlled avatars about the concept of needs and wants involves guidance rather

than instruction. Knowledge is also built via shared participation, rather than memorising validated truths, as chat is triggered during the task, prompting students to have a conversation about this topic and share their ideas. This can be seen in Figure 3.32. Furthermore, as the teacher is able to read and respond to chat, the design of this task supports teacher involvement.



Figure 3.32: Triggering students to chat about needs and wants

This task offers an immersive, realistic and complex environment and situates meaning. Players must choose what to buy and what not buy in the *GeoCity* world, weighing how choices relate to the satisfaction of avatars needs and wants. They must also respond to change. For example, when it snows, any avatar not wearing shoes, a jumper and long pants or a skirt says “I’m cold” and the indicator for clothing need satisfaction drops. An arrow points to this drop and a tip appears: “Wear clothes for cold weather to satisfy your need for clothing”, shown in Figure 3.33. So players are challenged to satisfy their avatar’s needs with respect to their changing situation, and doing so is useful, because it is a condition of game play. This is consistent with critical pedagogy, because it involves active learning, in which knowledge is built with regard to context. Furthermore, play involves feedback and learning during this task is part of game flow because it imbeds learning material in a player’s interactions with the game world. For example, when avatars choose their house they are also told that a house satisfies the need for shelter; when the needs of a player’s avatar have not been satisfied, they are told as

such, and an arrow appears on screen to indicate how the need can be satisfied; and if a player spends all their money satisfying wants, they will not be able to satisfy the needs of their avatar.



Figure 3:33: Guiding students to satisfy their need for clothing

Table 3.2 below summarises the design principles included in the goods, services and needs tasks.

Topic	Task	Design principles included in full
Goods, services and needs	Goods and services	<ul style="list-style-type: none"> <li>. Play involves collaboration (3)</li> <li>. Game play situates meaning (5)</li> <li>. Design respects cognitive load (6)</li> <li>. Offers an immersive, realistic and complex environment (7)</li> <li>. Design supports teacher involvement and access to related resources (9)</li> <li>. Play includes clear rules and objectives (10)</li> <li>. Play involves feedback (11)</li> </ul>
	Needs and services	<ul style="list-style-type: none"> <li>. Perceived to be useful, achievable and challenging (1)</li> <li>. Learning is part of game flow (2)</li> <li>. Play involves collaboration (3)</li> <li>. Game play situates meaning (5)</li> <li>. Design respects cognitive load (6)</li> <li>. Play involves feedback (11)</li> </ul>
	Needs and wants	<ul style="list-style-type: none"> <li>. Perceived to be useful, achievable and challenging (1)</li> <li>. Learning is part of game flow (2)</li> <li>. Players have identity and agency (4)</li> <li>. Game play situates meaning (5)</li> <li>. Design respects cognitive load (6)</li> <li>. Offers an immersive, realistic and complex environment (7)</li> <li>. Design supports teacher involvement and access to related resources (9)</li> <li>. Play involves feedback (11)</li> </ul>

Table 3.2: The design principles included in the goods, services and need tasks

#### 3.3.1.4.2 *Production and distribution*

##### **Syllabus outcomes addressed**

1. “Identifies the components of a system that provides goods and services and how the components need to interlink”.
5. “Examines the goods and services provided within the community and by community organisations to meet needs”.
6. “Makes statements about the social and environmental responsibilities of producers and consumers”.
10. “Investigates current community issues”.
11. “Investigates consumer rights and responsibilities” (Board of Studies NSW 1999, p. 110).

### **Relevant activities undertaken**

During game play, players watch, listen to and participate in the production and distribution of certain goods; tasks are triggered when they purchase these products. Specifically, when players buy bread and caged or organic eggs for the first time, they are transported from the supermarket or market garden to the farms and factories where the goods are produced, to watch and listen. In the case of organic eggs this also involves participation in production tasks. If, after a certain amount of time, players have not elected to buy these things, their avatar tells them they want bread or eggs from the supermarket, or eggs from the market garden. If this happens, players cannot take action unless it is steps to achieve these goals and triggering the associated task.

Being immersed in all the steps involved in bread, caged eggs and organic eggs production and distribution tasks enables the syllabus outcome: “makes statements about the social and environmental responsibilities of producers and consumers” (Board of Studies NSW 1999, p. 110). It stimulates thinking, acting and being in the game world, as players learn about the systems and then directly take part in them. The task has players choose whether to buy each product once they have knowledge about what is involved in production and distribution; this positions players as citizens with responsibility and choice, and means that these tasks support identity and agency, as well as situate meaning. Thus, reflection on the social and environmental responsibilities of consumers, will inform students’ decisions.

The production and distribution topic includes three tasks:

1. Bread
2. Caged eggs
3. Organic eggs

#### *3.3.1.4.2.1 Bread Task*

When a player buys bread, they are transported from the supermarket or market garden to watch and hear about bread production and distribution. This includes the main components of bread production and distribution, and how they interlink. The design supports access to related resources and offers an immersive, realistic and

complex environment as players click on the various steps involved. They watch and hear about wheat being planted, grown, harvested and moved to the flour mill; the milling process; flour being moved to the bread factory; and bread being made, packaged and moved to the supermarket. Screen shots of this process can be seen in Figure 3.34, and larger photos are included in Appendix E. These are a form of tutorial, prompted by players. As such, this task involves self-paced student inquiry. Players are also asked to put the steps involved in bread production and distribution into the correct order, dragging and dropping steps into a numbered list and working until they find the correct answers, in order to have \$50 paid to their avatar. There is no risk present during this task. Players just click buttons to watch and hear about each step in production and distribution and are presented with a table to drag and drop the steps in the correct order. This task does not provide any risk of failure at all, because correct answers are accepted, and incorrect answers are rejected. In other words, performance of this task treats failure as a way to receive feedback and try again. This, and the fact that players can move back and forth between the steps involved in bread production and distribution, ensures that play includes clear rules and objectives, and the task is perceived to be useful and challenging. Indeed, it also means the task design respects cognitive load and supports achievability. Arrows were included in the design, to indicate what to click on to access information or carry out the next step involved in production and distribution. In this way the task provides direct instructions to reduce cognitive load imposed by searching. To further reduce cognitive load, functionality and the user's interface are restricted to the events and tasks at hand.



Figure 3.34: Bread production and distribution task

Upon completion of the bread task, players are asked if they would still like to buy bread. By offering this choice after the learning content, players have identity and agency, particularly via avatars, and the task situates meaning.

#### 3.3.1.4.2.2 Caged eggs task

This same process occurs when players buy caged eggs, and the caged eggs task involves the same design principles as the bread task. However, the content includes the main components of caged eggs production and distribution, and how they interlink. Players have to move through a caged eggs factory, watching and listening to the steps involved in caged eggs production and distribution. These steps include:

- Beaks cut off

- Chickens put in cages
- Chickens given food and water
- Eggs collected
- Eggs washed
- Eggs packed
- Refrigerated
- Moved to supermarket

Players are again asked to put the steps involved in caged eggs production and distribution into the correct order, to have \$50 paid to their avatar. Finally, upon completion of the task, players are asked if they would still like to buy caged eggs. This learning task mirrors the design elements in the bread task. Screen shots of this process can be seen in Figure 3.35 and larger photos are included in Appendix F.

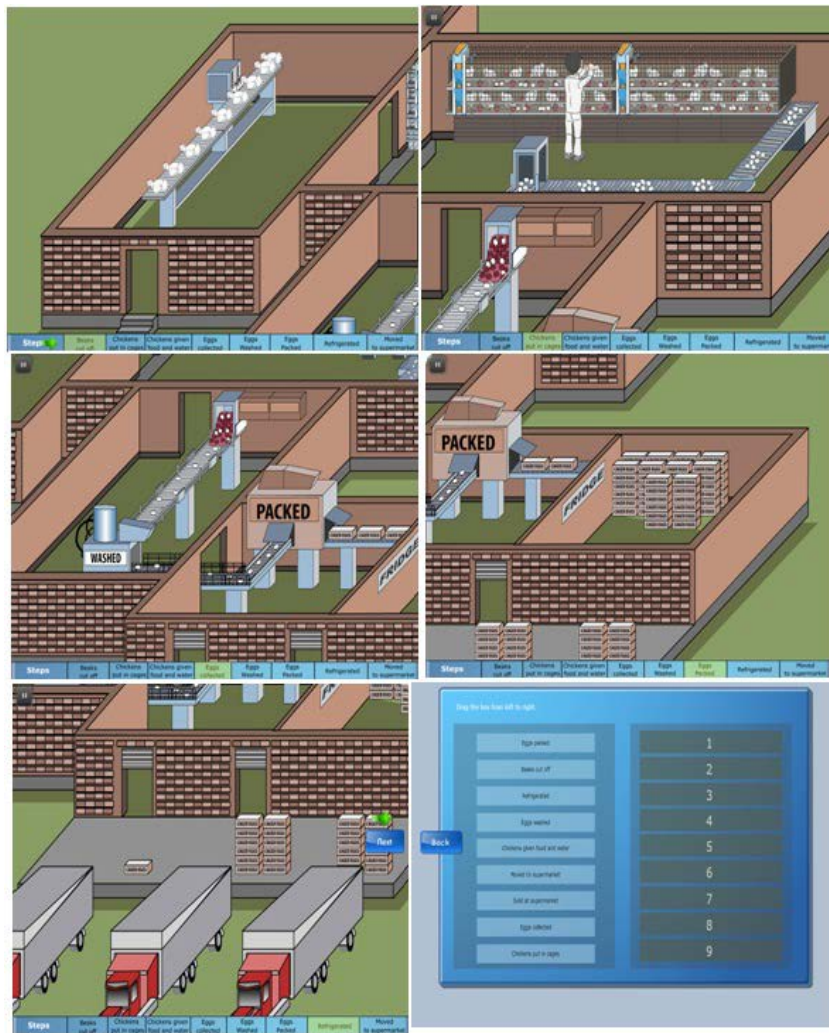


Figure 3:35: Caged eggs production and distribution task

### 3.3.1.4.2.3 Organic eggs task

A different process is triggered when a player buys organic eggs, though it still examines production and distribution. When a player tries to buy organic eggs for the first time, they are transported to a market garden farm to participate in the main components of the production and distribution of organic eggs. So this task offers an immersive, realistic and complex environment.

When players arrive at the farm, they are told: “Organic eggs come from free range chickens. That means the chickens can go outside during daylight hours.” Play includes clear rules and objectives, self-paced student inquiry, learning by doing and problem solving, as avatars are prompted to do the following:

- Let the chickens out of the chicken house

- Give the chickens water
- Feed the chickens
- Collect eggs from the chicken house
- Wash the collected eggs
- Pack the washed eggs into a carton

These activities are achieved by the avatar, controlled by a player, moving around the farm environment, and interacting with it. In this way players have identity and agency, and the task situates meaning. Furthermore, play involves feedback and learning is part of game flow, as players must carry out production activities and mistakes are treated as a way to gain feedback and adjust. Learning content is embedded in a situation that is uncovered through interactive game play; for instance, students have to let the chickens out before they can feed them in the yard. This demonstrates to students the steps involved in being an organic eggs farmer and the order in which they happen; that is, students interact with the learning content. This was also included in the game design with respect to the instructional theory of constructivism, as learning through these tasks is an active, contextualised, self-paced process.

The design of the organic eggs task also respects cognitive load. The number of steps involved in organic eggs production and distribution for this task takes into account the capacity of working memory, and is limited to the maximum recommendation of seven, plus or minus two, pieces of information. As with the caged eggs and bread tasks, arrows were also included to scaffold learning, and the user's interface is restricted to the task at hand to further reduce cognitive load.

Upon completion of the steps involved in organic eggs production and distribution, \$50 is paid to a player's avatar and they are asked if they would still like to buy organic eggs. This, together with the fact that the task includes scaffolding, ensures that this task is perceived to be useful, achievable and challenging. Screen shots of the process can be seen in Figure 3.36 and for bigger photos and more details see Appendix G.

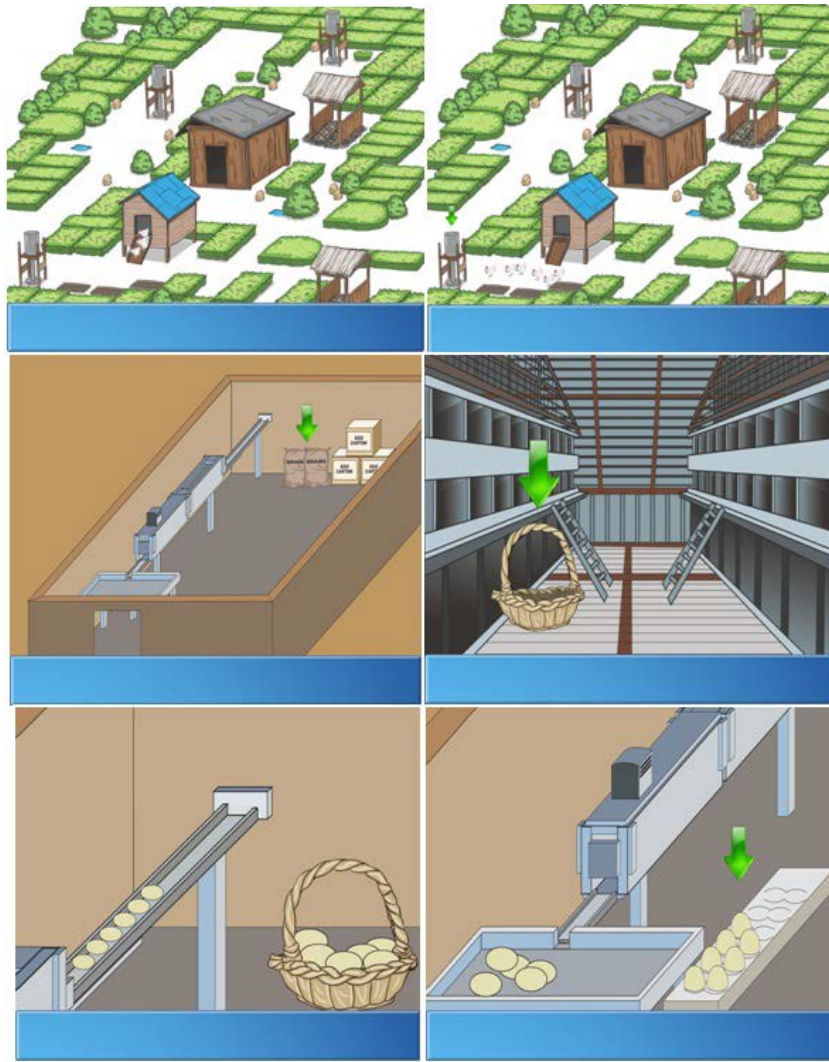


Figure 3.36: Organic eggs production and distribution task

Table 3.3 below summarises the design principles included in production and distribution task.

Topic	Task	Design principles included in full	Design principles included in part
Production and distribution	Bread	<ul style="list-style-type: none"> <li>. Perceived to be useful, achievable and challenging (1)</li> <li>. Players have identity and agency (4)</li> <li>. Game play situates meaning (5)</li> <li>. Design respects cognitive load (6)</li> <li>. Offers an immersive, realistic and complex environment (7)</li> <li>. Play includes clear rules and objectives (10)</li> <li>. Play involves feedback (11)</li> </ul>	<ul style="list-style-type: none"> <li>. Involves self-paced student inquiry (8)</li> <li>. Design supports access to related resources (9)</li> </ul>

Topic	Task	Design principles included in full	Design principles included in part
	Caged eggs	<ul style="list-style-type: none"> <li>. Perceived to be useful, achievable and challenging (1)</li> <li>. Players have identity and agency (4)</li> <li>. Game play situates meaning (5)</li> <li>. Design respects cognitive load (6)</li> <li>. Offers an immersive, realistic and complex environment (7)</li> <li>. Play includes clear rules and objectives (10)</li> <li>. Play involves feedback (11)</li> </ul>	<ul style="list-style-type: none"> <li>. Involves self-paced student inquiry (8)</li> <li>. Design supports access to related resources (9)</li> </ul>
	Organic eggs	<ul style="list-style-type: none"> <li>. Perceived to be useful, achievable and challenging (1)</li> <li>. Learning is part of game flow (2)</li> <li>. Players have identity and agency, particularly via avatars (4)</li> <li>. game play situates meaning (5)</li> <li>. Design respects cognitive load (6)</li> <li>. Offers an immersive, realistic and complex environment (7)</li> <li>. Involves self-paced student inquiry, learning by doing and problem solving (8)</li> <li>. Play includes clear rules and objectives (10)</li> <li>. Play involves feedback (11)</li> </ul>	

Table 3.3: The design principles included in production and distribution tasks

#### 3.3.1.4.3 *Technologies involved with monetary exchange*

##### Syllabus outcomes addressed

8. “Identifies the different technologies involved with monetary exchange”

(Board of Studies NSW 1999, p. 110).

##### Relevant activities undertaken

As part of game play, avatars must access money and use it to satisfy their needs and wants in the game world. Players must learn when, why and how to use different relevant technologies and services, available for avatar use in *GeoCity*, to succeed in the game. As such, this learning content ensures learning is part of game flow, and that the task situates meaning. Money can be withdrawn, bank balance checked, or PIN changed at the bank or one of three ATMs; goods can be bought in shops using cash or bank card, depending on what the shop accepts. Some shops allow the use of

cash or bank card, see Figure 3.37, while others allow cash only. As such, this task situates meaning and offers an immersive, realistic and complex environment.



Figure 3.37: Shop accepts cash or card

The development of the use and nature of money and how it may be accessed starts when, early in the first session of game play, each avatar receives a letter in the mail from the *GeoCity* bank manager with their personal identification number (PIN), as shown in Figure 3.38, prompting them to use an ATM in order to make purchases in *GeoCity*, as shown in Figure 3.39 and detailed in Appendix H.

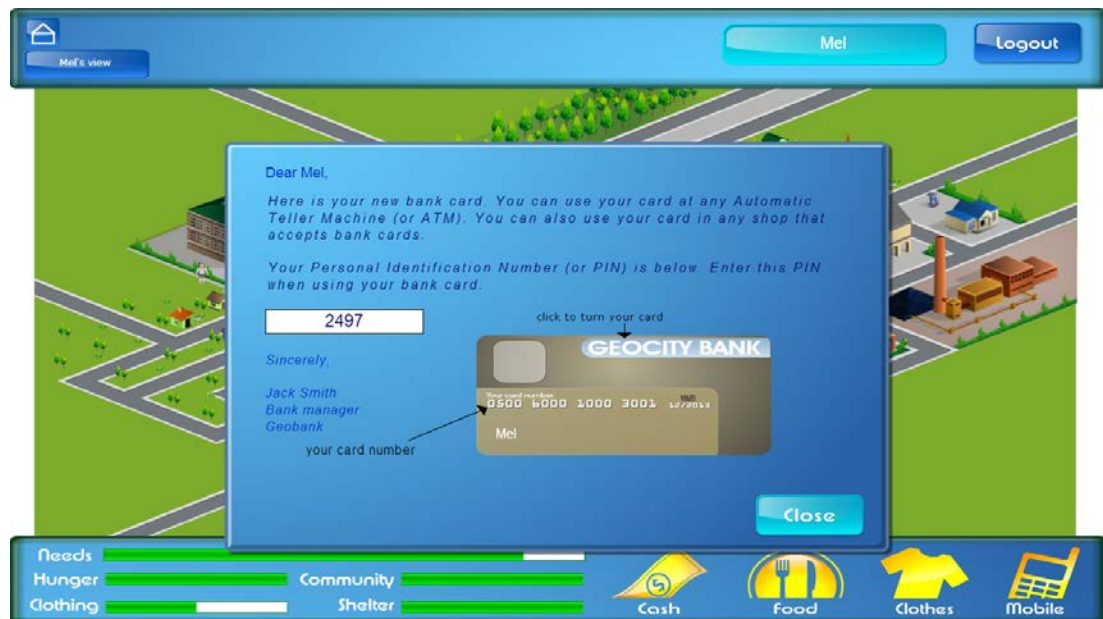


Figure 3:38: Letter with personal identification number task



Figure 3:39: Using an ATM

The first time players withdraw money it must come from the ATM, to ensure that all players practice the skill of using an ATM. The letter prompts this and the only interaction available with the bank until an ATM has been used is “Go here”. Once an avatar has used an ATM, they can go to the bank at any time during game play and “withdraw money” or “check balance” as shown in Figure 3.40.



Figure 3:40: Bank choices

This restriction on functionality coupled with instructions means that with the respect to the content to be learned, the design respects cognitive load.

Any money withdrawn from an ATM or the bank accrues in the avatar's cash inventory until spent. When purchasing goods in *GeoCity*, players must choose to spend this cash or use their bank card, as shown in Figure 3.41. If cash is chosen, cash inventory is depleted by the correct amount. If bank card is chosen, a bank card machine appears on screen, as shown in Figure 3.42 and players must correctly enter their avatar's PIN.

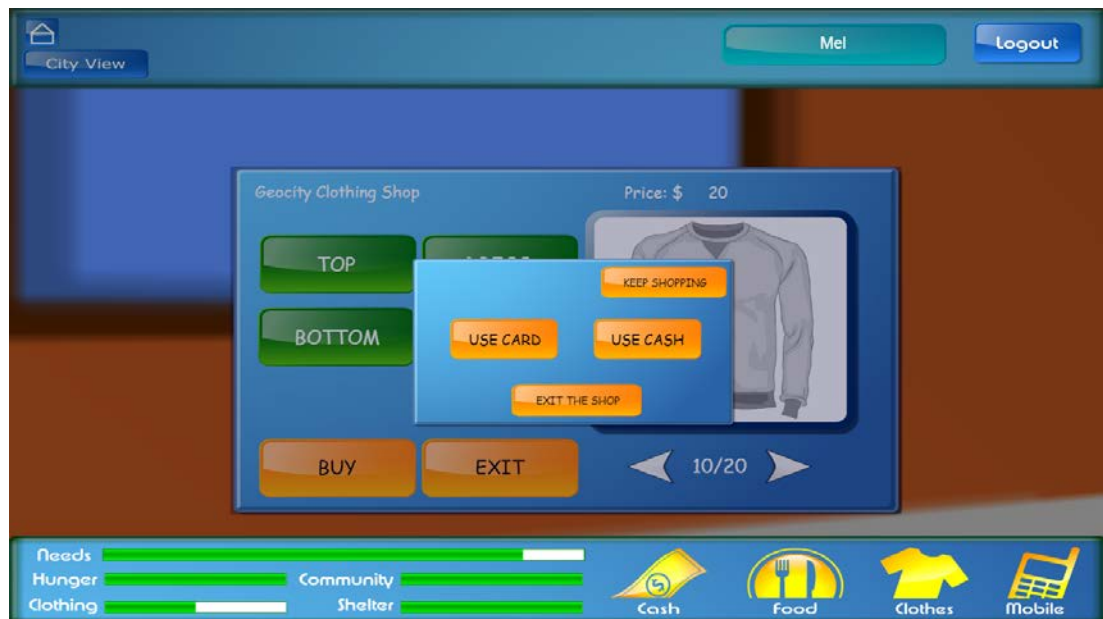


Figure 3:41: Choosing between cash or card

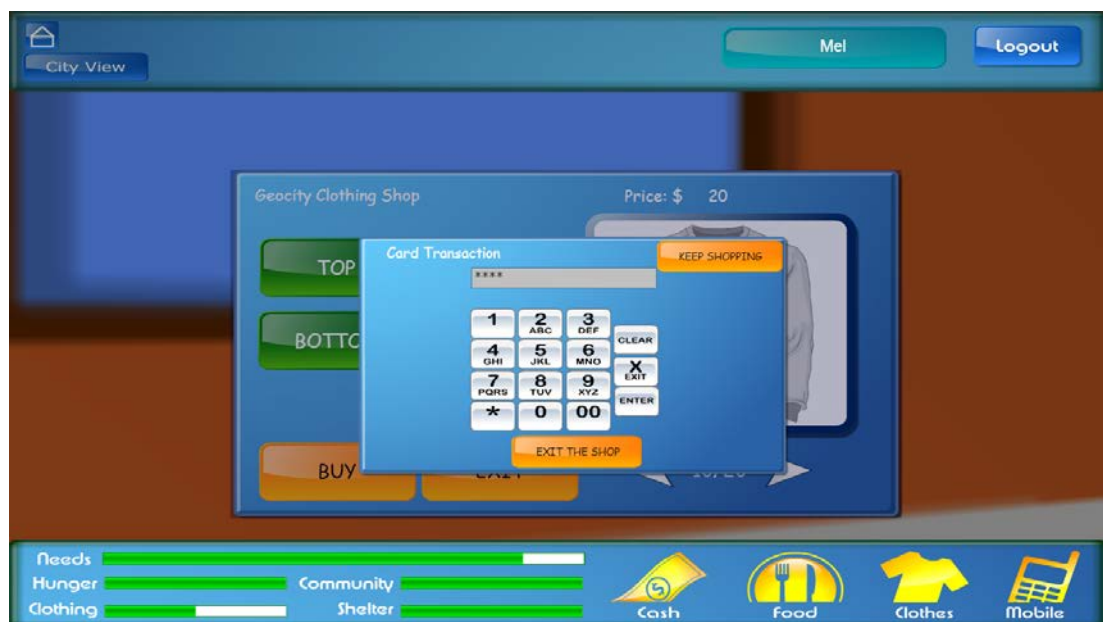


Figure 3:42: Bank card machine

Thus, players learn about technologies involved with monetary exchange via participation in the use of an ATM and bank to withdraw money, check bank balance and change their card's PIN number in their own timeframe. They also learn about different payment methods when they use them to purchase goods, cash or bank card,

so learning is part of game flow. Successful use of a technology means access to money, and unsuccessful use of a technology provides an opportunity to learn from mistakes and try until it works. As such, play involves regular feedback, self-paced student inquiry, learning by doing and problem solving, and can be perceived to be useful, achievable and challenging. Furthermore, prompted by the need to use technologies involved with monetary exchange to satisfy avatar needs and wants, when and which technologies are used is a choice, so players have identity and agency. Table 3.4 below summarises the design principles included in technologies involved with monetary exchange activity.

Topic	Task	Design principles included in full
Technologies involved with monetary exchange		<ul style="list-style-type: none"> <li>. Perceived to be useful, achievable and challenging (1)</li> <li>. Learning is part of game flow (2)</li> <li>. Players have identity and agency (4)</li> <li>. Game play situates meaning (5)</li> <li>. Design respects cognitive load (6)</li> <li>. Offers an immersive, realistic and complex environment (7)</li> <li>. Involves self-paced student inquiry, learning by doing and problem solving (8)</li> <li>. Play involves feedback (11)</li> </ul>

Table 3.4: The design principles included in technologies involved with monetary exchange task

#### 3.3.1.4.4 *Consumer rights*

##### **Syllabus outcomes addressed**

11. “Investigates consumer rights and responsibilities” (Board of Studies NSW 1999, p. 110).

##### **Relevant activities undertaken**

Players learn about consumer rights when they purchase items during game play – either from the supermarket, clothing, furniture, electrical or sporting equipment shop – that are faulty. They learn about their rights as a consumer in response to this, by exercising them via their avatar.

During game play, players discover that two items they have purchased have a problem. This is discovered immediately after they purchase said items, situating meaning. For this task, learning is uncovered by living the phenomena of a story.

When players purchase each of these two items they are told the item is off, broken or torn, and that they can act to redress this, setting up the challenge of this task. Related prior knowledge is incorporated via some of the content of this task already being familiar to players. The design of this task also respects cognitive load, supports achievability and includes clear rules and objectives, as players are supported and instructed through the process:

“If there is a problem with something you buy, the shop it came from must do one of three things:

- Fix it
- Replace it
- Refund your money

“Just go to the shop you bought it from and return the item. You can then choose what to do. These are your rights as a consumer.”

This is shown in Figure 3.43.

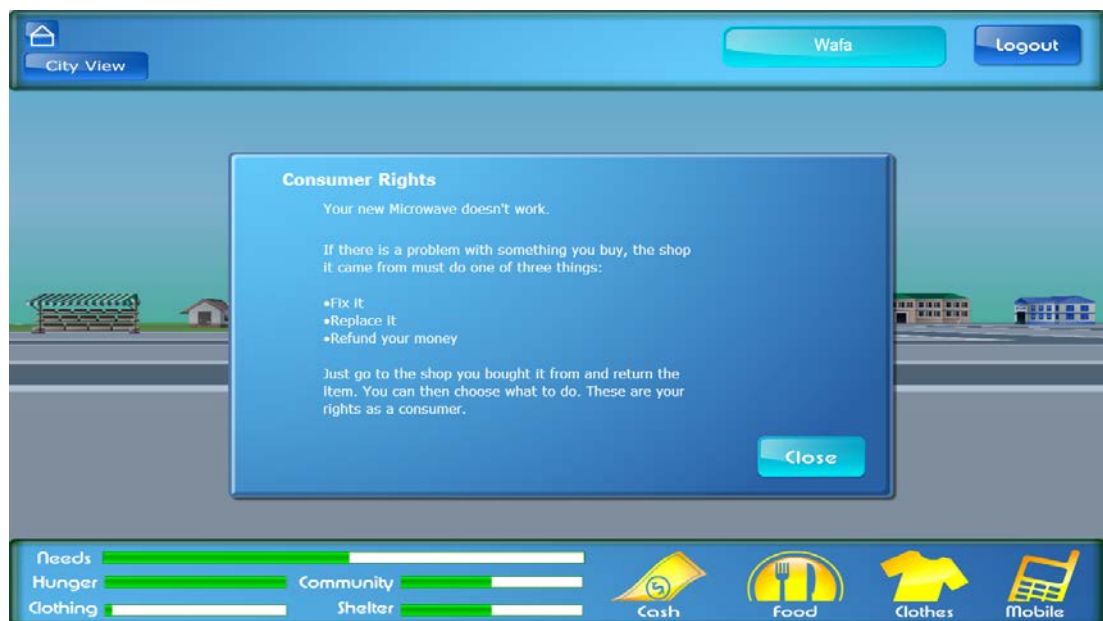


Figure 3:43: Consumer rights notice

At the shop the item came from, the interaction “return an item” becomes available. If players select this option they are asked:

“What would you like the shop to do?

- Fix it
- Replace it
- Refund your money”.

This is shown in Figure 3.44.



Figure 3.44: Exercising consumer rights

Players simply choose from the three options and the elected one happens, so that the task incorporates feedback and is useful for advancing game play. In this way, syllabus content is integrated into the mechanics of game play – making learning part of game flow. Furthermore, the task to exercise consumer rights is combined with making choices, ensuring that players have identity and agency and that the task involves learning by doing. Table 3.5 below summarises the design principles included in the consumer rights topic.

Task	Design principles included in full	Design principles included in part
Consumer rights	<ul style="list-style-type: none"> <li>. Perceived to be useful, achievable and challenging (1)</li> <li>. Learning is part of game flow (2)</li> <li>. Players have identity and agency (4)</li> <li>. Game play situates meaning (5)</li> <li>. Design respects cognitive load (6)</li> <li>. Play includes clear rules and objectives (10)</li> <li>. Play involves feedback (11)</li> </ul>	<ul style="list-style-type: none"> <li>. Involves learning by doing (8)</li> </ul>

Table 3.5: The design principles included in the consumer rights task

### 3.3.1.4.5 Coal or solar power

#### Syllabus outcomes addressed

2. “Examines a variety of systems that have been designed to meet needs in communities and identifies the advantages and disadvantages of their use”.
5. “Examines the goods and services provided within the community and by community organisations to meet needs”.
9. “Explain the processes involved in civic action within the community”.
10. “Investigates current community issues” (Board of Studies NSW 1999, p. 110).

#### Relevant activities undertaken

After about 90 minutes of game play, the *GeoCity* coal-fired power plant breaks down and needs to be replaced. The immediate consequence of this is that the electricity in *GeoCity* stops working. Players are told by mail that a town meeting has been called, and to go to the Town Hall immediately, as shown in Figure 3.45.



Figure 3:45: Notification of town meeting

Once all players have arrived at the Town Hall, the meeting starts. Avatars are welcomed to the meeting by the mayor of *GeoCity*, who outlines what will happen next. Here, play includes clear rules and objectives: the mayor explains that the old

power plant must be replaced, that citizens must decide what to replace it with, and that during the meeting avatars will:

- Hear an expert on coal and solar power talk about the economic, environmental and social impact for each technology, a current community issue.
- After the expert's talk, discuss with each other which of the two should be built in *GeoCity*.
- Vote to determine what is built.

The information presented by the expert about coal and solar power during this task provides access to related resources and supports achievability. The number of chunks of information is limited to seven: the cost to build, the cost to operate, the amount of fuel, whether it is renewable or non-renewable, and the environmental, and climate and health impacts. The user's interface is also restricted to the task at hand. As such, the design of this task respects cognitive load. Screen shots of this process can be seen in Figure 3.46 and for bigger photos and more details see Appendix I.

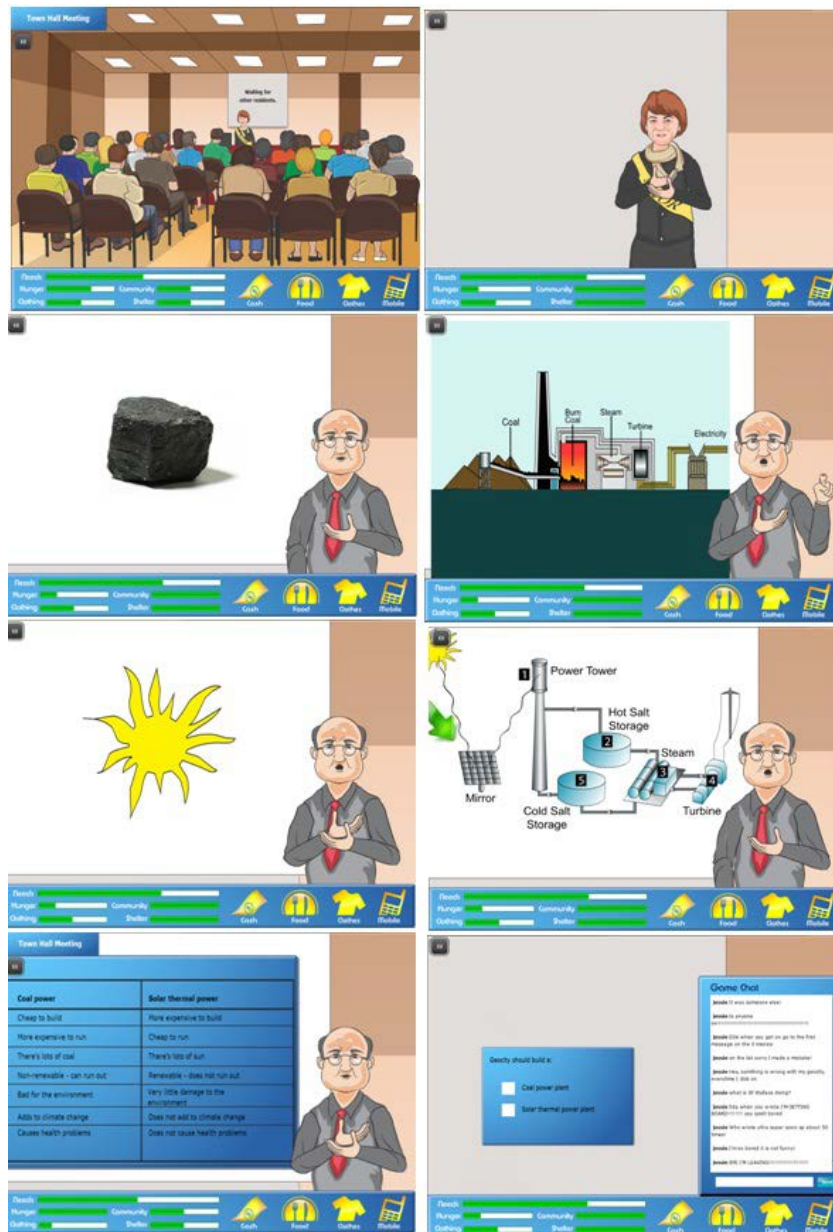


Figure 3:46: Electricity task

The mechanics of this learning experience ensure players have identity and agency and that play involves collaboration, when players are prompted to discuss their thoughts on coal and solar power. The task only concludes through shared participation in the vote in which each individual must make a choice. This was included on the understanding that learning improves when people collaborate and become an essential part of a social group. This task employs a key recommendation from the literature review: needing to solve tasks in collaboration with peers to achieve game goals. Furthermore, when avatars leave the meeting, the new power

plant selected replaces the old, so learning is part of game flow and play involves feedback.

This task situates meaning and stimulates thinking, acting, and being in the game world, incorporating usefulness and challenge. Through living the phenomena of a story, players learn about the syllabus outcomes targeted. The focus of this task is not on content, but on a content rich experience, which offers an immersive, realistic and complex environment. Table 3.6 summarises the design principles included in the coal or solar power task.

Topic	Task	Design principles included in full
Coal or solar power		<ul style="list-style-type: none"> <li>. Perceived to be useful, achievable and challenging (1)</li> <li>. Learning is part of game flow (2)</li> <li>. Play involves collaboration (3)</li> <li>. Players have identity and agency (4)</li> <li>. Game play situates meaning (5)</li> <li>. Design respects cognitive load (6)</li> <li>. Offers an immersive, realistic and complex environment (7)</li> <li>. Design supports teacher involvement and access to related resources (9)</li> <li>. Play includes clear rules and objectives (10)</li> <li>. Play involves feedback (11)</li> </ul>

Table 3:6: The design principles included in the coal or solar power task

### 3.3.2 PHASE TWO: DATA COLLECTION AND ANALYSIS

This section outlines the data collection and analysis techniques necessary to evaluate students across the categories of student learning of NSW Stage Two Human Society and its Environment (HSIE) syllabus outcomes, motivation to learn and critical thinking, as well as how the video game impacted these outcomes. This required multiple data sources, and data storage and analysis techniques, appropriate to the research, which are detailed here. Finally, the ethical considerations and the measures employed to ensure trustworthiness of the study are detailed in this section.

#### 3.3.2.1 Data collection

Phase Two involved the development of appropriate data collection techniques, comprising:

1. Log of video game play
2. Pre/post test of student knowledge (worksheets)
3. Pre/post test of student motivation to learn and critical thinking (questionnaire)
4. Pre/post interview with teacher
5. Interviews with focus group
6. Observation
7. Log of video game chat

All of the above sources were designed to respond to the research questions. The pre/post test of student knowledge (worksheets) was designed to measure student syllabus knowledge before and after use of *GeoCity*. The pre/post test of student motivation to learn and critical thinking (questionnaire) was designed to measure motivation to learn and critical thinking before and after use of *GeoCity*. Other data collection sources were designed to triangulate *in what ways* and *how* use of the video game impacted these outcomes.

The purpose and use of the data collection instruments are summarised below.

#### **3.3.2.1.1 *Log of video game play***

A log of video game play was collected to record student performance while using *GeoCity*. This was included in the back-end design of the game. It recorded individual student participation in all video game tasks: goods and services, needs and services, needs and wants, bread, cages eggs, organic eggs, technologies involved with monetary exchange, consumer rights and coal or solar power. It was included to enable the examination of changes to syllabus outcomes, motivation to learn and critical thinking, in the context of actual participation, as recorded in the log. The log of video game play was intended to provide both expected and unexpected information to help answer the research questions.

### **3.3.2.1.2 *Pre/post test of student knowledge (worksheets)***

Worksheets were designed to gauge student knowledge of the unit outcomes covered by *GeoCity* topics before intervention, and provide evidence of changes to student knowledge after the intervention. They were designed based on the HSIE syllabus outcomes for the Stage Two unit “Who Will Buy?” and included questions, charts, lists, descriptions, categorisations and opinion formulations. The worksheets were developed to be applied twice: first before using the video game and second on completion of the video game. A comparison of pre-test and post-test worksheets was designed to inform the researcher to what extent the video game supports geography outcomes specified by the NSW syllabus. However, this data source was not designed to explore the ways in which the video game supported syllabus outcomes. Other data sources were designed to help answer *in what ways* the video game supports students’ development of syllabus knowledge.

The worksheets were also designed by topic, a worksheet for each, so that students’ results could be examined by topic and in relation to particular *GeoCity* tasks. The worksheets and worksheets with ideal responses are included in Appendices J and K.

### **3.3.2.1.3 *Pre/post test of student motivation to learn and critical thinking (questionnaire)***

A verbal questionnaire was designed to measure student motivation to learn and critical thinking before and after the intervention. It was developed to be applied twice with the focus group: first before video game use in the classroom, and second following video game use in the classroom.

The design of the questionnaire was based on the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich, Smith, Garcia & McKeachie 1991). The MSLQ instrument is standardised and includes 81 questions in a Likert-type self-report format. It has been used by hundreds of researchers to measure motivation and learning strategies (Duncan & McKeachie 2005). The MSLQ was designed for university students, so the questionnaire was modified for this study to suit the research question and the age of the students. This included reducing the number of questions from 81 to 30, simplifying language, modifying the Likert-type scale from

seven to three items, and making it a verbal rather than written questionnaire. In addition, only four of the nine categories to measure learning strategies were retained: those that specifically related to critical thinking. The six defined motivation subscales – intrinsic goal orientation, extrinsic goal orientation, task value, control of learning beliefs, self-efficacy for learning and performance, and text anxiety – and four learning strategy subscales – rehearsal, elaboration, critical thinking and metacognitive self-regulation – are defined in Tables 3.7 and 3.8 below.

<b>Motivation Subscales</b>		
1	Intrinsic goal orientation	Intrinsic motivation stems primarily from internal reasons such as interest, enjoyment, challenge, mastery and curiosity (Chyung, Moll & Berg 2010; Pintrich & De Groot 1990) and leads to a focus on learning and mastery (Duncan & McKeachie 2005).
2	Extrinsic goal orientation	Extrinsic goal orientation stems primarily from external reasons such as grades, competition, approval or reward (Duncan & McKeachie 2005; Chyung, Moll & Berg 2010) and generally involves surface-level processing strategies such as memorisation or guessing (Chyung, Moll & Berg 2010).
3	Task value	Task value refers to student judgement of how interesting, useful, and important the content is (Duncan & McKeachie 2005; Pintrich et al. 1991).
4	Control of learning beliefs	Control of learning beliefs refers to students' perceived control over learning outcomes and causal factors; that is, the belief that outcomes depend on effort, rather than external factors (Duncan & McKeachie 2005; Pintrich et al. 1991). This belief often comes with increased satisfaction and greater engagement in self-regulated learning (Pintrich 2003).
5	Self-efficacy for learning and performance	Self-efficacy for learning and performance refers to a students' expectancy for success in performing a specific task (Duncan & McKeachie 2005). It counters anxiety about the task and is situational in nature rather than a stable trait (Linnenbrink & Pintrich, 2002).
6	Test anxiety	Text anxiety stems from students' concern over taking exams (Duncan & McKeachie 2005) and negatively effects academic performance (Pintrich & De Groot 1990).

Table 3.7: Motivation subscales measured by the questionnaire

<b>Learning Strategy</b>		
1	Rehearsal	Rehearsal activates short-term memory and is the most basic strategy used to process information (Paulsen & Gentry 1995). It involves practice such as repeating learning content over and over to oneself to help recall the information (Duncan & McKeachie 2005; Pintrich & De Groot 1990).
2	Elaboration	Elaboration refers to establishing connections across learning content and activating long-term memory (Paulsen & Gentry 1995). It involves strategies such as generative note-taking, paraphrasing, summarising and creating analogies (Pintrich et al. 1991).
3	Critical thinking	Critical thinking refers to the degree to which students apply previous knowledge to new situations to solve problems, make decisions or critically evaluate ideas (Duncan & McKeachie 2005; Pintrich et al. 1991). It is the process of identifying questions about knowledge, contextualizing them, and engaging in cycles of understanding, testing, evaluation and reflection (Freire 1972). It is “not the intellectual reproduction of what already exists” (Adorno 1998, pp. 291-292), but is situated in dialogue and the construction of new knowledge (Daniel & Gagnon 2011).
4	Metacognitive self-regulation	Metacognitive self-regulation refers the use of critical strategies by students to monitor, control and regulate their own learning and behaviours (Duncan & McKeachie 2005). It can involve planning, goals, monitoring, and regulating or adjusting one’s own learning (Duncan & McKeachie 2005).

Table 3.8: Learning strategy subscales measured by the questionnaire

The motivation and learning strategy subscales were included to allow the researcher to not only measure changes from pre to post intervention, but to also analyse the nature of students’ motivational beliefs and learning strategies in relation to critical thinking. Some motivational beliefs contribute more strongly to deeper cognitive processing than others. For example, Duncan and McKeachie (2005, p. 118) explain that “students with positive motivational beliefs such as holding intrinsic goals for learning, high self-efficacy and task value, and lower levels of test anxiety tend to engage in deep-processing strategies and metacognitive regulation, compared to students with less adaptive motivational beliefs”. Test anxiety in particular, while a motivating factor, can negatively affect learning performance because a focus on taking exams leads to more rote-focused learning (Pintrich & De Groot 1990). Similarly, for the learning strategies subscales, the questionnaire was designed to measure students’ use of rehearsal when learning (repeating and memorising), though this is considered the most basic strategy for processing information (Duncan

& McKeachie 2005). The three additional subscales – elaboration, critical thinking and metacognitive self-regulation – reflect progressively more complex cognitive strategies.

The questionnaire was designed to be scored by assigning one point to all negative answers, two points to all neutral answers and three points to all positive answers, and converted to percentages for the purpose of analysis. Eighteen questions measure motivation to learn; as such, the lowest possible score is 18, a neutral score is 36 and the highest possible score is 54. As 18 is the lowest possible score it was ascribed a value of 0% and as 54 is the highest possible score it was ascribed a value of 100%. The same process was ascribed for calculating critical thinking, for which 12 questions were included. So the lowest possible score is 12, a neutral score is 24 and the highest possible score is 36. As 12 is the lowest possible score it was ascribed a value of 0% and as 36 is the highest possible score it was ascribed a value of 100%.

The questionnaire was designed to be conducted:

- verbally by the researcher with each of the six students in the focus group; and
- before using the video game and on completion of the video game, to show the extent to which the video game, as a method of instruction, impacted motivation to learn and critical thinking.

The questionnaire was designed to tell the researcher to what extent the video game supported motivation to learn and critical thinking. It was not designed to explore *how* use of the video game motivated learning and critical engagement. Other data sources were designed to help to answer *how* the video game supported students' motivation to learn and critical thinking.

The modified MSLQ questionnaire and marking matrix is included in Appendix L.

#### ***3.3.2.1.4 Pre/post interview with teacher (visual and audio recordings and researcher notes)***

Pre/post semi-structured interviews with the teacher were designed to be applied twice: once before video game use in the classroom and once after video game use in the classroom. The interviews were designed to gauge the teacher's impressions of focus group students' critical thinking, motivation to learn and performance in Stage Two geography, so that the researcher could:

- explore the relationship between these factors and use of the video game; and
- uncover how the intervention impacted these outcomes.

The researcher planned to ask the teacher the research questions directly, and then discuss the evidence that led the teacher to their conclusions. To gain detail about the teacher's impressions of how and the ways in which the game supported students to meet the syllabus outcomes, and motivate learning and critical thinking, the classroom teacher would also be asked:

- Whether each student in the focus group was meeting Stage Two geography outcomes, motivated to learn and thinking critically, before and after implementation, and the basis of these assessments
- The ways in which pre-game methods of instruction supported these outcomes compared with the principles employed in the video game, respectively

As such, the interview was designed to be applied to gain a holistic response from the teacher, who worked with the students before, during and after video game use, to provide important data to answer both research questions.

The questions included in the pre/post semi-structured interview are included in Appendix M.

#### ***3.3.2.1.5 Interviews with focus group (researcher guidance and notes and visual and audio recordings)***

Group interviews offer data that is consistent with a critical and social constructivist framework, in that they offer collective student understandings of the impact of the video game. Interviews with students bring student perceptions and voice into research, a consideration often missing in the introduction of e-learning, according to Beavis, Muspratt and Thompson (2015). Interviews also provide information that

written responses cannot, through registering the tone of voice, facial expressions and attitude of respondents (Bell 2010, p. 161). The Assessment Reform Group (1999, p. 8) asserts that learning be identified through discussion, particularly when learners' work and reasoning are described.

Group interviews also have advantages; they enable discussions to develop, generating wide ranging responses, and they are often less intimidating and quicker than individual interviews, minimising disruption and providing better responses (Cohen, Manion & Morrison 2000). Encouraging students to express themselves clearly and taking care to minimise researcher influence on student responses (Creswell 2007) were considered by the researcher before implementation.

Given the young age of the participants, reducing intimidation was imperative to the way interview data was collected. Group size was considered an issue for interviews because "too few can put pressure on individual and too large can fragment the group and lead to less focus" (Cohen, Manion & Morrison 2000, p. 287). Lewis (1992 in Cohen, Manion & Morrison 2000) considers six students to be the optimum size.

As such, focus group interviews with the six focus group students were designed to provide answers to both asked and unasked questions and collect information about the students' experiences with *GeoCity*. The interviews were planned to take place immediately after each in-class video game play session and interview questions were designed to gauge student learning, critical thinking and motivation to learn, and how the video game impacted these outcomes. The questions include:

1. What did you learn today?
  - a. What in the game helped you learn this?
  - b. Do you want to learn more about this? Why?
  - c. Do you have any questions or ideas about this? Is it true? Why?
2. Did you forget about time passing while playing the game today?
3. Was the game hard or easy or just challenging enough today? Did you feel bored at all? Did you feel nervous while playing at all?

4. Did you feel involved in the game? Did you feel in control while playing the game?
5. Did you talk to other students while playing the game today? Why?

The interviews were designed to focus discussion on each learning task. For each task, evidence of the relevant syllabus outcomes would be graded on the Board of Studies NSW's A-E grade scale. Evidence of motivation to learn or critical thinking across all learning topics would be measured against the respective subscales. However, in designing the interviews, it was understood that if the students directed discussion to a topic other than the video game or course content, it could have value. As such, the questions were designed to be open-ended, to be asked after each session of video game play.

All interviews were planned to be digitally recorded, then transcribed to capture, sort and report all responses accurately, to be available for checking again as required (Bell 2010; Kervin et al. 2006; Noor 2008). An interview schedule of fixed times and location was prepared to ensure interviews without interruption (Bell 2010, p. 173).

#### ***3.3.2.1.6 Observation (visual and audio recordings during implementation)***

Methods of observation can range across a sequence (Creswell 2003; Merriam 1998). Based on Merriam's (1998) description, Figure 3.47 illustrates the sequence of positions a researcher can assume when entering the field as an observer. Adjacent elements are similar but the extremes are quite different.

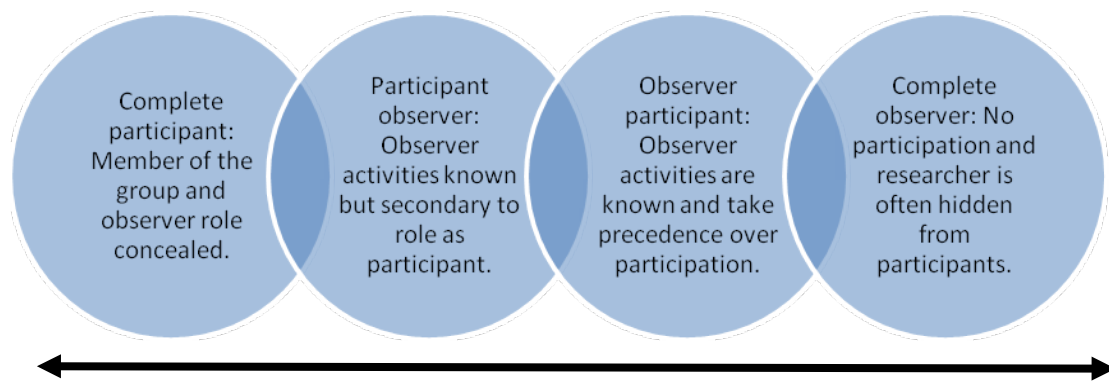


Figure 3:47: Observer Sequence

Merriam (1998) warns that the mix of participation and observation may change as the researcher becomes more familiar with the phenomenon being studied. This was the case with this study.

In observation involving researcher participation, the researcher needs to spend a substantial amount of time in the field for months or even years in order to be accepted as one of the group (Bell 2010, p. 193). So, due to the short time of this intervention, the researcher planned to take on the role of a complete observer, hidden from participants, and observe visual and audio recordings of classroom use of the video game to further recognise learning, critical thinking and motivation to learn (Assessment Reform Group 1999, p. 8) and as a way to gain information not accessible through other means, for example to confirm whether students acted as they described themselves acting (Bell 2010; Cohen, Manion & Morrison 2000; Noor 2008). The researcher planned to take video and audio recordings of all classroom geography sessions over a seven-week period. The video recording equipment would be set up at opposite corners of the classroom to gain multiple wide-angle views and audio recording equipment would be placed throughout the room. The recording equipment would be set up and used throughout implementation.

After recordings were taken, the researcher planned to observe and analyse the video and audio recordings to provide further understandings and evidence to answer the research questions, adopting a combination of structured and unstructured observation. In this way, the researcher intended to avoid one of the drawbacks of

structured observation, that structured analysis includes bias (Bell 2010, p. 195). Further, it would enable a flexible approach whereby new information can be probed (Merriam 1998).

Observation was designed to be conducted using a guide covering the context and experience of the intervention. This guide prompts descriptions of important outcomes and the factors that lead to them, with space for unexpected outcomes and observations of contributing factors. As such, the guide would be used to lead – though not limit – observation notes. The guide is included in Appendix N.

#### **3.3.2.1.7 Log of video game chat**

A log of video game chat was set up to collect to record what students' chatted about while playing the game. It was intended to provide both expected and unexpected information to answer research questions. This was included in the back-end design of the game. This was set up to uncover, for example, whether students actively sought syllabus content within the game world, and whether or not they showed any motivation or critical thinking via comments while playing the game.

#### **3.3.2.2 Implementation plan**

The classroom teacher and all of the Year Three class agreed to take part in the research study. The implementation plan – including use of the video game as a method of instruction and the data collection procedures as outlined in this chapter – is outlined in Table 3.9 below in the order in which they occurred.

<b>Tasks</b>	<b>Duration (all in school time)</b>
Conduct <b>pre-interview with the teacher</b> and provide access to the video game.	30 mins
Give the teacher instruction on the video game and worksheet. Withdraw six focus group students from class to conduct individual verbal questionnaires ( <b>pre-test of student motivation and critical thinking</b> ).	30 mins 15 mins per student
Teacher <b>issues worksheet (pre-test of student knowledge)</b> to whole class.	40 mins
Conduct four video game sessions with whole class. Withdraw focus group students from class after each video game session to	70 mins x 4 20 mins x 4

<b>Tasks</b>	<b>Duration (all in school time)</b>
conduct <b>semi-structured focus group interviews</b> , to gauge student learning, critical thinking and motivation to learn and how the video game impacted these outcomes. <b>Post interview with the teacher.</b>	30 mins
Teacher issues worksheet ( <b>post-test of student knowledge</b> ) to whole class. Withdraw six focus group students from class to conduct individual verbal questionnaires ( <b>post-test of student motivation and critical thinking</b> ).	40 mins  15 mins per student

Table 3.9: Implementation plan

### 3.3.2.3 Analysis techniques

Data storage and analysis techniques appropriate to the research context are outlined below. Case study research involves the “ongoing examination and interpretation of the data in order to reach tentative conclusion[s]” (Hancock & Algozzine 2006, p. 56), so a data analysis spiral was considered appropriate. This is illustrated here (see Figure 3.48), based on a process put forward by Creswell (2002) to allow for cycles of analysis and understanding, interpretation of findings in their context and evaluation and adaptation of conclusions. It was designed to cycle through three phases, adopted by this study: familiarisation with the data, categorisation of the data and synthesis of the data.

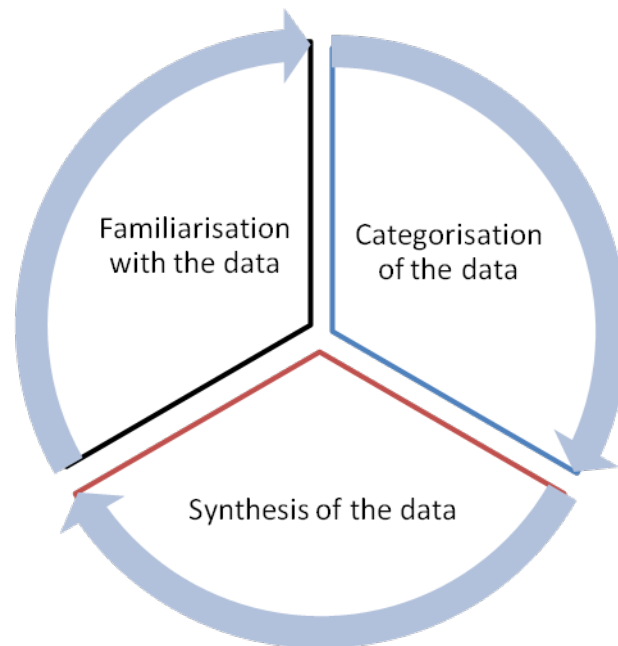


Figure 3:48: The data analysis spiral

#### 3.3.2.3.1 *Familiarisation with the data*

The researcher planned to conduct a process of familiarisation and storage as data was collected. Audio and visual recordings, and scanned copies of worksheets, questionnaire results, researcher notes and records of video game play would be organised into folders by source and date. All audio recordings would be transcribed and filed by source and date. The artefacts and data would be saved on the researcher's computer and an external driver, as well as stored in hard copy. The purpose of recording and storing data is to ensure the validity and accuracy of the information, the integrity of the research and to make it "easily retrievable" (Merriam 1998, p. 194).

The researcher planned to watch, listen to and read data multiple times throughout and post implementation, to gain strong familiarity, develop a sense of the data as a whole and discover emerging themes, as recommended by Kervin et al. (2006). This was been planned in line with theoretical sensitivities, or the

... personal quality of the research. It indicates an awareness of the subtleties of meaning of data ... It refers to the attribute of having insight, the ability to give meaning to data, the capacity to understand, and capacity to separate the pertinent from that which isn't (Strauss & Corbin 1990, p. 42).

Preliminary data analysis was also planned throughout data collection to guide subsequent categorisation and interviews (Kervin et al. 2006). Preliminary notes identifying the question/s addressed by data sources, emerging themes and categories and initial interpretations would be taken, as suggested by Bassey (1999), Kervin et al. (2006) and Merriam (1998). Throughout familiarisation, the researcher planned to identify data that related to learning syllabus outcomes, critical thinking and motivation to learn, as well as information about how and in what ways the design of the video game led to related outcomes.

### ***3.3.2.3.2 Categorisation of the data***

Once all data was collected, stored and familiar to the researcher, it would be categorised in a number of ways. This was guided by the research questions and the qualitative case study approach. First, data would be identified as relevant to the first research question, the second research question, or both research questions; or as having no clear relevance to the research questions (Hancock & Algozzine 2006). Second, all data related to the research questions would be sorted according to: if the data provides information about changes to syllabus outcomes, motivation to learn or critical thinking; in what ways the video game supported these changes; or both. Indications of syllabus outcomes via worksheets and focus group interviews would be graded according to the Board of Studies NSW (n.d.) common grade scale, defined as such:

- An ‘A’ grade level represents: “The student has an extensive knowledge and understanding of the content and can readily apply this knowledge. In addition, the student has achieved a very high level of competence in the processes and skills and can apply these skills to new situations.”
- ‘B’ grade level represents: “The student has a thorough knowledge and understanding of the content and a high level of competence in the processes and skills. In addition, the student is able to apply this knowledge and these skills to most situations.”
- ‘C’ grade level represents: “The student has a sound knowledge and understanding of the main areas of content and has achieved an adequate level of competence in the processes and skills.”

- ‘D’ grade level represents: “The student has a basic knowledge and understanding of the content and has achieved a limited level of competence in the processes and skills.”
- ‘E’ grade level represents: “The student has an elementary knowledge and understanding in few areas of the content and has achieved very limited competence in some of the processes and skills.”

In the case of the worksheets, these would first be awarded a mark, then converted from mark to grade using the conversion scale shown below in Table 3.10.

Mark	Grade
90 – 100	A
80 – 89	B
65 – 79	C
45 – 64	D
0 – 44	E

Table 3.10: Conversion from mark to grade

Third, data that relates to the second research question, and suggests how the use of a video game motivates learning and supports critical thinking, would be sorted into categories of critical thinking, motivation to learn or both.

All data that offers information about how and in what ways the video game impacted outcomes would also be sorted by emerging themes, the links between the video game and outcomes both positive and negative. Information would be coded to enable the researcher to quickly and efficiently locate data related to a category, and assist synthesis. Analysis was also designed so that there would also be a process of going back and forth between data and these emerging categories. This would enable the researcher to determine whether the categories actually fit and could be used for the study. If not, the researcher would refine the categories by going through the process again (Kervin et al. 2006, p. 144).

### 3.3.2.3.3 *Synthesis of the data*

The researcher planned to categorise and code the data, to make sense of it and recognise how it related to the research questions. This would involve interpretation of data, which sits at the core of qualitative research (Flick 2006); and require the researcher to organise the data to set goals and guide the ongoing research (Creswell 2007, p. 75). As Flick (2006) explains, the interpretation of data may pursue two goals, one reductive and the other additive, that can be applied alternatively or successively. The first aims to reduce the original text by paraphrasing, coding or summarising. The second seeks to uncover meaning and context behind the themes by adding a layer of annotations, links and analysis.

To form some initial answers to the research questions, the researcher planned to create diagrams, tables and charts to communicate the findings of the analysis as suggested by Kervin et al. (2006). The generalisability of findings would also be checked across each of the six focus students. Moreover, another round of familiarisation and categorisation, in all but the final cycle of analysis, would follow this interpretation, against which findings could be re-checked.

### 3.3.2.4 **Trustworthiness**

Trustworthiness, establishing a plausible connection between data and conclusions such that research results can be trusted (Hoepfl 1997; Merriam 1998), is essential to any research. Several techniques were used to address trustworthiness in the methodology. The techniques used to increase trustworthiness and reliability included the following:

1. Persistent observation (Davis 1995; Denzin 1994; Lincoln & Guba 1985),
2. Thick description (Kervin et al. 2006; Kincheloe & McLaren 2000; Merriam 1998; Shenton 2004),
3. Triangulation and movement between data and conclusions (Bell 2010; Cantrell 1993; Cohen, Manion & Morrison 2000; Merriam 1998; Guba & Lincoln 1989; Hancock & Algozzine 2006; Kervin et al. 2006; Kincheloe & McLaren 2000; Shenton 2004; Yin 2003), and
4. Member checks (Cantrell 1993; Bassey 1999; Guba & Lincoln 1989; Hancock & Algozzine 2006; Merriam 1998; Shenton 2004) with teacher.

The criteria used to ensure the trustworthiness of this study are summarised in Table 3.11 followed by an explanation of each technique, why they were selected and how they were applied.

Criteria	How addressed in this thesis
<b>Persistent observation</b>  (Davis 1995; Denzin 1994; Lincoln & Guba 1985)	<ul style="list-style-type: none"> <li>• Researcher was a full-time data collector over the seven weeks of implementation.</li> <li>• Range and combination of data sources (outlined in section 3.4.2.1) enabled the researcher to identify the most relevant information to the research question and examine it in detail.</li> </ul>
<b>Thick description</b>  (Kervin et al. 2006; Kincheloe & McLaren 2000; Merriam 1998; Shenton 2004)	<ul style="list-style-type: none"> <li>• Range and combination of data sources and documentation, and particular use of observation and semi-structured interviews in relation to all video game sessions.</li> <li>• Descriptions of the site, participants' background, video game itself, words and actions of participants and participant interactions were included wherever they shaped the researcher's conclusions.</li> </ul>
<b>Triangulation and movement between data and conclusions</b>  (Bell 2010; Cantrell 1993; Cohen, Manion & Morrison 2000; Merriam 1998; Guba & Lincoln 1989; Hancock & Algozzine 2006; Kervin et al. 2006; Kincheloe & McLaren 2000; Shenton 2004; Yin 2003)	<ul style="list-style-type: none"> <li>• Triangulation of sources when data from different participants were compared and crosschecked.</li> <li>• Triangulation of data collection instruments took place in this research when the six sources of data were compared.</li> <li>• The data analysis spiral used by this research enabled movement between data and conclusions. Cycling through phases of familiarisation, categorisation and synthesis (outlined in section 3.4.2.1) enabled interpretation of findings in their context and the evaluation and adaptation of conclusions.</li> </ul>
<b>Member checks with teacher</b>  (Cantrell 1993; Bassey 1999; Guba & Lincoln 1989; Hancock & Algozzine 2006; Merriam 1998; Shenton 2004)	<ul style="list-style-type: none"> <li>• Member checks with the teacher were used in this research to confirm that interview responses accurately reflected the teacher's opinions.</li> </ul>

Table 3.11: Summary of techniques used to address trustworthiness

#### **3.3.2.4.1 *Persistent observation***

Credibility of research is enhanced by persistent observation (Davis 1995; Denzin 1994; Lincoln & Guba 1985) or using adequate numbers of data collection sources (Davis 1995). Lincoln and Guba (1985) distinguish between this and prolonged engagement (or time), explaining:

If the purpose of prolonged engagement is to render the inquirer open to the multiple influences – the mutual shapers and contextual factors – that impinge upon the phenomenon being studied, the purpose of persistent observation is to identify those characteristics and elements in the situation that are most relevant to the problem or issue being pursued and focusing on them in detail. If prolonged engagement provides scope, persistent observation provides depth (p. 304).

The researcher was a full-time data collector over the seven weeks of implementation. The range and combination of data sources included: the pre/post test of student knowledge, the pre/post test of student motivation to learn and critical thinking, the focus group interviews with students, the pre/post interview with teacher, student observation throughout intervention and the log of video game play and chat. The variety of data collection methods enabled the researcher to collect the most relevant information to the research question and examine artefacts in detail.

#### **3.3.2.4.2 *Thick description***

In qualitative research, credibility requires detailed descriptions of the situation being investigated and the surrounding context (Kervin et al. 2006; Kincheloe & McLaren 2000; Merriam 1998; Shenton 2004). This requires recognising that meaning is generated in relation to the dynamic context in which it occurs (Kincheloe & McLaren 2000, p. 286). Persistent observation made this possible. The range and combination of data sources and documentation, and particular use of observation and semi-structured interviews in relation to all video game sessions, allowed for this. Descriptions of the site, participants' background, the video game itself, words and actions of participants and participant interactions were included wherever they shaped the researcher's conclusions.

#### ***3.3.2.4.3 Triangulation and movement between data and conclusions***

Credibility requires triangulation to build a coherent body of data (Bell 2010; Cohen, Manion & Morrison 2000; Merriam 1998; Guba & Lincoln 1989; Hancock & Algozzine 2006; Shenton 2004; Yin 2003) and studying the whole in relation to the parts and the parts in relation to the whole (Kincheloe & McLaren 2000, p. 286). This means cross-checking data and interpretations against different data sources (Cantrell 1993, p. 100) and constructing a chain of evidence to support conclusions (Kervin et al. 2006, p. 119).

In this research triangulation happened in two ways: triangulation of sources and triangulation of data collection instruments. Triangulation of sources took place when data from different participants were compared and crosschecked. For example, responses to the pre-test of students' knowledge were compared with responses to the post-test, and then crosschecked. Triangulation of instruments took place when the six sources of data – pre/post test of student knowledge, pre/post test of student motivation to learn and critical thinking, focus group interviews, pre/post interview with teacher, student observation and the logs of video game play and chat – were compared. For example, explanations students gave for their behaviour could be compared with observation of their behaviour; and, before implementation, a comparison could be made between the teacher's evaluation of a student's motivation to learn geography and the results of a pre-test assessment of student motivation to learn (the questionnaire). For an accurate assessment of syllabus outcomes as a result of video game use – the researcher could compare the data from observation, the focus group interviews, the post-test of student knowledge (worksheets), and the teacher post-interview.

The data analysis spiral being used by this research enabled movement between data and conclusions. Cycling through phases of familiarisation, categorisation and synthesis enables interpretation of findings in their context and the evaluation and adaptation of conclusions.

#### **3.3.2.4.4 *Member checks with teacher***

Guba and Lincoln (1989) consider member checks to be the single most important strategy to boost the credibility of qualitative research. This involves checking raw data with their sources (Cantrell, 1993; Bassey 1999; Guba & Lincoln 1989; Merriam 1998; Shenton 2004). This may occur at the time of data collection or at the end of data collection (Shenton 2004) or both. Bassey (1999) explains:

It is good practice after an interview to take the report of an interview back to the interviewee to check that it is an accurate record ... Sometimes people realise that they have not said what they meant to say and this provides an opportunity to put the record straight (p. 76).

As such, member checks with the teacher were used in this research to confirm that interview responses accurately reflected the teacher's opinions. This was done at the time of data collection and again with transcripts supplied to the teacher for feedback on accuracy.

Member checks with participating students were not conducted due to the young age of students involved in this research.

#### **3.3.2.5 Ethical considerations**

Approval to conduct the research according to ethical guidelines was gained from the University of Wollongong as is shown in Appendix O.

The research methodology dealt with five main ethical considerations (De Vaus 2002). First, informed consent was sought from all participants who received full disclosure of research goals and intent. Participants had the purpose of the research explained to them via a Participant Information Sheet, as is shown in Appendices P and Q. As informed consent was required for participation in the study, signed consent forms were obtained from the teacher and the parents/ primary care givers of students, as shown in Appendices R and S, before the practical part of the research started. Second, while the researcher was aware of the identity of participants, confidentiality was guaranteed and privacy protected. The researcher only contacted potential participants as a result of their response to letters issued to schools, names were changed for the dissemination phase of the research, all participants were

reminded that the information collected was confidential, and the results were reported anonymously and in a manner that respected the dignity of those participants. Third, participants were made aware that they could withdraw their consent at any time during the data collection phase of the research, as shown in appendices P and Q. Finally, it was expected that no harm would be inflicted upon participants. As the research was designed using the existing curriculum to provide both content and the parameters for online skills, it was developmentally appropriate.

### **3.3.3 PHASE THREE: PILOT STUDY**

This section discusses the findings and outcomes of Phase Three of the research, a pilot study which tested:

- video game functionality; and
- that the data collection and analysis techniques captured the information required to answer the research questions.

The pilot study was undertaken in April 2013 to uncover any problems across these areas that required change before Phase Four, and also provide further information to improve the research design.

#### **3.3.3.1 Case context**

##### ***3.3.3.1.1 Site***

The pilot study was conducted in the participants' homes, in rooms with computers with Internet access.

##### ***3.3.3.1.2 Participants***

The pilot study involved five participants, including:

- the researcher;
- two Year Three students;
- parent of each of the students.

Gender and student ability were taken into account when selecting participating students: one student was female with average school results in HSIE and the other

was male with above average school results in HSIE. The researcher participated as an observer, and gave instruction in video game and worksheet use in lieu of a classroom teacher, and conducted all interviews and questionnaires. A parent of each of the students completed the pre/post interview with the researcher, in lieu of a classroom teacher.

### **3.3.3.2 Pre-tests**

Before the video game was used by the students, the researcher collected data from three sources. First, an interview was arranged with a parent of each of the students, based on the pre interview with the teacher (see Appendix M) to gauge the parents' impressions of students' critical thinking, motivation to learn and knowledge of the unit "Who Will Buy?". Second, the pre-test of student motivation to learn and critical thinking (questionnaire) (see Appendix L) was carried out with each of the students to measure their motivation to learn and critical thinking before they played the video game. Third, the students completed the pre-test of student knowledge (worksheets) (see Appendix J) to gauge their knowledge of the unit outcomes covered by the video game before playing.

The pre-interview with the parents (see Appendix M) was found to successfully establish baseline data against which the post-test could be compared. The parents gave their impressions of students' critical thinking, motivation to learn and performance in Stage Two geography, against which changes could be measured.

Likewise, the pre-test of student motivation to learn and critical thinking (questionnaire) (see Appendix L) provided baseline data against which the post-test could be compared. Students were able to understand the questions as worded, with researcher support. This was indicated as both students clarified the meaning of some questions when they were unsure, and based on the researchers answers, subsequently answered the relevant questions. The time allocated was found to be sufficient to answer the questions and short enough for students to maintain focus.

However, the piloting of the pre-test of student knowledge (worksheets) (see Appendix J) revealed problems with three of the worksheets for data collection. The

goods and services, bread, and coal or solar power worksheets required students to transcribe lists of words as they sorted them into two categories. The sorting indicated knowledge, but the transcription of words took time even though it did not provide data about student knowledge. Both students indicated that having to re-write words, rather than simply sort the lists, was problematic. The researcher advised students to use arrows instead of re-writing words for the three relevant worksheets. As such, for Phase Four of the research:

- The pre-test of student knowledge (worksheets) was amended. The goods and services, bread, and coal or solar power worksheets were altered to have students sort lists into two categories using arrows, rather than transcription.

Finally, the three pre-tests – parent-interview, questionnaire and worksheets – were compared. Similarities were found between the parents’ assessments of students’ geography performance and the worksheet results for syllabus knowledge, and the parents’ assessments of motivation to learn and critical thinking and the questionnaire results for motivation to learn and critical thinking. In other words the results corroborated each other.

### **3.3.3.3 Video game functionality**

After data collection and preliminary analysis of the three pre tests, students were prompted to play the video game – *GeoCity* – on computers linked to the Internet for four 70-minute sessions, to test video game functionality.

Several problems were immediately detected. The researcher had set up usernames and passwords for the two students, but they could not log in. The game developer was alerted to this and resolved the problem. However, the first session of video game play had to be rescheduled. As such:

- The video game was fixed so that the researcher could set up new usernames and passwords for students to access the game.

Once the two students logged in, further problems were revealed over the course of video game play sessions. Listed below are the technical problems encountered (when the game did not function as designed), as well as problems with the game

design prompting changes. These were all sent to the video game programmer, and the action taken in advance of Phase Four is also detailed below.

#### ***3.3.3.3.1 Technical problems***

Several technical problems were revealed over the course of game play, when the game did not function as designed. First, once players entered “city view”, they could not go back to “avatar view”. They had to log out and back in again to trigger avatar view. This interrupted game flow, reduced the time spent playing the game, and reduced use of the feature. Second, the needs and wants information looped for both players about every 10 minutes, when it should have only happened once. Third, buying organic eggs, caged eggs and bread failed to trigger the associated tasks as planned; these were only triggered by time passing during game play. Fourth, the movements of other avatars was not visible when it should have been, to assist peer-to-peer learning. Fifth, the coal or solar power task did not trigger after the correct amount of time had passed. It had to be manually triggered by the researcher via the control panel for individual players. Sixth, the user accounts deleted prior to the pilot study were still visible in the game world. All avatars and their houses set-up in the game during the build and testing were still visible. This added unexplained detail and limited the choice of players as they could not choose these avatars or occupied blocks of land. Finally, a number of problems were also experienced with regard to choice, including products purchased by players. One student had problems with their food inventory: the content changed between logging out and back in. Both students experienced glitches with pets purchased: one purchased a ferret but it did not appear in their house, and the other purchased a dog and two appeared in their house. The look of avatars selected at the outset of the game, and the clothing they subsequently purchased and put on, were visible to other players but not to their owners in the game world. Players all saw their own avatar as a young man in shorts and a singlet. Similarly, the internal colour scheme of houses selected by students did not appear in the game world.

The game developer was alerted to these problems and the video game was fixed so that:

- Players can click between avatar view and city view while playing the game.

- The needs and wants information presents once during game play.
- Buying bread, caged eggs and organic eggs triggers the related tasks, if they have not yet been triggered by time passing.
- The coal or solar power task is triggered for all online players simultaneously, after about an hour and a half of game play.
- All information associated with deleted user accounts - avatars, blocks of land and the houses on them - reset when players are deleted through the administration panel.
- The movement of other avatars is visible to all players.
- Food inventories only change when players add or use items.
- All pets purchased, and only the pets purchased, appear in the house of the purchaser.
- All players view their own avatar as the character they selected, in the clothing selected.
- All players can choose a house from the list of options, including the internal colour scheme, and this is visible in the game world to all players.

#### **3.3.3.3.2 *Video game design***

A number of problems with the video game design were also revealed over the course of game play, necessitating changes. The first related to player understanding and use of inventories. Both players were confused by empty inventories – asking what they were and requiring support to close them in the early stages of playing the game. Both students also asked why the cash in their inventory was a different amount to their bank account balance, not understanding that one reflected money in their bank account and the other money withdrawn and unspent. Second, it was observed that players were not motivated by the need to shop and eat. The hunger need meter dropped too slowly to encourage activity on this basis, over and above shopping to satisfy wants. The third problem related to the needs and wants task. Definitions of needs and wants were provided via a speech bubble from computer controlled avatars. However, it was observed that when players used chat during the task, the chat log covered these definitions. Fourth, students complained that the appearance of their bank account balance on the ATM screen was too quick and that

they did not know their account balance as a result. Finally, one player complained about being asked whether or not they would like to buy bread when they completed the bread task. They stated that they had already purchased the bread and did not want to pay twice. Subsequently it was observed that for the bread, caged eggs and organic eggs tasks players purchased these items before the relevant task was triggered, and then were asked if they would like to purchase them when they completed the tasks. This was particularly problematic as the game was designed to prompt players to purchase these goods if they had not elected to do so after a certain period of game play, regardless of whether or not they had money to do so.

The game developer was alerted to these problems and the following solutions were requested and implemented:

- When there is nothing in an inventory the word "empty" is displayed, and the first three times inventories are clicked on, the words "click to close" and an arrow appear on screen, pointing to the relevant icon.
- A note appears in the cash inventory: "This is the money you have taken out of your bank account".
- The hunger meter drops sooner and faster, to motivate players to shop and eat.
- The chat log and use of chat is unavailable to players while definitions and examples of needs and wants are given via speech bubble from computer controlled avatars.
- The bank account balance displayed on the ATM screen appears for longer.
- The bread, caged eggs and organic eggs task are triggered when players click "buy" for these items, prior to payment. No money is taken from players at this time. Players choose whether to buy these items after the relevant task is completed, and only then do players who choose "yes" and select the payment method have money taken from them.

#### **3.3.3.4 Data collection during pilot study**

Throughout video game use by the students, the researcher collected data from four sources. First, interviews with both students were conducted immediately after each of the video game play sessions. These were video and audio recorded and the researcher took notes. Second, students were observed throughout video game play sessions and this was video and audio recorded and the researcher took notes. The third and fourth sources were the log of video game chat and video game play, which came from the back-end of the video game itself.

##### ***3.3.3.4.1 Interviews with focus group***

The semi-structured interview with focus group was tested as a method of data collection during the pilot study. The researcher interviewed the two students together after each session of video game play, using the method developed during Phase Two. In response to the questions and discussion, data was collected in relation to syllabus outcomes, motivation to learn and critical thinking, which also suggested some of the ways in which the video game supported these outcomes. For example, one student asked “*how do you use the ATM?*” and the other responded “*you get a bank card and put it in ATM and type your number and how much money you want*”. This answer shows some syllabus knowledge, suggests that learning this happened through using an ATM in the game world, and showed that discussion developed between students during interviews, as intended. Some critical thinking – particularly elaboration – was also evidenced during the focus group interviews. For example, while discussing the soup kitchen, one student asked “*is that like the church that gives out food to poor people?*” Furthermore, the video and audio recording of interviews captured interview content. Thus, the focus group interviews, as designed during Phase Two, gauged and recorded student learning, motivation to learn and critical thinking, as well as some of the ways in which the video game impacted these outcomes.

##### ***3.3.3.4.2 Observation***

As outlined in section 3.3.2.1.6, methods of observation range across a sequence (Creswell 2003; Merriam 1998). Based on Merriam’s (1998) description, Figure 3.47

illustrates the sequence of positions a researcher can assume when entering the field as an observer. Adjacent elements are similar but the extremes are quite different.

The researcher initially aimed to take on the role of complete observer, hidden from participants, but due to technical problems the researcher took on the role of participant observer. This was necessary to provide technical assistance as needed. The researcher did not carry out video game activities but facilitated implementation, providing technical assistance and guidance for students during the pilot study. Activities were still audio and video recorded. As a result:

- The observation technique was amended. The role of the researcher during observation changed, from that of a complete observer to a participant observer.

From this position of participant observer, the researcher made notes against the observation guide in Appendix N, and added further observations after video game play sessions, using the video and audio recordings of video game play sessions. Having the researcher participate also stimulated unexpected information. In particular, interactions between the researcher and students provided information that related to the research questions. This observation technique provided data in relation to syllabus outcomes, motivation to learn and critical thinking, and also suggested some of the ways in which the video game supported these outcomes. For example, one student asked a question while they sorted goods and services that revealed syllabus knowledge and critical thinking, as well as how the video game supported this: *“I am trying to figure out soup kitchen. The person says that goods are things you buy, but isn’t soup kitchen free?”*. Furthermore, much discussion observed focused on students’ frustration with technical problems. Students stated *“it’s boring that I have to keep buying the same things and they disappear”*, *“it’s annoying when the game doesn’t work”* and *“I put on the clothes I bought but then I wasn’t wearing them”*. This provided information about barriers to the video game supporting syllabus outcomes, motivation to learn and critical thinking.

#### **3.3.3.4.3 Log of video game chat**

The log of video game chat functioned as intended, with one exception. It recorded all chat during game play as required, but did not reset with the game, so chat that happened during game development (before the pilot study) remained in the chat log. As such, the game developer was alerted to this problem and the following solution was requested and implemented:

- The chat log was amended to reset with the video game.

#### ***3.3.3.4.4 Log of video game play***

The log of video game play, usage reports, built in to the back-end design of the game did not capture the information projected to contribute to answering the research questions. During the pilot study only participation in learning topics (not tasks) was recorded. This did not provide sufficient information about task participation, to compare participation rates to results. What was needed was a record of task participation by player, including:

1. Goods and services
2. Needs and services
3. Needs and wants
4. Snow
5. Bread
6. Caged eggs
7. Organic eggs
8. ATM
9. Bank
10. Consumer rights (first trigger)
11. Consumer rights (second trigger)
12. Coal or solar power

Furthermore, the record of video game play did not reset with the game, so play that happened during game development (before the pilot study) remained in the usage report. As such, the game developer was alerted to these problems and the following solutions were requested and implemented:

- The record of video game play was amended to include a record of task participation, by player.

- The record of video game play was amended to reset with the video game.

### 3.3.3.5 Post-tests

After video game use by the students, the researcher collected data from three sources. First, a post-interview was carried out with a parent of each of the students, akin to the post-interview with the teacher (visual and audio recordings and researcher notes) (see Appendix M), to gauge the parent's impressions of the student's critical thinking, motivation to learn and knowledge of the unit "Who Will Buy?" after video game use. Second, the post-test of student motivation to learn and critical thinking (questionnaire) (see Appendix L) was carried out with each student to measure their motivation to learn and critical thinking. Third, the students completed the post-test of student knowledge (worksheets) (see Appendix J) to gauge their knowledge of the unit outcomes covered by the video game.

There were no further problems with the worksheets or questionnaire in addition to those uncovered during the pre-tests. The comparative results for these two data sources showed overall improvements to syllabus outcomes for both students, and by topic; and overall improvements to motivation to learn and critical thinking, pinpointing internal increases and decreases for particular subscales. For example, both students showed an overall increase in critical thinking, with a decrease in rehearsal, but increases or no change in elaboration, critical thinking and metacognitive self-awareness.

However, there was a problem with the post-interviews with a parent of each of the students, and subsequently the comparison of pre and post interviews. Neither parent was present, nor talked with their child about the unit "Who Will Buy?", during implementation. As such, they did not have information to offer about changes to their child's knowledge, motivation to learn or critical thinking, nor impressions of the ways in which the video game supported changes, after using *GeoCity*. However, this was a problem with the design of the pilot study, not the design of the form of data collection. Phase Two was designed to include teacher participation during video game play sessions, and assumed ongoing contact between students and their teacher during which time changes to syllabus knowledge, motivation to learn, and

critical thinking could be gauged. As such, despite the encountered issue, no change was made to the data collection instrument: interview with the teacher.

#### **3.3.3.6 Data analysis techniques**

Data was watched, listened to and read over throughout and after the pilot study. During the pilot, the researcher was able to conduct some analysis and develop themes to guide interview questions. For example, observation suggested that technical problems negatively impacted access to learning content and motivation to learn, and questions were asked during focus group interviews to corroborate this and gauge student impressions.

All data relevant to the research questions was sorted into categories:

- By question
- By whether they provided information about changes to syllabus outcomes, motivation to learn or critical thinking or the ways in which the video game supported these changes
- For data that related to the second question, by critical thinking or motivation to learn

This was possible, though it was also clear that much data fitted multiple categories. On this basis, a change to the data analysis techniques was made:

- Data analysis was amended to support sorting of data into multiple categories.

Data was then synthesised. This included reducing the original text via paraphrasing, coding and summarising; and adding links, annotations and analysis. These methods were found to support answering the research questions. In particular, it was found that coding and links were easier to establish once paraphrasing, summarising and annotations were complete.

Furthermore, the results of the three post-implementation tests were compared. As such:

- Data analysis was refined to sequence data synthesis; first, paraphrasing, summarising and annotating relevant data and second, coding and linking the data as amended.

### 3.3.3.7 Summary

This section presented the findings and outcomes of Phase Three of the research, a pilot to trial the video game *GeoCity* and the data collection and analysis techniques created during Phase Two of the study. In order to strengthen data collection and analysis techniques, the following refinements were made as a result:

- The pre-test of student knowledge (worksheets) was amended. The coal and solar power, bread, and goods and services worksheets were altered to have students sort lists into two categories using arrows, rather than transcription.
- The observation technique was amended. The role of the researcher during observation changed, from that of a complete observer to a participant observer.
- The chat log was amended to reset with the video game.
- The record of video game play was amended to include a record of task participation, by player.
- The record of video game play was amended to reset with the video game.
- Data analysis was amended to support sorting of data into multiple categories.
- Data analysis techniques were refined to sequence data synthesis; first, paraphrasing, summarising and annotating relevant data and second, coding and linking the data as amended.

Furthermore, many technical problems with the video game were uncovered, as well as problems with the game design itself. Therefore, *GeoCity* was amended such that:

- The researcher can set up new usernames and passwords for students to access the game.
- Players can click between avatar view and city view while playing the game.
- The needs and wants information presents once during game play.

- Buying bread, caged eggs and organic eggs triggers the related tasks, if they have not yet been triggered by time passing.
- The coal or solar power task is triggered for all online players simultaneously, after about an hour and a half of game play.
- All information associated with deleted user accounts - avatars, blocks of land and the houses on them – reset when players are deleted through the administration panel.
- The movement of other avatars is visible to all players.
- Food inventories only change when players add or use items.
- All pets purchased, and only the pets purchased, appear in the house of the purchaser.
- All players view their own avatar as the character they selected, in the clothing selected.
- All players can choose a house from the list of options, including the internal colour scheme, and this is visible in the game world to all players.
- When there is nothing in an inventory the word “empty” is displayed, and the first three times inventories are clicked on, the words “click to close” and an arrow appear on screen, pointing to the relevant icon.
- A note appears in the cash inventory: “This is the money you have taken out of your bank account.”
- The hunger meter drops sooner and faster, to motivate players to shop and eat.
- The chat log and use of chat is unavailable to players while definitions and examples of needs and wants are given via speech bubble from computer controlled avatars.
- The bank account balance displayed on the ATM screen appears for longer.
- The bread, caged eggs and organic eggs task are triggered when players click “buy” for these items, prior to payment. No money is taken from players at this time. Player choose whether or not to buy these items after the relevant task is completed, and only then do players who choose “yes” then select the payment method and have money taken from them.

### **3.3.4 PHASE FOUR: IMPLEMENTATION**

Based on the outcomes of the pilot study, improvements and developments were made to the video game, and data collection and analysis techniques. After these changes were completed the video game was tested in a classroom in Term Two of the 2013 academic year. Data was collected and analysed after implementation. This section provides a description of the school context – including preliminary organisation at the school – classroom implementation, data collection, and technical problems.

#### **3.3.4.1 School context**

##### **3.3.4.1.1 Site**

The video game was implemented in a Stage Two class at a primary school in the Illawarra region of New South Wales. The school was selected because:

- It had a ratio of computers with Internet access to students in the computer lab of 1:1.
- Stage Two was studying the HSIE (geography) unit “Who Will Buy?”
- The school executive and classroom teacher was supportive of the research.

##### **3.3.4.1.2 Participants**

Implementation of the case study involved a number of participants:

1. The researcher
2. The class, a Year Three (Stage Two) class comprised of 21 students – nine girls and 12 boys of mixed ability, including a focus group (six members of the class – three boys and three girls of mixed ability)
3. The classroom teacher

#### **3.3.4.2 Preliminary organisation at the school**

The researcher visited the school, met with the school principal and the participating classroom teacher, and obtained background information about equipment and logistics prior to implementation of the video game. This enabled the researcher to outline the project, obtain permission from all stakeholders, develop an

understanding of the context and make specific implementation plans. This included gaining details of hardware and software availability, location of the classroom and computer lab, and the class timetable. All computers in the computer lab were installed with the video game *GeoCity* and Mozilla Firefox was set as the default browser on all computers. Adobe Flash Player was also updated. Earphones were purchased for all participating students to enable game play without disturbing each other.

The computers in the computer lab were PCs (21) and were linked to the Internet. The computers were Dell Optiplex 755 PCs from the year 2005, running the operating system Microsoft Windows XP Professional 2002. The students began playing the game using these computers. However, of importance to this study and explained in detail later in this section, a number of issues arose due to the age of the computers, operating systems and the Internet speed.

The researcher conducted the pre-interview with the classroom teacher during Term Two, 2013. As part of this interview, the researcher asked the classroom teacher to identify six students (three girls and three boys) with different average school results in HSIE, to be focused on by the research, to ensure balanced representation of male and female students and student ability. The six students identified were: Amy, Alf, Emma, Harry, May and Mark (pseudonyms given). The researcher then asked the classroom teacher about each of the six students, in line with the semi-structured interview schedule designed for the study (see Appendix M). The interview involved questions regarding the classroom teacher's perception of students' HSIE learning, motivation to learn and critical thinking. During this visit, the researcher gave the classroom teacher access to the video game and blank copies of the pre-test of student knowledge (worksheets) (listed in Appendix J), as well as instructions in how to use the video game and worksheets.

There were two weekly HSIE lessons of 45 minutes scheduled for Term Two. As there was only one computer in the classroom, arrangements were made by the classroom teacher to conduct eight HSIE lessons in the computer lab for implementation of this research project. The classroom teacher arranged HSIE

lessons to take place back-to-back every Thursday afternoon for four weeks. The lessons ran from 1.55pm to 3.25pm (90 minutes in total) to enable a 70-minute game play session, followed by a 20-minute discussion and debrief by students about the game and what they had learnt.

The 20-minute debrief after each video game play session was organised to take place in two groups: one with the six focus group students and the researcher in the computer lab, based on the semi-structured interview questions (see section 3.3.2.1.5), the other with the rest of the class and the classroom teacher in the classroom.

### 3.3.4.3 Data collection and analysis techniques during implementation phase

Before implementation of the research the use of data was clearly explained to the participants through Participant Information Sheets and Consent Forms (see Appendices P, Q, R & S). Table 3.12 provides a summary of the data collected: the first column lists the data type, the second column lists the potential data to be obtained, the third column lists the actual data obtained, and columns four and five indicate how the data relates to each of the research questions.

<b>Data type</b>	<b>Potential data</b>	<b>Actual data</b>	<b>Q1: Syllabus outcomes</b>	<b>Q2: Motivation to learn and critical thinking</b>
Log of video game play	1	1	X	X
Pre-test of student knowledge (worksheets)	21	20	X	
Pre-test of student motivation to learn and critical thinking (questionnaire)	6	6		X
Pre-interview with classroom teacher	1	1	X	X
Focus group interviews	24 (4 sessions x 6 students)	24	X	X
Student observation throughout intervention	84 (4 session x 21 students)	78	X	X
Post-test of student knowledge (worksheets)	21	19	X	

Post-test of student motivation to learn and critical thinking (questionnaire)	6	6		X
Post interview with classroom teacher	1	1	X	X
Log of video game chat	1	1	X	X

Table 3.12: Data collection summary

To answer the first research question, the pre/post test of student knowledge (worksheets) was used to measure Stage Two geography outcomes specified by the NSW syllabus before and after the intervention. The evaluation of student achievement of Stage Two geography outcomes, specified with the NSW syllabus, was made in line with the Australian Curriculum Achievement Standards, as outlined in section 3.3.2.3.2. Other data collection instruments, with the exception of the pre/post test of student motivation to learn and critical thinking (verbal questionnaire), were used to check worksheet findings and triangulate in what ways the video game design supported syllabus knowledge outcomes.

To answer the second research question, the information obtained from pre/post test of student motivation to learn and critical thinking (verbal questionnaire), was used to measure motivation to learn and critical thinking. Other data collection instruments, with the exception of the pre/post test of student knowledge (worksheets), were used to check questionnaire findings and triangulate how the video game design supported motivation to learn and critical thinking, as a method of instruction.

Data was watched, listened to and read over throughout and post implementation. This was done to build familiarity and sort the data. All data relevant to the research questions was sorted into the following categories:

- Data source
- Provision of information related to syllabus outcomes, motivation to learn or critical thinking

Table 3.13 shows the relationship between topics, tasks and syllabus outcomes included in the research design. These relationships were considered in the presentation of findings. Where appropriate, data was sorted into multiple categories.

	<b>Topic</b>	<b>GeoCity task</b>	<b>Syllabus outcomes addressed</b>
1	Goods, services and needs	<ul style="list-style-type: none"> <li>• Goods and services</li> <li>• Needs and services</li> <li>• Needs and wants</li> </ul>	<ul style="list-style-type: none"> <li>• Examines the goods and services provided within the community and by community organisations to meet needs.</li> </ul>
2	Production and distribution	<ul style="list-style-type: none"> <li>• Bread</li> <li>• Caged eggs</li> <li>• Organic eggs</li> </ul>	<ul style="list-style-type: none"> <li>• Identifies the components of a system that provides goods and services and how the components need to interlink.</li> <li>• Examines the goods and services provided within the community and by community organisations to meet needs.</li> <li>• Makes statements about the social and environmental responsibilities of producers and consumers.</li> <li>• Investigates current community issues.</li> <li>• Investigates consumer rights and responsibilities.</li> </ul>
3	Technologies involved with monetary exchange	<ul style="list-style-type: none"> <li>• Technologies involved with monetary exchange</li> </ul>	<ul style="list-style-type: none"> <li>• Identifies the different technologies involved with monetary exchange.</li> </ul>
4	Consumer rights	<ul style="list-style-type: none"> <li>• Consumer rights</li> </ul>	<ul style="list-style-type: none"> <li>• Investigates consumer rights and responsibilities.</li> </ul>
5	Coal or solar power	<ul style="list-style-type: none"> <li>• Coal or solar power</li> </ul>	<ul style="list-style-type: none"> <li>• Examines a variety of systems that have been designed to meet needs in communities and identifies the advantages and disadvantages of their use.</li> <li>• Examines the goods and services provided within the community and by community organisations to meet needs.</li> <li>• Explains the processes involved in civic action within the community.</li> <li>• Investigates current community issues.</li> </ul>

Table 3.13: The relationship between topics, tasks and syllabus outcomes

### 3.3.4.4 Video game use

In the first session playing the video game, the researcher outlined the game to all students, explained to them how to log in, encouraged them to explore *GeoCity*, and asked them to gain the researcher's attention by raising their hand if they needed help with the game.

Due to technical problems (discussed in Chapter Four) game play in the classroom was slow and interrupted on occasions. To address this problem, the researcher gave students the link to the game so they could play it at home in the last week of implementation. This was done to maximise game use and task completion.

Students played the video game over four 70-minute sessions in the computer lab (280 minutes in total), and were given home access to the video game over a one-week period, during which time they could choose to play the game should they wish. The record of video game play showed:

- Three students did not participate in all four video game play sessions, as they were absent from school on one or more of the designated days.
- 18 of the 21 students participated in all four video game play sessions.
- 17 of the 21 students played the game at home.
- An additional student joined the class during implementation; no data was collected for this student.

Participation by students in these sessions and/or at home is shown in Table 3.14.

Student	Session 1	Session 2	Session 3	Session 4	At home
<b>Focus group</b>					
Amy	✓	✓	✓	✓	✓
Alf	✓	✓	✓	✓	✓
Emma	✓	✓	✓	✓	✓
Harry	✓	✓	✓	✓	✓
May	✓	✓	✓	✓	✓
Mark	✓	✓	✓	✓	✓
<b>Rest of class</b>					
7	✓	×	×	×	✓
8	✓	✓	✓	✓	✓

Student	Session 1	Session 2	Session 3	Session 4	At home
9	✓	✓	✓	✓	✓
10	✓	✓	✓	✓	✓
11	✓	✗	✓	✗	✓
12	✓	✓	✓	✓	✗
13	✓	✓	✓	✓	✓
14	✓	✓	✗	✗	✓
15	✓	✓	✓	✓	✗
16	✓	✓	✓	✓	✗
17	✓	✓	✓	✓	✓
18	✓	✓	✓	✓	✓
19	✓	✓	✓	✓	✓
20	✓	✓	✓	✓	✗
21	✓	✓	✓	✓	✓
<b>Total</b>	<b>21</b>	<b>19</b>	<b>19</b>	<b>18</b>	<b>17</b>

Table 3.14: Student participation in video game activities by session

Throughout the implementation of the video game, student observation and group semi-structured interviews were conducted. A record of video game chat throughout all video game play was also collected.

There were five topics spanning nine tasks that students could participate in during game play:

1. Goods, services and needs (goods and services, needs and services, and needs and wants)
2. Technologies involved with monetary exchange
3. Production and distribution (bread, caged eggs and organic eggs)
4. Consumer rights
5. Coal or solar power

Students could also participate in a chat environment.

Each lesson involved free play, with some learning tasks triggered in the game by a set amount of time spent playing. The record of video game play showed that 16 of the 21 students participated in all learning activities. A full list of learning tasks and participation is detailed in Table 3.15.

Student	Goods, services and needs			Production and distribution			Technologies involved with monetary exchange	Consumer rights	Coal or solar power	Chat
	Goods and services	Needs and services	Needs and wants	Bread	Caged eggs	Organic eggs				
Amy	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Alf	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Emma	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Harry	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
May	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mark	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
7	✓	✗	✓	✗	✓	✗	✓	✓	✓	✓
8	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
9	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
10	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
11	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
12	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓
13	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
14	✓	✓	✓	✓	✗	✗	✓	✗	✗	✓
15	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
16	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
17	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓
18	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
19	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
20	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓
21	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
<b>Total</b>	<b>21</b>	<b>20</b>	<b>21</b>	<b>20</b>	<b>20</b>	<b>19</b>	<b>21</b>	<b>17</b>	<b>20</b>	<b>21</b>

Table 3.15: Student participation in video game activities by task

All members of the focus group participated in all activities. All students participated in goods and services, needs and wants, bank/ATM, and chat. While, 20 out of 21 students participated in needs and services, bread, caged eggs, and coal or solar power; 19 out of 21 students participated in organic eggs; and 17 out of 21 students participated in consumer rights. For all but the consumer rights task, non-participation related to absence from school over video game play sessions. In the case of consumer rights, some students failed to follow instructions prompting participation, and the findings and discussion in relation to this will follow.

### 3.4 Summary

This chapter presented the research methodology used to identify the ways in which an instructional video game based on best practice design principles supported students to achieve Stage Two geography outcomes specified by the NSW syllabus; and investigate how a video game based on best practice design principles motivates learning and supports critical thinking. To meet these aims and answer the research questions, a qualitative case study approach with an integrated focus group was adopted, chosen to recognise contextual factors and provide holistic answers consistent with the theoretical framework. The research methodology was carried out in four phases. The first phase involved designing *GeoCity* based on the design principles determined by the review of literature and supported by the theoretical framework. Phase Two developed the methods of data collection and analysis. Phase Three tested the video game and data collection and analysis in a pilot study, making changes to both the game design and data collection and analysis to support student learning, motivation to learn and critical thinking, and test these outcomes and the game's contribution to them. Finally, Phase Four implemented the research design in a Stage Two geography classroom.

## 4 RESEARCH FINDINGS

### Overview

This chapter presents the findings from individual data collection instruments in relation to the two research questions. It also examines the collected data and assesses whether the video game functioned as outlined in the design brief, so that student outcomes can be understood in the context of how the game functioned during implementation, not simply how it was planned to function. Finally, this chapter highlights the technical problems experienced during implementation.

### 4.1 Findings from individual data collection instruments

#### 4.1.1 PRE/POST TEST OF STUDENT KNOWLEDGE (WORKSHEETS)

The worksheets were designed based on Human Society and Its Environment (HSIE) syllabus outcomes, as outlined in Chapter Three, to provide evidence of student knowledge of the Stage Two HSIE unit “Who Will Buy?” before and after the intervention.

Worksheets were completed before video game use by 20 of the 21 participating students; and by 19 of the 21 participating students after all video game sessions were completed. So full worksheet data was collected for 18 students, including the six focus group students, and partial data was collected for three students. All pre and post worksheets that were completed were collected and marked out of 65 by the researcher in accordance with the marking scheme outlined in Appendix K. There was a worksheet for each topic and the breakdown of the 65 total possible marks by topic was:

- 21 for goods, services and needs
- 4 for technologies involved with monetary exchange
- 24 for production and distribution
- 3 for consumer rights
- 13 for coal or solar power

For the focus group students, the pre-test of student knowledge (worksheets) demonstrated that, on average, students achieved a mark of 69% for relevant syllabus knowledge included in the worksheet before playing *GeoCity*. It must be noted that this relatively high figure represents student knowledge of the unit “Who Will Buy?” after four weeks of classroom lessons on this section of the syllabus before the video game was introduced to the classroom. By comparison, the post-test of student knowledge (worksheets) showed that on average students achieved a mark of 89% for relevant syllabus knowledge included in the worksheet after four 70-minute sessions of game play, and the option to play *GeoCity* at home. These two figures represent an average 20% increase in syllabus knowledge included in the worksheets for the six focus group students, having played the video game. All focus group students improved their mark over the video game play period. Moreover, individual post-test results also show that all focus group students achieved the geography outcomes specified by the NSW syllabus having played *GeoCity*, with scores ranging from 66% to 97%.

The pre, post and comparative results for the focus group are shown in Table 4.1.

Student	Pre		Post		Change	
	Mark	Percentage	Mark	Percentage	Mark	Percentage
	/65	/100	/65	/100		/100
Amy	37.5	58	55	85	17.5	27
Alf	33	51	43	66	10	15
Emma	49.5	76	62	95	12.5	19
Harry	52	80	62	95	10	15
May	57	88	62	95	5	8
Mark	41	63	63	97	22	34
<b>Average</b>	<b>45</b>	<b>69</b>	<b>58</b>	<b>89</b>	<b>13</b>	<b>20</b>

Table 4.1: Pre/post worksheet results for focus group

These results sit within whole of class data. For the class, the pre-test of student knowledge (worksheets) showed that on average, students achieved a mark of 61% for relevant syllabus knowledge included in the worksheet before playing *GeoCity*. By comparison, the post-test of student knowledge (worksheets) showed that on

average students achieved a mark of 83% for relevant syllabus knowledge included in the worksheet after playing the game. These averages represent a 21% increase in syllabus knowledge over the course of this research for the class. All students from whom pre and post worksheets were collected improved their syllabus outcomes over the video game play period. Moreover, individual post-test results also showed that all students achieved the geography outcomes specified by the NSW syllabus having played *GeoCity*, with scores ranging from 63% to 98%.

The pre, post and comparative results for the class are shown in full in Table 4.2 and illustrated in Figure 4.1.

Student	Pre		Post		Change	
	Mark	Percentage	Mark	Percentage	Mark	Percentage
	/65	/100	/65	/100		
Amy	37.5	58%	55	85%	17.5	27%
Alf	33	51%	43	66%	10	15%
Emma	49.5	76%	62	95%	12.5	19%
Harry	52	80%	62	95%	10	15%
May	57	88%	62	95%	5	8%
Mark	41	63%	63	97%	22	34%
7	31	48%	-	-	-	-
8	35.3	54%	42.5	65%	7.2	11%
9	33.5	52%	56	86%	22.5	35%
10	31.5	48%	48	74%	16.5	25%
11	26	40%	50	77%	24	37%
12	-	-	55.5	85%	-	-
13	46	71%	64	98%	18	28%
14	28	43%	-	-	-	-
15	48	74%	55	85%	7	11%
16	30.8	47%	43	66%	12.2	19%
17	48	74%	57.5	88%	9.5	15%
18	53	82%	62	95%	9	14%
19	31	48%	41	63%	10	15%
20	30	46%	54	83%	24	37%
21	48.5	75%	55	85%	6.5	10%
<b>Average</b>	<b>39.53</b>	<b>60.82%</b>	<b>54.24</b>	<b>83.45%</b>	<b>13.52</b>	<b>22.63%</b>

Table 4.2: Pre/post worksheet results for class

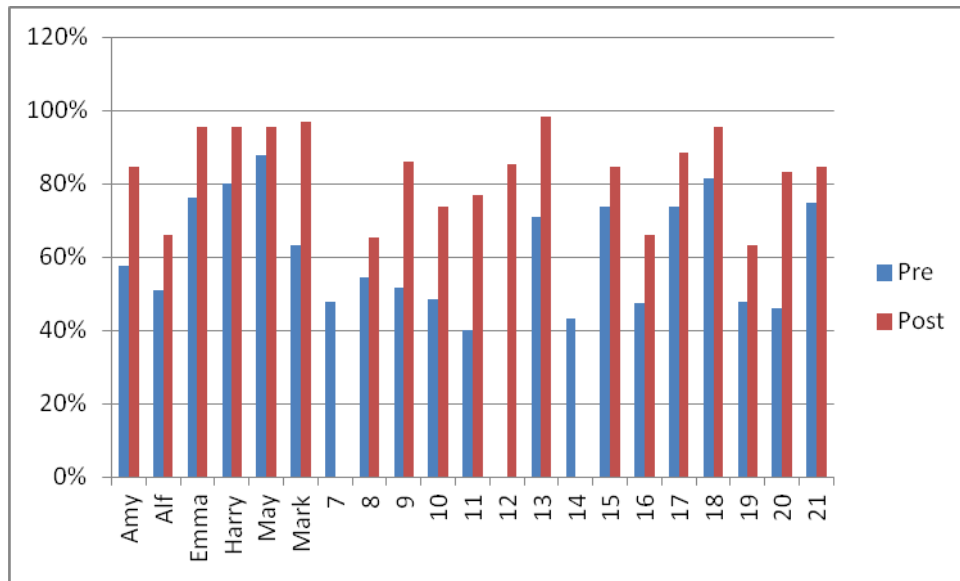


Figure 4:1: Pre/post worksheet results for class

Findings from the worksheets included:

- The focus group's overall average improvement was consistent with the average of the class, at 20% and 22% respectively.
- All students who completed pre and post worksheets improved their syllabus outcomes over the video game play period, suggesting that *GeoCity* supported syllabus learning and positioning the focus group as consistent with the class for this indicator.
- All students achieved the geography outcomes specified by the NSW syllabus having played *GeoCity*, with scores ranging from 63% to 98%.

However, the overall worksheet results also showed:

- The focus group's overall average pre-scores were higher than the average of the class, at 69% and 61% respectively.
- The focus group's overall average post-scores were higher than the average of the class, at 89% and 83% respectively.

Pre-test data placed none of the focus group in the bottom third of the class for related knowledge, three in the middle third of the class (Mark, Amy and Alf), and three in the top third of the class (May, Harry and Emma). It gave a different picture of class position for three of the six focus group students to that given by the

classroom teacher in the pre-interview: Emma was described as average, but received an above average result on the worksheet pre-test; Amy and Mark were described as below average, but received average results on the worksheet pre-test. Furthermore, the lowest score on the pre-test from the focus group was Alf, who the classroom teacher positioned in the middle of the class in the pre-interview. In other words, the worksheet results suggested the focus group was comprised of average and above average students, in contrast to the teacher's assessment of students' understanding of HSIE.

Worksheets were also organised by topic for analysis:

- Goods, services and needs
- Production and distribution
- Technologies involved with monetary exchange
- Consumer rights
- Coal or solar power

Through this organisation the pre and post worksheet results also indicated changes in syllabus knowledge by topic.

The average pre to post worksheet results showed that the focus group students made small improvements in knowledge for goods, services and needs, at 16%, and production and distribution, at 14%; they showed greater improvements in knowledge for technologies involved with monetary exchange, at 29%; consumer rights, at 22%; and coal or solar power, at 34%. They also showed that for each topic the focus group achieved the geography outcomes specified by the NSW syllabus based on the following results:

- 85% (or B) for goods, services and needs
- 90% (or A) for production and distribution
- 92% (or A) for technologies involved with monetary exchange
- 83% (or B) for consumer rights
- 95% (or A) for coal or solar power

Furthermore, all focus group students individually achieved the geography outcomes specified by the NSW syllabus by topic, with one exception: Alf scored 9 out of 21, or 43%, on the post-worksheet for the goods, services and needs topic. Finally, all focus group students individually improved their knowledge of all topics over the video game play period with two exceptions:

- Alf showed a 10% decrease in knowledge of the goods, services and needs topic from the pre to post-test.
- May showed a 25% decrease in knowledge of the technologies involved with monetary exchange topic from the pre to post-test (in the pre-test she answered all four questions correctly, but in the post-test she answered three of the four questions correctly).

The pre, post and comparative results from the worksheets for the six focus students are shown in full in Table 4.3.

	<b>Goods, services and needs</b>		<b>Production and distribution</b>		<b>Technologies involved with monetary exchange</b>		<b>Consumer rights</b>		<b>Coal or solar power</b>	
Marks possible	/21		/24		/4		/3		/13	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Amy	13	15	15	21	0	4	2	2	7.5	13
Alf	11	9	14	19	3	3	0	2	5	10
Emma	14	21	20.5	22	3	4	2	3	10	12
Harry	16	21	20	21	4	4	3	3	9	13
May	19	21	22	23	4	3	2	2	10	13
Mark	14	20	18	23	1	4	2	3	6	13
AVERAGE %	69.05	84.92	76.04	89.58	62.50	91.67	61.11	83.33	60.89	94.87
CHANGE (rounded)	16 %		14 %		29 %		22 %		34 %	

Table 4.3: Pre/post worksheet results for focus group by topic

The above results sit within whole of class averages. The average pre to post worksheet results showed that the class made small improvements in knowledge for goods, services and needs at 13%, and production and distribution at 16%; and greater improvements in knowledge for technologies involved with monetary exchange at 38%, consumer rights at 24%, and coal or solar power at 46%. They also

showed that for each topic the class achieved the geography outcomes specified by the NSW syllabus based on the following results:

- 77% (or C) for goods, services and needs
- 85% (or B) for production and distribution
- 93% (or A) for technologies involved with monetary exchange
- 72% (or C) for consumer rights
- 90% (or A) for coal or solar power

Furthermore, all students individually achieved the geography outcomes specified by the NSW syllabus by topic, with three notable exceptions:

- One student scored 9 out of 21, or 43%, on the post-worksheet for the goods, services and needs topic.
- Three students scored 0 out of 3, or 0%, on the post-worksheet for the consumer rights topic.
- One student scored 5 out of 13, or 38%, on the post-worksheet for the coal or solar power topic.

Finally, all students individually improved their knowledge of all topics over the video game play period, with the following exceptions:

- Three students showed a decrease in knowledge of the goods, services and needs topic from the pre to post test.
- One student showed a decrease in knowledge of the production and distribution topic from the pre to post test.
- One student showed a decrease in knowledge of the technologies involved with monetary exchange topic from the pre to post test.
- One student showed a decrease in knowledge of the coal or solar power topic from the pre to post test.

The pre, post and comparative results for worksheets by topic for all students are shown in full in Table 4.4.

	<b>Goods, services and needs</b>		<b>Production and distribution</b>		<b>Technologies involved with monetary exchange</b>		<b>Consumer rights</b>		<b>Coal or solar power</b>	
Marks possible	21		24		4		3		13	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Amy	13	15	15	21	0	4	2	2	7.5	13
Alf	11	9	14	19	3	3	0	2	5	10
Emma	14	21	20.5	22	3	4	2	3	10	12
Harry	16	21	20	21	4	4	3	3	9	13
May	19	21	22	23	4	3	2	2	10	13
Mark	14	20	18	23	1	4	2	3	6	13
7	9	-	14	-	3	-	1	-	4	-
8	8.3	10.5	16	18	1	3	0	3	10	8
9	12.5	16	15	22	2	4	2	2	2	12
10	7	13	18.5	18	1	4	1	3	4	10
11	7	14	13	18	2	3.5	0	1.5	4	13
12	-	16	-	20	-	4	-	2.5	-	13
13	18	20	21	24	4	4	3	3	0	13
14	15	-	11	-	0	-	2	-	0	-
15	17	16	15	20	3	3	3	3	10	13
16	11.3	12	12.5	17	3	3	0	0	4	11
17	19	18.5	20	20	3	4	1	2	5	13
18	21	21	21	21	2	4	3	3	6	13
19	14	15	13	17	1	4	0	0	3	5
20	12	17	12	20	1	4	0	0	5	13
21	12	13	20.5	23	3	4	2	3	11	12
AVERAGE %	64.30	77.44	69.16	84.87	55.00	92.76	48.33	72.93	44.42	90.08
CHANGE (rounded)	13 %		16 %		38 %		24 %		46 %	

Table 4.4: Pre/post worksheet results for class by topic

The worksheet results by topic showed that the design of some tasks was more effective than others in supporting Stage Two students to achieve the geography outcomes specified by the NSW syllabus. For each topic, the results of the focus group and the class showed:

- The cohort achieved the geography outcomes specified by the NSW syllabus, on average.
- The cohort improved, on average.

The average improvements by topic positioned the focus group within 3% of the class for the goods, services and needs, production and distribution, and consumer

rights topics. However, there were marked differences in pre/post worksheet results between the focus group and the whole of class for the other two topics. While the focus group averaged a 29% improvement for technologies involved with monetary exchange, the class averaged a 38% improvement; and while the focus group averaged a 34% improvement for the coal or solar power topic, the class averaged a 46% improvement. In both cases the significant difference was in the pre-result: the average post-result for the focus group for both these topics was a difference of 5% or less than the class average.

Furthermore, class and focus group averages showed improvements and overall achievement of all syllabus outcomes by topic, but this was not the case for all individuals. All students who completed the post-test achieved the geography outcomes specified by the NSW syllabus for the topics production and distribution, and technologies involved with monetary exchange; and more than 83% of students achieved the geography outcomes specified by the NSW syllabus for each topic. However:

- One student scored 9 out of 21, or 43%, on the post-worksheet for the goods, services and needs topic.
- Three students scored 0 out of 3, or 0%, on the post-worksheet for the consumer rights topic.
- One student scored 5 out of 13, or 38%, on the post worksheet for the coal or solar power topic.

Finally, all students who completed the pre and post tests improved for the consumer rights topic, and more than 83% of students improved for each topic. However:

- Three students showed a decrease in knowledge of the goods, services and needs topic from the pre to post test.
- One student showed a decrease in knowledge of the production and distribution topic from the pre to post test.
- One student showed a decrease in knowledge of the technologies involved with monetary exchange topic from the pre to post test.
- One student showed a decrease in knowledge of the coal or solar power topic from the pre to post test.

Triangulation of these findings, against other data sources, can assist understanding of the ways in which the video game supported Stage Two students to achieve the geography outcomes specified by the NSW syllabus. This synthesis and discussion is conducted in Chapter Five.

#### **4.1.2 PRE/POST TEST OF STUDENT MOTIVATION TO LEARN AND CRITICAL THINKING (QUESTIONNAIRE)**

To understand students' motivation to learn and critical thinking, a verbal questionnaire was conducted before and after intervention with the students selected to participate in the focus group. The questionnaire was undertaken with each of the six focus group students before video game use and again after completion of video game sessions.

##### **4.1.2.1 Motivation to learn**

Eighteen of the 30 questions asked of focus group students were designed to gauge the extent to which the video game, as a method of instruction, impacted motivation to learn. The questionnaire was scored by assigning one point to all negative answers, two points to all neutral answers and three points to all positive answers using the tables in Appendix L. Overall scores were also converted to percentages for the purpose of analysis. For motivation to learn, 18 questions were asked. As such, the lowest possible score was 18, a neutral score was 36 and the highest possible score was 54. As 18 was the lowest possible score it was ascribed a value of 0% and as 54 was the highest possible score it was ascribed a value of 100%.

Using these methods, the data showed the average overall motivation to learn for the six focus group students improved from pre to post video game use. Before video game use, students on average reported 73.15% motivation across all categories. After video game use, students on average reported 79.63% motivation across all categories. This represents a 6.48% average increase. The lower and upper limits of this change were Alf, who showed no overall change in motivation, and Amy, who showed a 19.44% increase in motivation. These results are presented in Table 4.5.

Student		Amy	Alf	Emma	Harry	May	Mark	Average
Score	Pre	46	46	46	47	33	48	44.33
	Post	53	46	47	48	37	49	46.67
	Change	7	0	1	1	4	1	2.33
Percentage	Pre	77.78	77.78	77.78	80.56	41.67	83.33	73.15
	Post	97.22	77.78	80.56	83.33	52.78	86.11	79.63
	Change	19.44	0	2.78	2.77	11.11	2.78	6.48

Table 4.5: Questionnaire results for motivation to learn

Results were also sorted into six categories as outlined in Chapter Three, including: intrinsic goal orientation, extrinsic goal orientation, task value, control of learning beliefs, self-efficacy for learning and performance, and test anxiety. Changes in individual student motivation by category were inconsistent across the six focus group students. The data showed average improvements to motivation to learn across all categories except test anxiety, for which an average decrease was found. On the nine-point scale, the smallest changes to the average score were for control of learning beliefs and test anxiety, which registered a 0.17 and -0.17 point average change respectively. The biggest change by score was for intrinsic and extrinsic goal orientation, which each registered a 0.83 point average change. Students who shifted two or more points on the nine-point scale, by category, included:

- Amy, who showed a two point increase in self-efficacy for learning and performance, and a four point increase in test anxiety.
- Alf, who showed a four point increase in intrinsic motivation, a two point decrease in self-efficacy for learning and performance, and a two point decrease in test anxiety.
- Emma, who showed a two point increase in self-efficacy for learning and performance.
- May, who showed a four point increase in extrinsic goal orientation.
- Mark, who showed a three point increase in intrinsic goal orientation and a two point decrease in test anxiety.

The full results for the pre/post questionnaire in relation to motivation for each of the six focus group students are detailed in Table 4.6.

Student		Amy	Alf	Emma	Harry	May	Mark	Average
Intrinsic Goal Orientation	Pre	9	5	9	9	8	6	7.67
	Post	9	9	9	8	7	9	8.50
	Change	0	4	0	-1	-1	3	0.83
Extrinsic Goal Orientation	Pre	9	9	8	9	4	6	7.50
	Post	9	9	8	9	8	7	8.33
	Change	0	0	0	0	4	1	0.83
Task Value	Pre	7	9	9	8	5	9	7.83
	Post	8	9	9	8	6	9	8.17
	Change	1	0	0	0	1	0	0.33
Control of Learning Beliefs	Pre	9	9	8	8	6	9	8.17
	Post	9	9	8	9	6	9	8.33
	Change	0	0	0	1	0	0	0.17
Self-Efficacy for Learning & Performance	Pre	7	9	7	8	7	9	7.83
	Post	9	7	9	9	7	8	8.17
	Change	2	-2	2	1	0	-1	0.33
Test Anxiety	Pre	5	5	5	5	3	9	5.33
	Post	9	3	4	5	3	7	5.17
	Change	4	-2	-1	0	0	-2	-0.17

Table 4.6: Questionnaire results for motivation to learn by subscale

In summary, the pre/post test of student motivation (questionnaire) showed average improvements in motivation to learn from pre to post video game use. The data also showed average improvements to motivation to learn across all categories except text anxiety, for which an average decrease was found. Furthermore, changes to individual student motivation by category were inconsistent across the six focus group students. The results did not show how the video game, as a method of instruction, prompted these changes. However, triangulation of these findings, against other data sources, can assist an understanding of the ways in which the video game motivated learning. This synthesis and discussion is conducted in Chapter Five.

#### 4.1.2.2 Critical thinking

Twelve of the 30 questions asked of focus group students were designed to gauge critical thinking before video game use, as well as the extent to which the video game, as a method of instruction, impacted critical thinking.

The questionnaire was scored by assigning one point to all negative answers, two points to all neutral answers and three points to all positive answers using the tables in Appendix L. Overall scores were also converted to percentages for the purpose of analysis. For critical thinking, 12 questions were asked. As such, the lowest possible score was 12, a neutral score was 24 and the highest possible score was 36. As 12 was the lowest possible score it was ascribed a value of 0% and as 36 was the highest possible score it was ascribed a value of 100%.

Using these methods, the data showed the average overall critical thinking for the six focus group students improved from pre to post video game use. Before video game use, students on average reported 57.64% critical thinking across all categories. After video game use, students on average reported 75.7% critical thinking across all categories. This represents an 18.06% average increase. The lower and upper limits of this change were Harry, who showed a 4.17% increase in critical thinking, and Emma, who showed a 37.5% increase in critical thinking. These results are detailed in Table 4.7.

Student		Amy	Alf	Emma	Harry	May	Mark	Average
Score	Pre	23	28	24	27	25	28	25.83
	Post	26	33	33	28	27	34	30.17
	Change	3	5	9	1	2	6	4.33
Percentage	Pre	45.83	66.67	50.00	62.50	54.17	66.67	57.64
	Post	58.33	87.50	87.50	66.67	62.50	91.67	75.70
	Change	12.50	20.83	37.50	4.17	8.33	25.00	18.06

Table 4.7: Questionnaire results for critical thinking

Results were also sorted into four categories as outlined in Chapter Three, including: rehearsal, elaboration, critical thinking and metacognition. Changes in individual student critical thinking by category showed:

- An average decrease in rehearsal from pre to post video game use (-1.33), with all students recording a decrease in this category.
- An average increase in elaboration from pre to post video game use (1.83), with five students recording an increase in this category, and Mark recording maintenance of the maximum score for this category from pre to post video game use.
- An average increase in critical thinking from pre to post video game use (2), with four students recording an increase in this category, and Harry and May recording maintenance of their score for this category from pre to post video game use.
- An average increase in metacognition from pre to post video game use (1.83), with three students recording an increase in this category, and Amy, Harry and May recording maintenance of their score for this category from pre to post video game use.

The full results for the pre/post questionnaire in relation to critical thinking for each of the six focus group students are detailed in Table 4.8, the average changes by category are detailed in Figure 4.2, and the individual changes to critical thinking are shown in Figure 4.3.

Student		Amy	Alf	Emma	Harry	May	Mark	Average
Rehearsal	Pre	7	9	8	5	5	9	7.17
	Post	5	8	7	4	4	7	5.83
	Change	-2	-1	-1	-1	-1	-2	-1.33
Elaboration	Pre	4	7	7	6	5	9	6.33
	Post	7	9	8	8	8	9	8.17
	Change	3	2	1	2	3	0	1.83
Critical thinking	Pre	5	7	4	8	7	5	6.00
	Post	7	8	9	8	7	9	8.00
	Change	2	1	5	0	0	4	2.00
Metacognition	Pre	7	5	5	8	8	5	6.33
	Post	7	8	9	8	8	9	8.17
	Change	0	3	4	0	0	4	1.83

Table 4.8: Questionnaire results for critical thinking by subscale

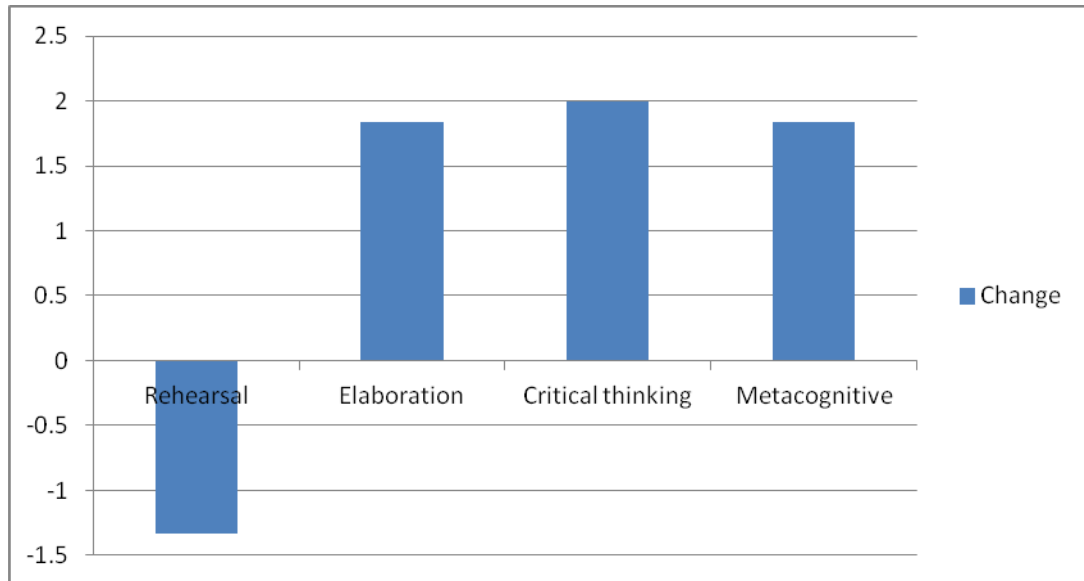


Figure 4:2: Average changes to critical thinking by subscale

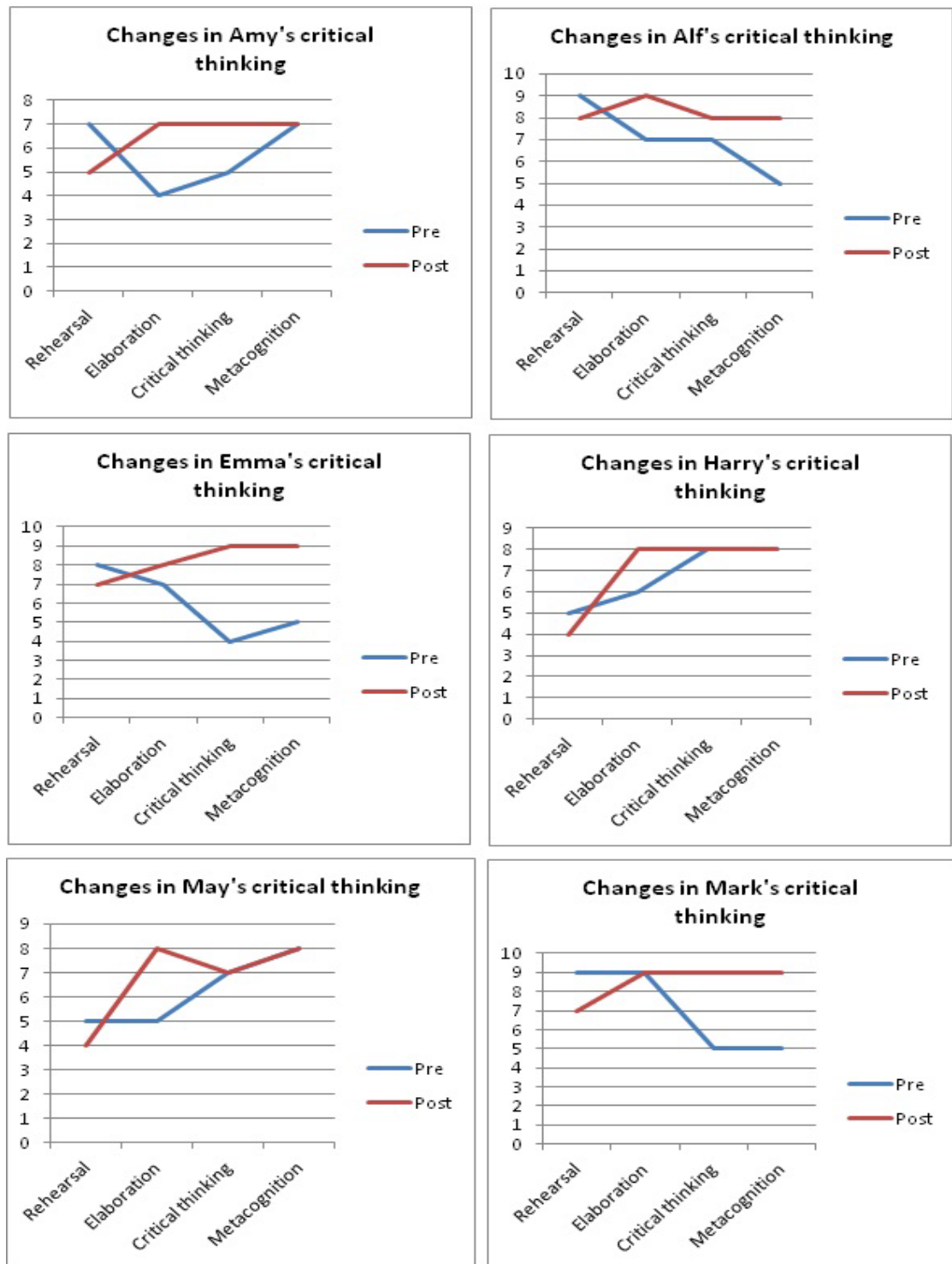


Figure 4.3: Individual changes to critical thinking by subscale

In summary, the pre/post test of student critical thinking (questionnaire) showed average improvements in critical thinking from pre to post video game use. The data also showed an average decrease in rehearsal and an average increase in elaboration, critical thinking and metacognition. It also showed that each of the focus group

students decreased their rehearsal from pre to post video game use, and increased or maintained their score for elaboration, critical thinking and metacognition from pre to post video game use. The results did not show how the video game, as a method of instruction, prompted these changes. However, triangulation of these findings against other data sources can assist an understanding of the ways in which the video game supported critical thinking. This synthesis and discussion is conducted in Chapter Five.

#### **4.1.3 PRE/POST INTERVIEW WITH CLASSROOM TEACHER**

The semi-structured interview with the classroom teacher (Appendix M) was designed to provide data to help answer both research questions, by gauging the classroom teacher's impressions of:

1. The focus group's knowledge of geography outcomes specified by the NSW syllabus, before and after video game use
2. The ways in which the video game supported geography outcomes specified by the NSW syllabus
3. The focus group's motivation to learn and critical thinking, before and after video game use
4. How the video game supported motivation to learn and critical thinking as a method of instruction

As intended, the interviews provided information about changes in student syllabus knowledge, motivation to learn and critical thinking for the focus group, from pre to post intervention, and provided some information about the ways in which the video game supported these changes. In discussion about syllabus outcomes, motivation to learn and critical thinking, the teacher identified which aspects of her method of instruction she believed supported these three aims. In all cases these aligned with design principles identified in the literature review for this research. The teacher also identified aspects of game play that went beyond the scope of her method of instruction. Table 4.9 summarises the comments the teacher made about her own instructional approach and when *GeoCity* went beyond the scope of her instructional method, sorted by the best practice design principle identified in the literature

review. These are further described in this section in relation to syllabus outcomes, motivation to learn and critical thinking.

<b>Design principle</b>	<b>Teacher's method of instruction</b>	<b>Principle beyond the scope of teacher instruction</b>	<b>Reference</b>
1. Perceived to be useful achievable and challenging		<p><i>"[Students were] really comfortable with it", "super excited"</i></p> <p><i>"[Alf] really sees learning as a chore, whereas I don't think he initially realised that this was a learning activity."</i></p> <p><i>"[Amy] was very comfortable with [the game] ... She can often let the defeat of not knowing something really get to her. So to have her always happy, hand up, asking a million questions ... you know she is really comfortable"</i></p>	DiSessa 2000; Gee 2005a
2. Learning is part of game flow		<i>"I don't think ... the kids realised they were actually learning something, which is perfect."</i>	Habgood, Ainsworth & Benford 2005; Villalta et al. 2011
3. Play involves collaboration	<i>"There is always some sort of activity, whether it is a group activity, verbal or a worksheet", "I try to answer other people's questions with the whole class".</i>		Fisher & Baird 2005; Salmon 2000; Steel 2009; Voulgari, Komis & Sampson 2014; Vygotsky 1978
4. Players have identity and agency	The teacher did not describe instruction equivalent to this principle, nor confirm or deny its effect.		Gee 2005a; Lombard & Ditton 1997; Ryan, Rigby & Przybylski 2006; Turkay et al. 2014; Villalta et al. 2011
5. Game play situates meaning	<i>"I try to question students ... in terms of topics or things that might be more familiar to them", "building upon where I know that they've come from".</i>		An & Bonk 2009; McRae 2001
6. Design respects cognitive load	<i>"There's usually some sort of written notation of what the introduction</i>		Gee 2005a; Sweller, Van Merriënboer &

Design principle	Teacher's method of instruction	Principle beyond the scope of teacher instruction	Reference
	<i>or the focus of each lesson is, so the students can refer back to definitions or any new information that is coming out."</i>		Paas 1998; Turkay et al. 2014
7. Offers an immersive, realistic and complex environment		<i>"[Mark's] a lot more settled and engaged."</i>	Dittmer 2010; Merchant 2010
8. Involves self-paced student inquiry, learning by doing and problem solving		<i>"There was a chance to go back ... [Amy] was one of the kids of the initial goods and services task ... for the whole first session, I think. But she didn't get defeated." "If they got something wrong, it wasn't just their mark and that was it."</i>	Ang & Wang 2006; Merchant 2009
9. Design supports teacher involvement and access to related resources	<i>"I try to vary things by using Interactive White Boards; we're using a lot of Internet based things [and] videos", "We'll quickly Google things as a whole class in case anyone else had that question as well".</i>		Barta-Smith & Hathaway 2000; Stumpf II, Douglass & Dorn 2008; Woener 1999
10. Play includes clear rules and objectives	<i>"They can copy ... a short paragraph to introduce what we are focusing on ... after the interactive introduction ... then there is always some sort of activity. And that's usually in every HSIE lesson."</i>		Garris, Ahlers & Driskell 2002; Santamarina et al. 2010; Shin et al. 2012
11. Play involves feedback	The teacher did not describe instruction equivalent to this principle, nor confirm or deny its effect.		Adam 1998; Friedman 1999; Gaber 2007

Table 4.9: Design principles included in teacher's method of instruction and video game

#### 4.1.3.1 Syllabus outcomes

The pre/post interview with the classroom teacher suggested that the video game supported Stage Two students to achieve the geography outcomes specified by the NSW syllabus. When asked if each of the six focus group students was achieving Stage Two geography outcomes before the intervention, the classroom teacher answered “yes” in regard to Alf, Emma, Harry and May, and “no” in regard to Amy and Mark. When asked how this was known, the classroom teacher stated that assessment results over the past five terms (all of 2012, and first term of 2013) were the main source, but also in-class activities, including worksheets and discussion.

In the post-interview, when asked if each of the six focus group students was achieving Stage Two geography outcomes the classroom teacher answered “yes” in regard to each of the six focus group students, indicating that all of the focus group students were learning Stage Two geography outcomes post-intervention. When asked how this was known the teacher said that these conclusions were based on:

- an assessment of the unit “Who Will Buy?” conducted independently by the classroom teacher; and
- observation and in-class discussion and questions throughout implementation.

It was the classroom teacher's impression that traditional classroom teaching supported four of the six members of the focus group to achieve Stage Two geography outcomes, and that *GeoCity* supported all focus group students to achieve Stage Two geography outcomes for the unit “Who Will Buy?”. These results can be seen in Table 4.10. The teacher noted the positive impact of *GeoCity* on student learning outcomes, stating: “*I was a bit concerned in the beginning, thinking ‘how much are they really going to learn?’, and I thought that my name was on the line [due to] how strict our reporting and assessing is. But I was really happily surprised with it.*”

Student	Achieving Stage Two geography outcomes pre intervention	Achieving Stage Two geography outcomes post intervention
Amy	No	Yes
Alf	Yes	Yes
Emma	Yes	Yes
Harry	Yes	Yes
May	Yes	Yes
Mark	No	Yes

Table 4.10: Teacher impressions of pre/post student achievement of Stage Two geography outcomes

Of particular significance were changes in learning of Stage Two geography outcomes noted by the classroom teacher for Emma and Mark. Emma was identified by the classroom teacher as an average student prior to the intervention; however, the classroom teacher stated that with the change in method of instruction: “[Emma] actually topped the class this term ... Judging by her written answers on the assessment, not a single fault could be found. I think that shows a massive growth from even her last term’s tests.” Mark, who was described by the classroom teacher as below average and not meeting Stage Two geography outcomes, also showed significant learning improvements from pre to post intervention. Before video game use, the classroom teacher explained: “He is not achieving the outcomes” and “my current instruction is not supporting his learning”. However, after video game use the classroom teacher noted that the assessment showed he was achieving Stage Two geography outcomes, that there had been a significant change in his learning, and stating:

*His written answers weren’t clear and concise. But he has difficulties with literacy as a base anyway. But sort of reading between lines, I understood what he was trying to say ... which is a big change. We had a similar amount of written answers in our science assessment, and the results were nowhere near as improved as this.*

When asked how her method of instruction supported syllabus outcomes, in the pre-interview the classroom teacher noted the following features:

- Written explanations on the focus of each lesson, including definitions, for students to refer back to, that students copy down
- Interactive whiteboard, incorporating web browsing, interactive activities and videos
- Collaborative, verbal and/or worksheet activities
- Class discussion of key learning content, including linking to existing knowledge
- Asking questions about familiar content and delivered content, to construct knowledge
- Responding to student questions by uncovering answers as a class, via Google or the dictionary, for example

This instructional approach is consistent with some of the instructional approach embedded in the game design, specifically: play involves collaboration and situates meaning, design respects cognitive load (via scaffolding), supports access to related resources and teacher involvement, and includes clear rules and objectives. Isolating these consistencies is important because, when asked about the ways in which the video game supported students to achieve Stage Two geography outcomes, the classroom teacher noted game design attributes outside the scope of her instructional approach. She did not comment on features consistent with her approach, to confirm or deny their presence or contribution to syllabus outcomes. However, the classroom teacher noted that learning being part of game flow in *GeoCity* produced positive results:

*I don't think – and this was across the board – the kids realised that they were actually learning something; which is perfect ... I think [Harry] responds well to this type of learning because he really sees learning as a chore, whereas I don't think he initially realised this was a learning activity.*

Likewise, the classroom teacher commented on the inclusion of feedback, opportunities for self-paced student inquiry and learning by doing and problem solving, and that the game was both challenging and achievable. She commented:

*I noticed that, with the activities, if they got something wrong, it wasn't just their mark and that was it. There was a chance to go back ... [Amy] was one of the kids on the initial goods and services task... That poor love was doing it for the whole first session, I think. But she didn't get defeated.*

This stands in contrast to the classroom teacher's comments about Amy before video game use, when she stated, "[Amy] has a big problem with self defeat". Finally, the classroom teacher noted the effectiveness of the immersive and complex environment to be explored, closely reflecting reality, evidenced in test results. In particular, she stated that students cited examples from the game environment to explain or give answers. She said: "You could see after the test that we did yesterday, then we went back through some of the questions, and I asked them 'how did you know this?' and they said 'from the game'."

The particular ways in which the video game supported these outcomes, noted by the teacher were:

- Perceived to be achievable and challenging (though whether it was *useful* wasn't confirmed or denied)
- Learning is part of game flow
- Offers an immersive, realistic and complex environment
- Involves self-paced student inquiry, learning by doing and problem solving
- Play involves feedback

The teacher did not comment on design features consistent with her instructional approach, nor note any ways in which the game adversely impacted syllabus outcomes.

#### **4.1.3.2 Motivation to learn**

The pre/post semi-structured interview with the classroom teacher also suggested that the video game supported students' motivation to learn. For the class as a whole, the classroom teacher noted that in relation to the game "*the kids were super excited ... in the days leading up to*" playing the game. When asked if each of the six focus group students was motivated to learn geography prior to the intervention, the classroom teacher answered "yes" in regard to Alf, Emma, Harry and May, and "no" in regard to Amy and Mark. This answer related to the classroom teacher's assessment of their motivation to learn geography over five terms (all of 2012 and first term of 2013), as indicated by their application to learning tasks and additional related learning, feedback from parents, questions, and concentration levels. When asked if each of the six students was motivated to learn post the intervention, the

teacher reported that five of the six students were, all except Alf, as indicated by these same sources during the period of implementation. These results are shown in Table 4.11.

Student	Motivation to learn pre intervention	Motivation to learn post intervention
Amy	No	Yes
Alf	Yes	No
Emma	Yes	Yes
Harry	Yes	Yes
May	Yes	Yes
Mark	No	Yes

Table 4.11: Teacher impressions of pre/post student motivation to learn

So, the classroom teacher noted changes that related specifically to Amy, Alf, Mark and Harry. Amy and Mark went from not being motivated to learn geography, to being motivated to learn geography, and Alf's motivation to learn decreased. Furthermore, she noted that Harry was more motivated to learn via the game than ordinary classroom instruction: *"He is a lot more motivated to learn this way."* So the teacher's impressions were that three of the six students were more motivated and one was less motivated to learn from pre to post intervention.

The most significant change was in Mark, about whom she noted: *"This afternoon he was panicking because of the limited time because of the computer crashing. He would nowhere near as much ... If his book burnt he would be alright."* She said: *"His behaviour in class has changed, definitely ... He's a lot more settled and engaged."* Similarly, the change in Amy's motivation noted by the teacher was stark. Before the intervention, the classroom teacher said that Amy was *"reluctant to participate in discussions. Usually she has to be called upon for information, rather than volunteering any information or suggestions."* However, after using the video game the classroom teacher noted that during implementation Amy was *"always happy, hand up, asking a million questions. You know that she's really comfortable and not unsure of things when she is doing the calling out and being quite loud and happy"*, and *"well, she came back from the weekend playing it, and she had some*

*information about her experience and stuff*". She added that Amy *"will talk about it, what she's learnt"*.

In the pre-interview the classroom teacher noted that her method of instruction supported student motivation to learn via the following features:

- Interactive whiteboard, incorporating web browsing, interactive activities and videos
- Class discussion of key learning content, including linking to existing knowledge
- Asking questions about familiar content and delivered content, to construct knowledge
- Pausing the lesson in response to, or to create space for, questions

This instructional approach is consistent with some of the instructional approach embedded in the game design, specifically: play involves collaboration and situates meaning, and design respects cognitive load (via scaffolding), supports teacher involvement and access to related resources, and includes clear rules and objectives.

As with the teacher's impressions of the ways in which the video game supported syllabus outcomes, isolating these consistencies is important. When asked about the ways in which the video game supported student motivation to learn, the classroom teacher noted game design attributes that were outside the scope of her instructional approach. She did not comment on features consistent with her approach, neither confirming nor denying their presence or contribution to motivation to learn.

However, the classroom teacher attributed the increases in motivation to learn post-intervention to students not realising the game was a learning activity, that being comfortable with and not defeated by the game was vital, including *"if they got something wrong ... there was a chance to go back"*, and the game being fun. In particular, before the intervention, the classroom teacher noted the impediment of *"the defeat of not knowing"* or fear that they would *"look stupid"* as de-motivating factors for Amy and Mark, which appeared to dissipate with video game use. These reflect the highlighted design principles of learning being part of game flow, and

self-paced student inquiry, learning by doing and problem solving. They also add detail about the teacher's impressions of the ways in which the game applied these principles in support of motivation to learn.

Furthermore, when asked about the shift in Alf's motivation, from more to less motivated to learn, the teacher identified his diminished motivation to learn as being "*with most things at the moment*". Though the game did not prevent or reverse this trend, the classroom teacher did not attribute this to the game, but to Alf's response to increasing levels of difficulty:

*He's always been the type of student that has been lucky to have the skills behind him that if he didn't put in effort, he'd still pass with flying colours. I think, especially this term, across all [key learning areas], it's finally starting to catch up with him. I've noticed this across the board now.*

The classroom teacher described him as being quite disinterested "*because he already knows it ... And when I say 'he already knows it', I mean he thinks he does*".

#### **4.1.3.3 Critical thinking**

The pre/post interviews with the classroom teacher also reinforced that the video game supported students' critical thinking. When asked if each of the six students was demonstrating critical thinking before the intervention, the classroom teacher reported two of the six were, three were not, and one was "*somewhat*" demonstrating critical thinking. Post the intervention, she reported that three out of the six were, that two were "*somewhat*" demonstrating critical thinking, and that one was not. The classroom teacher did not comment on changes in the quality of their thinking – such as rehearsal, elaboration, critical thinking or metacognition – but spoke about instances in which they were or were not displaying or prompting critical thinking, via questions, comments, answers, or other forms of communication.

The classroom teacher stated that Harry and May both displayed critical thinking prior to video game use, and that they continued to do so after the intervention. However, the classroom teacher noted changes for all other students. She said that three students showed improvements: Amy, who was not displaying critical thinking prior to the intervention, but post intervention the classroom teacher noted that she was "*somewhat*" displaying critical thinking; Emma, who was not displaying critical

thinking prior to the intervention, but was post video game use, and Mark, who was not displaying critical thinking prior to the intervention, but showing critical thinking “*somewhat*” after the intervention. However, she said that Alf showed a decline in critical thinking from pre to post video game use, from showing critical thinking “*somewhat*”, to showing no signs of critical thinking. These results are shown in Table 4.12.

Student	Critical thinking pre-intervention	Critical thinking post-intervention
Amy	No	Somewhat
Alf	Somewhat	No
Emma	No	Yes
Harry	Yes	Yes
May	Yes	Yes
Mark	No	Somewhat

Table 4.12: Teacher impressions of pre/post student critical thinking

In the pre-interview the classroom teacher noted that her method of instruction supported critical thinking via the following features:

- Responding to student questions by uncovering answers as a class. The classroom teacher said: “*When students have a certain question because they want to know more, or they’re trying to figure out why things are that way, the whole class is focussed on the answer. So, when we go off and Google things, or look something up in the dictionary, the answer’s not just given to the student who asks for it. So, critical thinking, I volunteer that sort of information*”. The teacher also noted that when students were not thinking critically they were still “*forced to engage with the ones we have with the whole class*”.
- Class discussion.
- Pausing the lesson in response to, or to create space for, questions.

This approach is consistent with some of the design features embedded in the game, specifically: play involves collaboration; situates meaning; design respects cognitive load (via scaffolding); and design supports access to related resources, and teacher involvement.

As with the teacher's impressions of the ways in which the video game supported syllabus outcomes and motivation to learn, isolating these consistencies is important as, when asked about the ways in which the video game supported critical thinking, the classroom teacher noted game design attributes outside the scope of her instructional approach. She did not comment on features consistent with her approach, to confirm or deny their presence or contribution to critical thinking.

However, when asked her impressions of how the video game supported critical thinking, the classroom teacher noted that students could make connections between the immersive and complex environment, and reality, including what they already knew. She also said that students were “*really comfortable with it*”, “*super excited*” and not defeated by the game. In other words, they found the game engaging, achievable and challenging. Furthermore, the teacher noted that, in support of critical thinking, “*if they got something wrong, it wasn’t just their mark ... there was a chance to go back*” and to work at their own pace.

The perceived decrease in critical thinking displayed by Alf was attributed to the same factors as those that negatively impacted his motivation to learn – a response to increasing levels of difficulty – and being “*exactly what [the classroom teacher is] experiencing in class too*”.

#### **4.1.4 INTERVIEWS WITH FOCUS GROUP**

Four interviews were conducted with the focus group, each immediately after an in-class video game play session. To gauge student learning, critical thinking and motivation to learn, and how the video game supported these outcomes, the interviews were semi-structured and involved asking students the following questions:

1. What did you learn today?
  - What in the game helped you learn this?
  - Do you want to learn more about this? Why?
  - Do you have any questions or ideas about this? Is it true? Why?
2. Did you forget about time passing while playing the game today?

3. Was the game hard or easy or just challenging enough today? Did you feel bored at all? Did you feel nervous while playing at all?
4. Did you feel involved in the game? Did you feel in control while playing the game?
5. Did you talk to other students while playing the game today? Why?

The interviews were also designed to generate discussion between students that could offer information in response to unasked questions, and provide further opportunities for students to demonstrate syllabus learning, motivation to learn and critical thinking, and their perception of the ways in which the video game supported these outcomes. Substantial data was collected about students' experiences performing and learning via each task in relation to the relevant syllabus outcomes (Appendix A). As such, findings about syllabus outcomes, and the ways in which the video game supported them, are organised and discussed in this section by topic. Further, many comments provided information about motivation to learn, critical thinking and how the game supported these. These related to interaction with the game generally, rather than particular topics. As such, these findings are not sorted by task, though when they relate to particular topics and tasks this is noted.

When asked if they talked to other students while playing the game, answers focussed on the chat function, though also mentioned some verbal communication that occurred in the classroom. Specifically, students mentioned what they liked and disliked about the chat function and why they used it. Amy, Emma and May stated they used it when they needed help. Emma also noted she used it *"when I needed to go somewhere or when I couldn't find something; and I helped other people. When I found something new I could tell other people"*. She added: *"my favourite part is when you can chat to people."* May and Mark talked about using it to identify other students in the game world. Mark and Harry said they used it to answer the questions of other students, and May noted using it to discuss with Emma how they would vote during the coal or solar power task. However, all also stated that they found it *"too much"* at times, and Mark said it was *"really annoying"* during particular parts of game play. Amy linked the problem to times when other writing was on screen, stating: *"too much writing; you can't concentrate and then all these things just*

*popped up*” and seeing it as a particular problem when *“it comes over the top”*. Furthermore, Mark noted frustrations when he asked questions via chat and *“no one was responding”*. Other discussion included positive comments about collaboration during game play: being used to get instructions, advice and ideas. For example, students noted: *“other people taught me how to get another pin number if I forgot”* and *“I tried the organic because [the teacher] came around saying ‘you should buy the organic eggs’”*. The one criticism of classroom discussion was from Alf who noted that it interrupted his listening to audio information presented in the game.

Through these interviews, the focus group students demonstrated:

- Syllabus-related knowledge
- Motivation to learn and play a game embedded with learning content
- Critical thinking, elaboration and rehearsal

They also provided information about the ways in which the video game supported these outcomes. Many comments related to interaction with the game generally, rather than for particular tasks, most of which suggested evidence of motivation to learn and critical thinking, which are detailed further in this section.

#### **4.1.4.1 Syllabus outcomes**

Contributions from the focus group interviews included discussion on each of the learning topics included in the game design. The sum of these contributions related to all eight syllabus outcomes for which learning content was included in the video game design. However, the frequency and quality of discussion in relation to topics and tasks and these outcomes varied.

Specifically, transcription and analysis of video and audio recordings taken during the focus group interviews showed that the task for which the most contributions were made was needs and wants, with 40 mentions. This was followed by goods and services with 30 mentions, then technologies involved with monetary exchange with 22 mentions. Goods and services, needs and wants and the technologies involved with monetary exchange were the only three tasks that were constant throughout game play. Indeed, accessing money was necessary to buy goods for the ongoing

satisfaction of needs. Thus, there was a clear relationship between frequency of content in the game and frequency of task discussion in the group semi-structured interviews. Of the remaining tasks, coal or solar power was mentioned 20 times, caged eggs 17 times, bread 13 times, and organic eggs and consumer rights nine times, and needs and services eight times. How this discussion of the various tasks and relevant design features related to evidenced syllabus outcomes are detailed below.

#### ***4.1.4.1.1 Goods, services and needs***

Students discussed many of the goods and services available in *GeoCity*, but there were only three contributions that defined them respectively, one of which was incorrect. The definitions of goods and services offered by computer-controlled avatars via speech bubble were not repeated by students, nor shown to have contributed to syllabus outcomes during the group semi-structured interviews. However, when asked, correct examples of goods (various food items and electrical goods) and services (“*hospital*”, “*soup kitchen*”, “*fire brigade*”, and “*police*”) were noted. An A grade response for this task would have given clear definitions for a selection of goods and services to demonstrate a thorough knowledge of the topic. However, based on the comments given, the focus group showed sound or C grade learning in relation to goods or services for the relevant syllabus outcome: the group was able to give some examples, but could not give clear definitions or conclusions in detail.

This data source also provided evidence about the ways in which *GeoCity* supported learning for this task. The correct examples provided by students were all goods and services available in *GeoCity*, providing evidence that meaning was situated, and that the immersive environment contributed to learning about goods and services. Harry commented: “*It’s like playing a real life game. You need to go place by place*”. However, significantly, students raised difficulties with the goods and service task. They said they found the rules and objectives of the task to be clear, but noted that it felt too difficult, test-like and that the availability of chat during the task was annoying and distracting. Students commented: “*When I had to do the activity I got a bit confused when I was doing it*”; “*It’s hard when all the goods and services came*

up". Comments such as, *"I was trying to do the test and someone's sending messages, and it comes over the top; it was so annoying"* and *"[Emma] just keep sending me notes and notes and notes"* call into question the success of planned respect for cognitive load experienced by learners with this task, and show that the way in which collaboration occurred was a hindrance at this point in the game for some students.

Discussion about needs and services task during the focus group interviews provided further information about the ways in which *GeoCity* supported syllabus outcomes. It also revealed that some game design features did not support learning. Students defined needs: *"You need all the stuff that will help you live"* and *"something that will keep you alive"*. However, no definition of services was given by students, nor needs in relation to services, though students elaborated with several correct examples of services such as *"protect the community"*, suggesting a sound but not thorough understanding of needs and services. These included the hospital, soup kitchen, police, and fire brigade. Students talked about needing to and calling the fire brigade when Jack's house was on fire and that this led to the fire brigade putting out the fire.

Taken together, the group's comments demonstrated a sound or C grade level of knowledge and understanding of the main areas of content and an "adequate level of competence in the processes and skills" (Board of Studies NSW, n.d.) in relation to needs and services for the relevant syllabus outcome. An A grade would be given for answers with clarity, the number and strength of examples given, and a description of why the learning content was important. The group was able to define needs but gave only examples of services with no reasoning to support their knowledge, and could not explain the importance of needs and services to a community.

Moreover, discussion confirmed that using services to address Jack's needs in the game was seen as useful and achieved through video game play, that learning was part of game flow, that the immersive environment contributed to student knowledge (a design principle that was not intentionally included in this task), that is meaning was situated, and that actions in the game had consequences.

However, discussion of this topic was brief and detail was only discussed in relation to the incident where Jack's house caught fire; suggesting, students did not demonstrate broader definitions about needs in relation to services, nor apply learning about needs and services to other contexts. The way in which collaboration was prompted for this task, all needing to participate simultaneously, also led to some incorrect conclusions. Emma noted: *"You need to work together to make the fire station work, because if one person is making the fire station call there won't be enough calls from everybody in the street."* Here it was clear that the inclusion of necessary collaboration, at the expense of replicating the way in which the fire brigade meets community needs in reality, had a negative impact on learning. Furthermore, while it was intended that this part of the game would also include scaffolding, the success of this part of the design was neither confirmed nor denied in the group interviews.

Similarly, the focus group interviews provided information about what students learned via the needs and wants task as a result of using the game. Students gave examples of needs that must be satisfied in the game, including food, community, clothing and shelter. They also defined needs and demonstrated evaluation – *"you need all the stuff that will help you live"*, *"something that will keep you alive"* – and contrasted them to wants – *"something that you don't need, but you want to have it"*, *"like a toy or chocolate"*, *"like a PlayStation"*. Students also gave examples of needs and wants outside of the scope of the game; that is, they successfully applied the definition, for example, *"water"*, *"love"*, and *"earning money"*.

From these examples it can be seen that students demonstrated high, or B grade, development of knowledge about needs and wants: the group showed a "thorough knowledge and understanding the content" and were able to "apply this knowledge and these skills in most situations" (Board of Studies NSW n.d.). The group could have given more concise explanations, and better defined examples, which would have warranted an A grade. The group also addressed the syllabus outcome included for this task: examine the goods and services provided within the community and by community organisations to meet needs.

Students also indicated the ways in which the game supported their learning. Mark commented: *“When I was playing, it said I wanted an Xbox, but he said ‘I don’t really need it but I just want it’.”* This affirms that the inclusion of access to resources during this task, Mark was referencing information stated by the computer-controlled avatar Jack via speech bubble, functioned to support cognitive load via scaffolding and syllabus outcomes. A statement from Emma suggested learning was part of game flow, that she experienced identity and agency in the game world through her avatar: *“When everything ran out on hunger and clothes, I needed to buy everything, so I went to see how much cash I had and I had \$100, so I went and I bought some clothes and some food”.* May said: *“You should think about what you really need.”* It should be noted that there was no spoken confirmation of the respect for cognitive load, nor of cognitive overload, in relation to this task; that is, this intended design feature was neither confirmed nor denied via the group interviews.

#### ***4.1.4.1.2 Technologies involved with monetary exchange***

During the focus group interviews students demonstrated learning about the technologies involved with monetary exchange, and provided information about how the video game supported this learning. Students described, in detail, the technologies involved with monetary exchange. A discussion between Alf, Harry and May provided one example. Alf said: *“When I was playing the game I didn’t know how to get another PIN number.”* Harry responded: *“You go to the ATM and press right in the corner on the ATM screen. You can see ‘get another PIN number’.”* May added: *“Enter your card where it’s supposed to go, then it says ‘type in your PIN’. You type in your PIN, but if you get it wrong, then it says ‘request PIN’. You press that and you go out and it says ‘you’ve got mail’. You get your mail and you get a new number”.* Taken together, these comments demonstrate outstanding or A grade learning, including an extensive knowledge and understanding of the technologies involved with monetary exchange, and a very high level of competence in the process and skills involved. The group met the related syllabus outcome, “identifies the different technologies involved with monetary exchange”, by giving clear explanations, numerous examples and

discussing the consequences and experiences of technology and money.

Students also explained the ways in which the video game supported this learning. They affirmed the presence of design principles applied in this part of the game and noted some of the specific ways they were applied in support of syllabus outcomes. For example, Alf said, *“I typed in how much but first it said ‘failed, failed, failed’ and then I typed in \$100 and I actually got \$100”*, Emma added, *“if you press on the wrong number you got to do it all over again”*, and Harry elaborated *“I wanted to go to the bank but then I realised that you need a bank card”* and *“When I buy something, I thought I was using cash but I was using credit; when I pressed cash I was using my credit”*, providing evidence of player agency, self-paced student inquiry, learning by doing, problem-solving, feedback and that the task was perceived to be useful, achievable and challenging. It was also evident that learning was situated, critical, part of game flow, and contributed to by the immersive and complex environment. Amy said: *“You get a credit card. If you go to the bank, you can get money out, and then you can go shopping and then you can use it”*. Finally, May made comments that noted the contribution of scaffolding to learning outcomes. She said: *“The only problem with having a bank card is, when I got my bank card and saw the PIN number, I thought I had it in my head and pressed close, but I forgot my PIN number. I tried to remember it but I don’t know whether it’s the right PIN number or not”*. Then, suggesting that collaboration supported syllabus outcomes during the task, an unintended inclusion, and how critical thinking was supported by the activity, she said: *“I have four PIN codes, but I forgot all four pin numbers. Because when you get your first one if you don’t use it then that becomes... you have to use your last one. I tried to use one I already had but I couldn’t use it. And then one of the other people taught me how to get another PIN number if I forgot”*.

#### **4.1.4.1.3 Production and distribution**

Throughout the group semi-structured interview, students demonstrated learning about bread, caged eggs and organic eggs production and distribution, and provided information about how the video game supported learning via the associated tasks. Students identified the components of the systems involved in bread and eggs

production and distribution, how the components need to interlink, and how these goods are provided within the community to meet needs, meeting syllabus outcomes 1 and 5 (see Appendix A). May said she *“learnt today how to make bread... I learnt that after you collect the wheat you have to mill the grain, and then you take it to the bread factory.”* Harry said: *“I learned about where bread comes from ... I learned that first you have to plant the wheat, then you harvest it. And sometimes there can be so many seeds, and then you have to grow the wheat. When it’s done you have to put it in the flour mill, and mill the grain”* and *“You first make the bread. To make the bread you use dough, then you package it. No, no, no... Then you put it in the oven – not package it – then it’s bread. Then you package it and send it to the supermarket, and then you buy it.”* When asked what “milling” was, students were able to elaborate on their explanations: *“It’s like you put it in like a wheel then just like mix it up,”* Harry said. Emma explained: *“Milling grain: you put it in this kind of box and you sift it, and then you take it off and sift it again, and keep on sifting again until you get flour.”* May said: *“I think you put it in like a square thing. You put your wheat in and then it goes through all these things and you push and the shell cracks.”* Amy said: *“They get ground small.”* About caged eggs, Harry said: *“It showed like chickens all in cages and then the cages getting the eggs, and then the farmers get the eggs, and they wash it and put it in the packages and send it to the supermarket. And then they sell it”.* He elaborated: *“There was all chicken in the cages. They were caged and they couldn’t get out.”* Mark said: *“They have to cut their beaks off. Then they’re put in the cage. Then they give them food and water. Then they eat the food. Then they get the eggs from them. Then they clean the eggs. Then they package the eggs and then they take them to the supermarket.”*

About organic eggs, Alf said: *“It showed me the house with the hens in it, and I had to press the house so the hens can come out. I turned the tap on so they can keep on drinking so I can go in. And then said get all 12 eggs and that was all of them but there were more missing. And then after a while, after I collected them, it showed me this big place, and it’s like a line and you can’t just press the egg, you have to drag it and put it on the line, then it washes for you and then you put it in a little lid.”* May evaluated: *“I did the task with organic eggs. I had to get the eggs from hen house, and get them washed, and feed the chickens. So I got of an idea of how a farmer*

*would do it.”*

Students also demonstrated an investigation of current community issues, meeting syllabus outcome 10 by commenting on and asking questions about caged and organic eggs:

- Alf evaluated: *“Organic eggs... They’re treated well. Caged eggs, it’s like when they’re not treated well”.*
- Amy elaborated: *“I learned that organic eggs can run around, and they have more fresh air than caged eggs”.*
- Emma said: *“You can buy caged eggs or you can buy organic eggs.”*
- About caged chickens, Alf evaluated: *“They chop their beaks off. That’s so cruel”.* May added: *“That’s so sad”* and *“Organic eggs are better for the chickens because they’re not treated as badly as caged eggs.”*
- Emma evaluated: *“What I learned about organic eggs was that organic eggs is better for the chickens because they can run around they can eat, but when you are in the caged eggs you have to cut their beaks off, they can’t run around, they have to stay in this little house”.*

Through the discussion outlined students’ demonstrated achievement of syllabus outcomes 5 and 10. However, the learning was less clear for content in line with syllabus outcomes 6 and 11: “makes statements about the social and environmental responsibilities of producers and consumers” and “investigates consumer rights and responsibilities” (Board of Studies NSW 1999, p. 110). Students made value-based comments, offering some evaluation, such as *“Organic eggs... they’re treated well”*, *“Caged eggs, it’s like when they’re not treated well”*, *“You shouldn’t treat chickens as if they don’t have feel, like chopping their beaks off”* and *“It says ‘do you want to buy organic eggs?’ and I said ‘yes’”*. However, these comments were not explicitly linked to producers and consumers.

Overall, this discussion provided evidence of high or B grade learning in relation to bread, caged eggs and organic eggs. The group showed a thorough, but not extensive, knowledge and understanding of the associated learning, and slightly

stronger syllabus outcomes in relation to organic eggs, with student comments noting the relationship of the task to the real world. They were also able to apply the knowledge to numerous examples and conclusions. However, it also showed the syllabus objectives were not sufficient in relation to syllabus outcome 6. Students asked questions and made general statements about the ethics of caged and organic eggs production; one spoke about responsibilities from the perspective of a consumer, but none spoke explicitly about the responsibilities of producers. Discussion of the steps involved in each of the processes demonstrated that participation in the task was achievable, and that learning came via game flow and the immersive, realistic environment in which learning was situated.

#### ***4.1.4.1.4 Consumer rights***

Students' comments on consumer rights provided further information about the ways in which *GeoCity* supported syllabus outcomes, and also revealed some problems with the design of this learning task. When asked what they could do if they purchased a faulty product, students correctly explained their rights: that they could return it, or have it replaced or fixed. In response to the question students responded: *"You have to like give it back, and then they have to replace it and give you another one, or you can get your money back"*, *"fix it"*, *"give you your money back"* and *"take it back to the shop and get your money back"*. These comments provide evidence of high or B grade learning of the relevant syllabus outcome, by demonstrating a thorough understanding of consumer rights and their application. They also reflect the three available options presented in the game world when players purchased a faulty product, providing evidence that students learned by doing and through actions having consequences; and show that the concepts around consumer rights were situated and part of game flow. Responding in the first person, talking about exercising their rights, also suggests students experienced identity and agency during this task. However, the data also showed a problem with the design of the consumer rights task. Students did not always realise the product was faulty at the time of purchase, and/or assumed the problem encountered was their fault. As such, when this happened, they did not seek to exercise their rights as a consumer. Emma incorrectly thought her ripped top was her fault, and Mark noted there was *"something wrong"* with a television

he purchased so he “*lost some money because there was no TV*”. In both cases, only some of the information provided when the fault was found was comprehended by students. Though they were told how they could exercise their rights as a consumer, some missed this, suggesting that too much information led to cognitive overload and that the rules were not clear to all students during this task.

#### **4.1.4.1.5 Coal or solar power**

Student discussion examined coal and solar power systems, designed to meet needs in communities, and identified their advantages and disadvantages (a current community issue), relating to syllabus outcomes 2, 5 and 10. For example, Emma repeated learning content by saying: “*I learned that coal power is made out of this kind of rock under the ground and solar power is made out of heat and light, and that they make electricity.*” She added: “*Solar power is more expensive than coal power, but coal power is more expensive to run.*” Mark also relayed learning content: “*Solar power is much more healthier and coal power gives you pollution and can make you sick.*”

Further discussion demonstrated the group could apply their knowledge to new situations, in this case, in civic action in the community when the task required them to vote on *GeoCity*’s energy generation. Harry said: “*Coal causes air pollution and solar doesn’t do pollution. Coal is non-renewable and solar power is renewable because the sun is always there*”. The group noted what they were voting for, why, and the individual and collective implications of the outcome, relating to syllabus outcome 9. For instance, May said: “*The most expensive to build is solar power... But you just get sunlight, just like that, and you don’t have to pay anything. But when you do coal power, it’s cheap to build but then you have to pay more when using it*”. Emma said: “*I chose solar power because it’s much healthier for you.*”

Taken together, these comments indicate an outstanding or A grade development of knowledge for the group under the NSW Board of Studies A to E grade scale, as outlined in Chapter Three; the group had “extensive knowledge and

understanding of the content” and were able to “readily apply this knowledge” (Board of Studies NSW n.d.). Their definitions of coal and solar power were clear and concise, and they were able to give examples of how each impacted the community of *GeoCity* and applied this knowledge to reality. Further, the group was able to speak extensively about their roles in civic action within the community and assessed consequences to draw conclusions.

The group's comments also indicate the ways in which this learning was achieved. The weighing of pros and cons of coal and solar power, and collaboration between students on how they would vote and work together situated meaning and was useful for decision-making. The group's consistent first-person referral to their avatars indicated the players had identity and agency. The game was also perceived to be achievable, as May noted: *“I didn't really know what coal power was and then when I came back here, now I know what coal power is.”* A comment from Emma provided evidence that the inclusion of clear rules and objectives for the task functioned as intended, that the design supported access to related resources, and that learning was part of game flow: *“I learned that there was this woman and man, and they were talking about how solar and coal power was working, and then you have to choose between coal power and solar”*. That this task involved feedback was recognised by Mark who noted that before the vote there was a coal power plant in *GeoCity*, and that afterwards there was a solar power plant. Design features that were not affirmed nor denied via discussion during the interviews were: design respects cognitive load and includes scaffolding, offers an immersive and complex environment that closely reflects reality, and that the task was challenging.

#### **4.1.4.2 Motivation to learn**

All six focus group students asked for access to the game outside of class time, suggesting independent motivation to play. Comments suggested motivation to learn in this way, not just motivation to play the game. For example, Harry stated: *“it was like playing the best thing you could ever play, because you are actually learning something”*. During the first group semi-structured interview all students stated they forgot about time passing while playing the game, that they felt involved in the game

world, in control, and that they were not bored at all while playing the game. Indeed, May commented, *“I felt like I was actually in the game”* and *“when you play the game, you just want to sit there and keep playing and keep playing and keep playing; so it really, like, pulls you to the computer”*; Mark said, *“it was like our own bodies and it was like we were grownups”*; and May added, *“it’s good because it’s like you are an adult, and you get to choose what you want to buy, and you get to hold onto a bank card, and you get to go to the ATM and collect money and buy what you want”*.

During subsequent interviews, students raised issues such as the technical problems that occurred during game sessions, and reflected on how they affected their motivation. In particular students noted that when technical problems occurred they found the game difficult and their interest levels dropped, especially when loading was slow. For example, May said *“I wasn’t bored when I was playing the game, but I was bored when it was loading”* and all members of the group stated their agreement. Alf also stated that he noticed time passing out of concern he would *“run out of time”*.

The group confirmed the game was *“just hard enough”* and May summarised *“it was hard but it was fun”*, but some students indicated they experienced test anxiety in relation to some tasks, such as the goods and services task. Mark said: *“There was that test kind of thing. I’m like, which one is it.”* Emma, Harry, May and Alf stated they did not feel nervous while playing the game; Amy expressed nervousness in relation to the goods and services task which she also called a *“test”*, and Mark stated, *“I was really shy about playing the game; I didn’t know what to do... and who was going to see”*.

Students also asked questions during the semi-structured interviews that indicated motivation to learn more: *“What happens if they have their beaks and they’re caged? Do they just have a fight and does one die?”*, *“What if they’re in a big cage?”*, and *“What happens if you, for example, have two chickens on a farm, and a chicken gets sick, would the chicken still have to stay in the cage, or could you take it out?”*.

Finally, Harry expressed a desire for more from the game world, indicating both motivation to play and that he wanted more from the game: *“I think there should be more detail, because you should have shown which place you want to go to; like the world, but you want to go to Australia, you want to go to Europe...”*.

#### **4.1.4.3 Critical thinking**

During focus group interviews students demonstrated not only learning and motivation to learn but critical thinking. For instance, Harry discussed and evaluated coal and solar power via comparison: *“Coal causes air pollution and solar doesn’t do pollution. Coal is non-renewable and solar power is renewable because the sun is always there”*. May, on the other hand, evaluated the two energy sources based on cost: *“The most expensive to build is solar power... But you just get sunlight, just like that, and you don’t have to pay anything. But when you do coal power, it’s cheap to build but then you have to pay more when using it”*. Rehearsal, elaboration and evaluation were further demonstrated in the coal and solar task when students explained the process involved in civic action within the community, noting what they were voting for, why, and individual and collective implications of the outcome, relating to syllabus outcome 9. For example, May said to Emma: *“When I was voting I asked [Emma] ‘what did you vote?’ and she said ‘solar’, and I said ‘I will vote for solar as well’.”* Amy noted: *“We have to be together and work together”*, drawing conclusions about how public decisions are made from the context of the task. Mark said: *“If there is just one person there and you just vote there was not enough people are there, you won’t be able to vote because if you just vote for one thing, then the other thing has zero votes, and you just voted for one thing.”* Emma concluded: *“I chose solar power because it’s much healthier for you.”* This weighing of pros and cons of coal and solar power presented by students, to determine how they voted, provided evidence that the task supported critical knowledge building.

Elaboration and critical thinking in relation to the needs and wants task was evidenced when May said: *“If you’re freezing and you already have a couch and you want to buy another one, you should think about what you really need. You should buy the things you really need and then buy what you want; you should buy all the things that you need first and then what you want because you have lots of wants and*

*if you don't buy the things you need your person will get very hungry and very cold*". This affirms the inclusion and positive impact on learning of situating meaning and supporting critical knowledge building via this task. In addition, May and Amy noted design features that contributed to this. May said: *"When my person got hungry I had to feed it, otherwise it would get really hungry"*. This shows learning about needs via feedback, and that actions were useful, challenging, and involved decision-making. Amy said: *"You figure out the shops. You get to buy fun things. If you need to buy clothes you have to go to the right shop"*. This provides evidence that the immersive, realistic and complex environment intended for this task was successfully delivered. Notably, the group's ability to identify examples of needs and wants outside of the scope of the game such as "water", "love", and "earning money" were required to meet outcomes, but also demonstrated elaboration and critical thinking, as students applied prior knowledge to the definition in providing answers.

Furthermore, the questions asked about caged and organic eggs demonstrated critical knowledge building and evaluation. For example, students asked, *"What happens if they have their beaks and they're caged? Do they just have a fight and does one die?"*, *"What if they're in a big cage?"*, and *"What happens if you, for example, have two chickens on a farm, and a chicken gets sick, would the chicken still have to stay in the cage, or could you take it out?"*.

Finally, comments from May in relation to the technologies involved with monetary exchange task suggested both that the task supported critical thinking and how the task did this. She said: *"I have four PIN codes, but I forgot all four pin numbers. Because when you get your first one if you don't use it then that becomes... you have to use your last one. I tried to use one I already had but I couldn't use it. And then one of the other people taught me how to get another PIN number if I forgot"*. May's weighing of options and testing of solutions noted here, suggests critical thinking. They also suggest that collaboration, an unintended inclusion during this task, supported this process. Furthermore, other comments from May provide further evidence of design principled that supported this. She said: *"The only problem with having a bank card is, when I got my bank card and saw the PIN number, I thought I had it in my head and pressed close, but I forgot my PIN number. I tried to remember*

*it but I don't know whether it's the right PIN number or not*". This suggests that scaffolding and the inclusions of self-paced student inquiry, learning by doing and problem solving, also contributed to critical thinking during the technologies involved with monetary exchange task.

#### **4.1.5 OBSERVATION**

Students were observed over the course of the four video game play sessions, in the classroom and from video and audio recordings of the sessions. In the classroom the researcher acted as participant observer, providing guidance and assistance and making structured and unstructured observations against the observation guide in Appendix N. The researcher also made further observations of video game play sessions, using the video and audio recordings. These observations provided information about student learning, motivation and critical thinking and how these were supported by the video game. They also provided evidence of how the design of *GeoCity* functioned; that is, how and in what ways the video game design principles actually functioned. Some of these related to syllabus outcomes, motivation to learn and critical thinking, not just one of these aims. These general findings are outlined below, followed by findings that related specifically to syllabus outcomes, motivation to learn and critical thinking. Triangulation of these findings, against other data sources, can assist an understanding of the ways in which the video game supported syllabus outcomes, motivation to learn and critical thinking. This synthesis and discussion is conducted in Chapter Five.

The online immersive world with multiplayer capability was chosen to support immersion in the environment being studied, interaction and collaboration, and active engagement with the learning material. The researcher observed immersion in the video game and interaction/active engagement with the game world during game play, evidenced via concentration on and participation in video game play. The two exceptions to student immersion were when technical problems interrupted video game functioning, and when students felt unable to achieve particular tasks. In both cases student's concentration/participation was broken, and they asked the researcher for assistance if the problem persisted. This also related to cognitive load. Observation suggested that cognitive load was respected most of the time during the

game. Evidence for this included all the times students successfully navigated the game without support and when there was no evidence of cognitive overload. However, it also provided evidence that cognitive overload was experienced in relation to technical problems that added load, and with particular features and tasks, explored below.

Collaboration was observed throughout video game play. Students collaborated via textual chat in the game world as planned. In addition, verbal and non-verbal communication in the classroom was also witnessed. How this related to syllabus outcomes, motivation to learn and critical thinking is outlined below. However, it should also be noted that this was observed to support game navigation, essential to participation in the game world and shared syllabus knowledge. For example, students asked and gained information about how to access particular tasks, such as how to use the ATM. Questions related particularly to unlocking features, and students were observed looking at each other's monitors and seeking to access the particular game play witnessed, particularly for the caged and organic eggs and bread tasks and for ATM use. In fact, students discussed content while participating in the ATM and organic eggs tasks; tasks that did not include audio. This provided evidence that the game provided access to related resources and teacher involvement, by positioning players, the researcher and the teacher together in the classroom during game play.

The final general observation that related to video game function related to access. Some students required support from the researcher to assist with navigation when they first started playing *GeoCity*. While some were comfortable clicking on things and uncovering and using features via exploration and trial-and-error, others clearly wanted instructions. In the case of the latter, this was provided by the researcher when asked. The need for researcher support with navigation abated after the first video game play session. The two exceptions were requests for support in relation to technical difficulties, and to trigger and use particular features. This was especially the case for the technologies involved with monetary exchange tasks, the goods and services task, the consumer rights task and production and distribution tasks.

#### 4.1.5.1 Syllabus outcomes

Observation of student navigation of the video game, discussion, questions, non-verbal communication and requests for assistance, provided information about syllabus outcomes and the ways in which the video game supported them.

Questions and requests for assistance during the goods and services task suggested that too much information was provided simultaneously, and that cognitive overload and sustaining immersion were a problem during the task. Observation suggested that the goods and services task did not include immersion nor meaning that was situated, as this task happened outside of normal game play and largely preceded interactions in the game world with goods and services. Many students asked for help during the task and their requests indicated some had either missed a crucial definition, piece of information, or instruction, or were concerned they had. However, some students also framed barriers they faced in the context of what they were learning. For example, five students correctly defined goods and services in order to ask how particular features in *GeoCity* fit with the definitions, in order to complete the task. Students used the definitions on screen, as well as the explanations of the various goods and services, in framing their questions, providing evidence of the value of this aspect of the task. Students also asked questions suggesting the goods and services task was perceived to be useful, and that feedback and consequences were recognised: they asked for help when incorrect answers meant they could not advance in the game world, indicating the use they found in the task for advancing game play, and related content to real-world objects. Furthermore, while a great deal of chat use was observed, adding cognitive load, none of the chat witnessed during the goods and services task, was used to share learning content or support task completion. In fact, chat use during the goods and services task interrupted learner's attention, and many students complained about the presence and persistence of video game chat use during the task. Rather than being used to support syllabus outcomes, chat content during the goods and services task reflected student excitement to use the function and the game. For example, students asked which class members had particular user names, and greet and ask how each other were. It should be noted that this task took place early in the first session of game play, as

students discovered the chat function. Furthermore, when open, chat was observed to cover up an important definition for the task.

One of the game aims is to satisfy the needs and wants of avatars. The hunger meter, which displays one of the avatar's needs at the bottom of screen at all times during normal game play, was observed to prompt student learning across two syllabus topics: needs and wants and technologies involved with monetary exchange. When the hunger meter dropped, students sought to buy food, often talking to one another, the teacher and the researcher about how to satisfy hunger. Students also sought to access money to buy food, asking questions of each other such as "*how do you get a bank card?*". Students were also observed asking one another how to use the ATM, bank card facility and bank and watching others use the ATM to learn how, as the hunger meter dropped.

Evidence of how students used the game and accessed learning content was also provided via observation of game navigation. Players hovered the cursor over objects to access information about them. In the case of the technologies involved with monetary exchange, consumer rights and organic eggs tasks, students were observed successfully operating the ATM, exercising their rights as a consumer and carrying out tasks on the organic eggs farm; actions dependent on establishing syllabus knowledge. Students were also observed asking one another how to use the ATM, bank card facility and bank and watching others use the ATM and navigate the organic eggs task; so peer-to-peer collaboration via talking, watching and the chat function also supported navigation in-line with syllabus outcomes. Talking and watching were not part of the game design, but clearly having students play in the same room allowed for this additional collaboration.

Written instructions, including those delivered via speech bubble, in a pop-up box or chat, were observed to support learning in some instances, though were missed by some students in others. As with the goods and services task, multiple written pieces of information, provided to students in quick succession, impeded syllabus outcomes for some. For the consumer rights task, while some students were witnessed successfully navigating the task, others were seen failing to exercise their rights as a consumer. In terms of game design, it was clear that all students who attempted to

exercise their rights as a consumer were able to navigate the relevant process in the game. However, some simply did not register or comprehend the written message, that a product they just purchased was faulty and/or that they could do something if they purchased a defective product. It should be noted that this information was given in two written messages, given in quick succession. This contrasts the observed interaction with the needs and services task, during which students correctly navigated the task without asking for assistance. They followed the instructions delivered via speech bubble in slow succession, attempting both correct and incorrect actions, though correcting incorrect answers in response to game feedback.

In the case of the coal or solar power, caged eggs and bread tasks, students were observed watching and listening to information about production and distribution. However, when it came time to sorting the steps involved in bread and caged eggs production into the correct order or choosing what to vote for, students were observed talking to other students, often pointing at words on screen and discussing the learning material and weighing their decisions. Collaboration at this time and in this way appeared to support learning; an unexpected inclusion as this was not part of the video game design. Students displayed no signs of missing pieces of information, nor being overwhelmed by what was presented, suggesting the design of the coal or solar power, caged eggs and bread tasks respected cognitive load. Indeed, for all three tasks students did not ask for the researcher's help to navigate them.

#### **4.1.5.2 Motivation to learn**

Student motivation to play the video game was evidenced when students rushed to computers at the start of each session, noted how happy and excited they were to be playing, announced things they were doing based on their learning such as "*I'm voting for solar*", a comment also demonstrating student agency, and lamented when the video game play sessions ended. The excitement was not expressed specifically in terms of motivation to learn; it was motivation to play a game embedded with learning content. Motivation to learn and advance in the game world was indicated via student's questions such as "*how do you get a bank card*", queries that sought to uncover learning content. As such, collaboration and the ongoing availability of

support when needed, from the researcher, the classroom teacher and other students, clearly met this motivation by supporting participation and achievability. This is significant, as while students struggled with the goods and services and consumer rights tasks, as outlined above, challenges were overcome and the tasks were perceived to be achievable with this support. Likewise, students were observed hovering with the cursor over objects to uncover information about them, again supporting achievability and also access to related resources.

Interestingly, the highest levels of concentration were observed when information was being presented via audio, including during the coal or solar power, bread and caged eggs tasks, when information entirely reflected syllabus content. The presentation of information via audio appeared to support student engagement. High concentration levels were observed during coal or solar power, caged eggs and bread audio presentations, with students' silent, concentrating and focussing on their monitors.

Motivation to participate in some tasks was clearly prompted by seeing others do so, and trying out previously unused or locked content. Students were observed watching other students, at times then asking how to trigger the relevant task. Students being located in the same room while playing the game made this possible. This was particularly the case for the technologies involved with monetary exchange goods and services, consumer rights and the production and distribution tasks, during which many students were observed watching others screens and imitating their actions.

Various opportunities for self-paced learning appeared to support participation and engagement from students with varied capacities. For ATM use and the production and distribution tasks, students worked through activities at different paces, and often made mistakes and took multiple attempts to complete them. For the bread and caged eggs tasks students also moved through factories at different speeds; some students listened to chunks of information more than once, affirming and showing the value of opportunities for self-paced student inquiry. They demonstrated correct navigation of the tasks at various speeds, particularly in relation to ATM use. There did not appear to be a difference in concentration levels observed between students who

completed the tasks slowly, and those who completed them quickly.

Finally, rewards appeared to motivate students to seek out and successfully complete some learning tasks. In relation to the production and distribution tasks, students expressed pleasure when they earned money via completion of the tasks, telling one another what they had earned, and asking each other how they could earn more money. Once they completed their first production and distribution task and received their reward, some sought similar to earn more money. Students made comments such as *“I want to make more money”* and *“I need to do the bread stuff to get money”*. This reward of money created opportunities to buy things in the game world, and motivated action to earn more money.

#### **4.1.5.3 Critical thinking**

Questions and discussion observed also provided evidence of critical thinking. However, as the researcher did not prompt this, it was almost entirely limited to occasions when problems were experienced that students sought to overcome. As such, minimal evidence of critical thinking was observable in relation to tasks that did not require support. The meant that little data was collected via researcher observation in relation to critical thinking, though this did not mean critical thinking did not occur.

This said, the goods and services task provided some evidence of critical thinking. Two questions focussed on how to define the soup kitchen, weighing the fact that soup kitchens offer goods, but also a service, providing evidence of evaluation. In the task this discussion was prompted by computer-controlled avatars discussing needs and wants, giving examples to explain their definitions, and calling on players to sort various providers by these definitions. This evidence was produced in the context of students experiencing difficulties and wanting assistance, also highlighting the role of access to a researcher/teacher in supporting achievability. Indeed, this support for critical thinking happened in relation to discussion with the researcher and teacher.

Students also asked questions during the coal or solar power task that suggested critical thinking. For example, one student asked *“does solar work at home like this?”* in response to information presented about the storage of solar thermal power,

suggesting elaboration. Another student probed how the energy created was stored, suggesting critical thinking. It should be noted that neither of these questions related to completing game tasks. However, the material presented, visually and verbally, and in the context of immersion and a vote that offered agency prompted students to seek further understanding. The students appeared to take their vote seriously, with much classroom discussion about what individuals were voting for; and acknowledgement that their decision changed electricity production in *GeoCity*, expressed via comments, such as “*see the solar power we now have*”.

#### 4.1.6 RECORD OF VIDEO GAME CHAT

All 21 students participated in chat discussion while playing the game. This was an option, not a requirement, of game play, and shows that engagement in chat was universal. The number of chat posts by session was highest at home, where students were not physically in the same space. This was followed by session one, two, four, and three. However, variations in the Internet speed, particularly students getting stuck on the loading screen in the classroom, impacted capacity to use the chat function.

Participation continued throughout video game use, though the chat content changed over time. Chat during the first session of video game play mainly involved students greeting and introducing themselves or attempting to identify classmates in the game world because the students were free to name their avatar what they liked as away to support player identity and agency in the game world. For example, students wrote “*who is dj morsi*”, “*who is mehmet*”, “*hi morsi*” – not their actual names – and “*hows your new house guys*”. They also indicated excitement about the novelty of the game, and a desire to elicit a response from other students. For example, Alf commented “*lets steel money*”, and Harry said “*im awesome and its me [Harry]*”. No syllabus related questions or information were shared during the first session of video game play. In terms of design features, students noted the game was “*complicated*” and “*like problem solving*”. Furthermore, interruptions caused by chat use during the first session clearly frustrated some students, but not others, with three writing “*stop*” and another writing “*you stop*”.

Chat contributions were all short, and provided minimal evidence about syllabus outcomes, motivation to learn and critical thinking, and/or how the video game supported these. However, the relevant findings are noted below.

#### 4.1.6.1 Syllabus outcomes

Sessions two, three and four, and play at home, all included the sharing of syllabus related questions and information. For example, one student asked what to do with a rotten vegetable and others replied, “*go to the shop and return it*” and “*you don’t eat it you return it*”, sharing information about consumer rights. Many students asked how to access money and received various replies including “*use the ATM*”, “*go to bank*” and “*you earn it*”, sharing information about the technologies involved with monetary exchange and game rewards.

Much syllabus related discussion via chat was also a direct response to questions from the computer-controlled avatars. For example, when computer controlled avatar Dina Ali stated: “*Jack’s house is on fire*”, and asked “*What should we do?*” various correct responses were given, such as “*we call the fire department*”, and “*I called the fire br[i]gade*”. These questions and answers were visible to all students and included contributions from the classroom teacher who shared information and answered student questions. So while some students asked questions or shared information that related to the syllabus more than others, syllabus information shared via chat in the game was available to all. This included practical help with navigation that could support syllabus outcomes, often assisted by the fact that players could see one another's actions in the game world. For example, one player asked, “*where is the market*” and another replied “*the market is where i am*”.

However, an unanticipated problem also arose with respect to the inclusion of chat as a means to share syllabus information: the sharing of incorrect information. For example, one student stated that in the case of an emergency people should call “123”. This is correct in a number of countries around the world, but not Australia. However, this was neither explained nor corrected in chat, and was repeated by two other students during the course of video game play. So while chat was used to share some syllabus information with all students, it also acted as a source of incorrect information.

#### 4.1.6.2 Motivation to learn

Chat also provided some evidence of motivation to play and learn. Using chat to ask and answer questions and share information, a voluntary activity, suggested motivation to learn. Task value and intrinsic goal orientation, including curiosity and interest, were indicated, specifically. This was evidenced when students wrote about what they uncovered and wanted, and prompted others to try things: *"I got a bank card"*; *"I want money"* and *"go to the shop"*. Students also asked questions that indicated a desire to participate in the game world and control learning: *"how did you get a bank card"*, *"how do we eat"*, and *"how do you work"*. Use of the first person provided evidence of agency contributing to motivation in this context.

#### 4.1.6.3 Critical thinking

Some questions and answers shared via chat also showed critical engagement, as students wanted to understand what they were experiencing. For example, when Emma wrote *"i got two bank cards"*, others asked *"how"* and *"how did you get it"*; and when one student asked *"how do get money"* another responded *"you earn it"*, linking real world experience to the game. Towards the end of implementation Harry ran out of money in the game world, and critical thinking was evidenced, as various students applied previous knowledge to the situation and evaluated ideas to help solve the problem. Discussion included the following:

- Harry: *"i don't have money"*
- Respondent: *"go to atm"*
- Harry: *"i don't have money in the atm"*
- Respondent: *"atm card"*
- Harry: *"i can't"*
- Respondent: *"y"*
- Harry: *"because i don t have money in it"*
- Harry: *"what should i do"*
- Respondent: *"go to bank"*
- Harry: *"i don t have money"*
- Respondent: *"go to atm and write... anything"*
- Respondent: *"did you get card"*

- Harry: “*but old one dosn t work*”

These contributions focussed on Harry’s problem and the discussion occurring on chat with the class, there were multiple solutions offered to Harry which indicates that critical thinking was occurring.

#### Performance of video game design

During Phase One of this research, an educational video game was designed for the Stage Two geography classroom. The design was based on the best practice video game design principles identified in the literature review to support learning, motivation to learn and critical thinking. The principles are:

- Perceived to be useful, achievable and challenging
- Learning is part of game flow
- Play involves collaboration
- Players have identity and agency
- Game play situates meaning
- Design respects cognitive load
- Offers an immersive, realistic and complex environment
- Involves self-paced student inquiry, learning by doing and problem solving
- Design supports teacher involvement and access to related resources
- Play includes clear rules and objectives
- Play involves regular feedback

An assessment of the data collected showed whether these principles worked as planned. The presence of these design features is assessed for *GeoCity* generally, and then specifically for each of the learning topics and tasks. Furthermore, the technical problems evidenced during implementation are also outlined below.

#### **4.1.7 PERFORMANCE OF DESIGN FEATURES PRESENT IN *GEOCITY***

All 11 best practice design principles were included in the design brief for *GeoCity*, as outlined in Chapter Three. A critical assessment of the data, to ascertain whether each principle was present during implementation, follows.

The principle “perceived to be useful, achievable and challenging” was included in the design of *GeoCity* through content that was useful beyond game tasks: applicable in the real world and for syllabus outcomes. The game was designed to be realistic and have clear objectives to ensure choice and action in the game was perceived to be useful. It was designed to be complex and holistic, involving decision-making and learning through doing, to ensure challenge. Furthermore, the game was designed to be achievable, particularly through learner control, a simple interface, and opportunities to learn from mistakes. The interviews with the focus group provided evidence that this principle functioned as intended. Students noted the game included both choice and parallels with the real world, supporting usefulness: *“it’s like you are an adult, and you get to choose what you want to buy, and you get to hold onto a bank card, and you get to go to the ATM and collect money and buy what you want”*. One comment explicitly noted usefulness: *“it was like playing the best thing you could ever play, because you are actually learning something”*. Furthermore, students affirmed that the game was both challenging and achievable throughout game play, noting the game was *“just hard enough”* and *“it was hard but it was fun”*. This was affirmed by other data sources. Comments from the classroom teacher added further evidence that the game was both achievable and challenging: the teacher’s impression was that students were *“really comfortable with [the game]”* and able to work at their own pace, and *“[Amy] was one of the kids on the initial goods and services task ... That poor love was doing it for the whole first session, I think. But she didn’t get defeated”*. Likewise, researcher observation also showed that students were both challenged and could achieve game objectives, while highlighting the complementary role of peer, teacher and researcher assistance that supported this. Students asked for and were given help when incorrect answers meant they could not advance in the game world, indicating challenge and that they wanted to advance in the game world. They were also able to complete tasks, sometimes with support and at other times on their own.

The design also incorporated the principle “learning is part of game flow”, because students needed to apply learning content to advance in the game world. For example, players had to consistently maintain the needs of their avatar, requiring that they know these needs and how to address them. For example, students had to know

that they need to satisfy hunger, and apply the skill of using an ATM to access money and buy food. Interviews with the classroom teacher, interviews with the focus group, student observation and chat transcripts provided evidence that this principle functioned as intended. Students were observed talking about and asking and answering questions in relation to learning content and general game navigation, and the chat transcripts showed similar interactions in text. For example, when a student asked how to get money, other students provided responses such as “*go to atm*” and “*go to bank*”. The classroom teacher confirmed: “*I don’t think, and this was across the board, the kids realised that they were actually learning something; which is perfect*” and “*I think [Harry] responds well to this type of learning because he really sees learning as a chore, whereas I don’t think he initially realised this was a learning activity*”. Harry’s comment during the focus group interviews supports the teacher’s impressions: “*It was like playing the best thing you could ever play, because you are actually learning something.*”

The design incorporated the principle “players have identity and agency” through the inclusion of unique avatars for each player, customisation of land, house, clothing, food, furniture, pets, electrical goods, and sporting equipment, and choice about the actions undertaken in the game world. The research findings included evidence that this principle was successfully included in *GeoCity*. During the semi-structured interviews with the focus group, students talked in the first-person about avatar movements and noted when they made meaningful choices in the game world. For example, May said: “*you get to choose what you want to buy, and you get to hold onto a bank card, and you get to go to the ATM and collect money and buy what you want*”. Video game chat transcripts provided further evidence of this. Students wrote: “*I called the fire br[i]gade*”, “*I got a bank card*”, and “*go to the shop*”. Furthermore, researcher observations provided similar data: students said: “*how do you get a bank card?*”, “*I’m voting for solar*”, “*I want to make more money*”, and “*I need to do the bread stuff to get money*”.

“Play involves collaboration” was made possible in the design of the video game through the following features:

- The format of a multiplayer synchronous environment

- The inclusion of chat function
- Capacity to view the actions of other players in the game world

The data collected during implementation showed that students collaborated via the video game chat function, viewing one another's actions in the game world, and by talking and watching each others' actions in the classroom. During the focus group interviews, students noted: *"I helped other people"* and *"my favourite part is when you can chat to people"*. The chat transcripts showed students asking and answering one another's questions, and telling each other what they were doing in the game world. Viewing each other in the game world was also evidenced through chat. For example, one student wrote *"where is the market"*, and another replied *"the market is where i am"*. Furthermore, collaboration that was not intended was evidenced during implementation. Students were observed talking and viewing each other's screens outside of the game world, for example talking about game content and watching each other use the ATM and navigate the organic eggs task. During the focus group interviews one student noted: *"one of the other people taught me how to get another PIN number if I forgot"*. Talking and watching were not an intended part of the game design, but clearly having students play in the same room allowed for this additional collaboration.

The literature review suggested that ways to include the principle "game play situates meaning" included using the format of an immersive virtual world, and having the game world closely reflect reality. These features were included in the design of *GeoCity* as outlined in Chapter Three. That these features were successfully included in the design was reflected most clearly during the interviews with the focus group. Students talked about learning content in *GeoCity* and their engagement with it. For example, May stated: *"If you're freezing and you already have a couch and you want to buy another one, you should think about what you really need. You should buy the things you really need and then buy what you want; you should buy all the things that you need first and then what you want because you have lots of wants and if you don't buy the things you need your person will get very hungry and very cold."* Another student noted: *"I wanted to go to the bank but then I realised that you need a bank card."* The teacher noted that situating meaning is part of her instructional

approach, and so did not mention it as something added by the game. However, observation affirmed that *GeoCity* situated meaning. Students sought to buy food, often talking to one another, the teacher and the researcher about how to satisfy hunger; when the hunger meter dropped, students sought to buy food. Likewise, students also sought to access money to buy food in this context.

The principle “design respects cognitive load” was included in the design of *GeoCity*, particularly via clear, concise, Years Three and Four appropriate text; limited elements at any one time within a player’s interface; and making information about objects, such as the supermarket and bank, available at all times, though only when players chose to access it. The data outlined in the previous section provided information about the success of this principle during implementation, with evidence of times when cognitive overload was experienced, as well as times when there was no evidence of cognitive overload. Observation suggested that cognitive load was respected most of the time during the game. Evidence for this included all the times students successfully navigated the game without support and when there was no evidence of cognitive overload. However, it also provided evidence that cognitive overload was experienced in relation to technical problems that added load, and with particular features and tasks. Similarly, the focus group and teacher interviews suggested that cognitive load was respected, via the absence of evidence of cognitive overload in relation to most of the game while also providing evidence of cognitive overload in relation to particular game features. So the data affirmed that the design of *GeoCity* included the principle “design respects cognitive load” most of the time, though not in relation to particular features or when technical problems were experienced. How this related to particular tasks is explored later in this chapter.

The principle “offers an immersive, realistic and complex environment” was included in the video game design via the format of a virtual world and game objects consistent with those that exist in the real world, such as an ATM. Evidence of immersion was strong. Student immersion was observed with active engagement with the game world displayed via concentration on and participation in video game play. Furthermore, during the focus group interviews, all six students said they felt involved in the game world. May commented: “*I felt like I was actually in the*

*game*”, and Mark said, “*it was like our own bodies and it was like we were grown-ups*”. The only exception, that was not task specific, was when technical problems interrupted video game functioning (see section 4.3). When this happened, student’s concentration and participation was interrupted, and they asked the researcher for assistance if the problem persisted. For instance, during the focus group interviews, May said: “*I wasn’t bored when I was playing the game, but I was bored when it was loading*” and all members of the group stated their agreement. Likewise, there was strong evidence that the game environment closely reflected reality. During the focus group interviews Harry commented: “*It’s like playing a real life game. You need to go place by place*”; and other students likened the game to acting in the real world as an adult. However, while there was strong evidence that the game world reflected reality, Harry also noted a desire for more: “*I think there should be more detail, because you should have shown which place you want to go to; like the world, but you want to go to Australia, you want to go to Europe...*”

In line with the principle “involves self-paced student inquiry, learning by doing and problem solving”, *GeoCity* was designed to include an environment that required trial, error and understanding to advance in the game world. For example, players needed to buy food in order to satisfy their avatar’s need of hunger, which required uncovering this fact, accessing money and using it to buy food from the supermarket or market garden. Data provided by the classroom teacher suggested this principle functioned as intended. She noted: “*I noticed that, with the activities, if they got something wrong, it wasn’t just their mark and that was it. There was a chance to go back.*” Further evidence affirmed this. During the focus group interviews students reflected on their pursued lines of inquiry. For example, Harry said: “*I wanted to go to the bank but then I realised that you need a bank card*”, and May noted “*the only problem with having a bank card is, when I got my bank card and saw the PIN number, I thought I had it in my head and pressed close, but I forgot my PIN number. I tried to remember it but I don’t know whether it’s the right PIN number or not*”. Likewise, questions via chat affirmed the inclusion of the principle. For example, one student asked “*where is the market*” and another replied “*the market is where i am*”. One student even noted the game was “*like problem solving*”.

To ensure that the “design supports teacher involvement and access to related resources”, *GeoCity* included the following features throughout game play:

- The classroom teacher had an avatar and participated as a player in the game world.
- Information about the game world, such as the supermarket and bank, was available if students, accessed by hovering over objects.

Data collected during implementation provided evidence that this access and involvement was made available. The chat transcripts showed teacher involvement, answering student questions. Observation confirmed that players hovered over objects to find out about them, and that the researcher and teacher answered questions verbally. Furthermore, observation and focus group interviews provided evidence of further access to related resources, and teacher involvement, beyond the scope of what was planned. Students talked to each other, the teacher and the researcher, outside of the game world during game play, asking questions and gaining access to learning content and the game in this way. During the focus group interviews one student noted “*I tried the organic because [the teacher] came around saying ‘you should buy the organic eggs’*”.

The principle “play includes clear rules and objectives” was included throughout game play in the design of *GeoCity*. Players were required to satisfy the needs of their avatar at all times, navigate game tasks, and take meaningful action in the context of the game community. The focus group interviews, researcher observation, and the record of video game chat confirmed that students understood these objectives and the framework within which they were to be met. During the focus group interviews, students named the needs that had to be satisfied in the game, including food, community, clothing and shelter and explained the rules for this, noting: “*when everything ran out on hunger and clothes, I needed to buy everything*” and “*when my person got hungry I had to feed it, otherwise it would get really hungry*”. Students also commented on meaningful action, for example, “*I will vote for solar*”. Furthermore, students were observed talking to one another, the teacher and the researcher about task navigation. For example, students asked and gained information about how to access particular tasks, such as how to use the ATM.

Questions related particularly to unlocking features, and students were observed looking at each other's monitors and seeking to access particular game play witnessed, particularly for the caged and organic eggs and bread tasks, and for ATM use. Finally, the record of video game chat included questions and answers about need satisfaction, such as: *"how do we eat"* and *"go to the shop"*.

Finally, the principle "play involves feedback" was incorporated into the design of the game. For example, players had to consistently buy food and feed their avatar in order to satisfy the need of hunger. Hunger satisfaction levels were continuously shown on screen, going down as time passed without eating and going up when players ate something; restrictions were placed on actions possible in the game world if this need was not satisfied. Another example in the design was that, following the vote on coal or solar power, the power source with the most votes would be built in *GeoCity*. Evidence that this principle functioned as intended was provided during the focus group interviews and researcher observation. During the interviews, May said: *"when my person got hungry I had to feed it, otherwise it would get really hungry"*. Emma said: *"When everything ran out on hunger and clothes, I needed to buy everything, so I went to see how much cash I had and I had \$100, so I went and I bought some clothes and some food."* Furthermore, during the interviews Mark noted that before the vote there was a coal power plant in *GeoCity*, and that afterwards there was a solar power plant; another student was observed by the researcher stating: *"see the solar power we now have"*.

#### **4.1.7.1 Conclusion**

All 11 best practice design principles included in the design brief for *GeoCity* were found to be present during implementation.

#### **4.1.8 PERFORMANCE OF TASK SPECIFIC DESIGN FEATURES**

All 11 best practice design principles were also included across *GeoCity* tasks, though not all were included for each task. The five topics of study – goods, services and needs; technologies involved with monetary exchange; production and distribution; consumer rights; and coal or solar power – covered by the game's tasks are examined below. The intended design principles included for each task (as

outlined in Chapter Three) are examined against findings of how the design principles functioned during implementation.

#### 4.1.8.1 Goods, services and needs

The goods, services and needs topic included three tasks:

- Goods and services
- Needs and services
- Needs and wants

The intended design principles included for each task, as outlined in Chapter Three, are listed in Table 4.13. Against this, the data collected is examined to determine whether these principles functioned as intended.

Task	Intended design principles included in full
Goods and services	<ul style="list-style-type: none"> <li>. Perceived to be useful, achievable and challenging (1)</li> <li>. Play involves collaboration (3)</li> <li>. Game play situates meaning (5)</li> <li>. Design respects cognitive load (6)</li> <li>. Offers an immersive, realistic and complex environment (7)</li> <li>. Design supports teacher involvement and access to related resources (9)</li> <li>. Play includes clear rules and objectives (10)</li> <li>. Play involves feedback (11)</li> </ul>
Needs and services	<ul style="list-style-type: none"> <li>. Perceived to be useful, achievable and challenging (1)</li> <li>. Learning is part of game flow (2)</li> <li>. Play involves collaboration (3)</li> <li>. Game play situates meaning (5)</li> <li>. Design respects cognitive load (6)</li> <li>. Play involves feedback (11)</li> </ul>
Needs and wants	<ul style="list-style-type: none"> <li>. Perceived to be useful, achievable and challenging (1)</li> <li>. Learning is part of game flow (2)</li> <li>. Players have identity and agency (4)</li> <li>. Game play situates meaning (5)</li> <li>. Design respects cognitive load (6)</li> <li>. Offers an immersive, realistic and complex environment (7)</li> <li>. Design supports teacher involvement and access to related resources (9)</li> <li>. Play involves feedback (11)</li> </ul>

Table 4.13: Intended design principles for the goods, services and needs tasks

#### Goods and services

Correct examples of goods and services students named during the focus group

interviews were all goods and services available in *GeoCity*. This provided evidence that the game environment included realistic content. Researcher observation showed support from both the classroom teacher and the researcher, with students asking questions and weighing answers. For example, two students focused on how to define the soup kitchen, weighing the fact that soup kitchens offer goods, but also a service. Researcher observation also suggested that the goods and services task did not include immersion or meaning that was situated, as this task happened outside of normal game play and largely preceded interactions in the game world with goods and services. Further, during the focus group interviews students raised difficulties with the goods and services task. This suggested the task was challenging, as students asked for help when incorrect answers meant they could not advance in the game world, but also that they perceived the task to be useful for advancing game play, and in relation to understanding the real-world. One student noted: *“it’s hard when all the goods and services came up”*. Students asked for help when incorrect answers meant they could not advance in the game world, in the context of the rules, objectives and feedback, indicating that these were clear. However, they also noted that it was too difficult, test-like and that the availability of chat during the task was annoying and distracting, adding cognitive load. For example, students commented: *“I got a bit confused when I was doing it”*, and *“I was trying to do the test and someone’s sending messages, and it comes over the top. It was so annoying”*. Data from observation reinforced this. Indeed, questions and requests for assistance during the goods and services task suggested that too much information was provided simultaneously, and that cognitive overload was a problem. This also suggested that the task was not perceived to be achievable. Most prominently, while chat use indicated collaboration, it was also observed to interrupt the learner’s attention on the task, and many students complained about the presence and persistence of chat use during the task. Finally, the provision of assistance by the teacher and researcher during this task showed that implementation allowed for teacher involvement and access to related resources. Table 4.14 presents the design principles evidenced during the goods and services task.

<b>Task</b>	<b>Design principles evidenced in full</b>	<b>Design principles evidenced in part</b>
Goods and services	<ul style="list-style-type: none"> <li>. Play involves collaboration (3)</li> <li>. Design supports teacher involvement and access to related resources (9)</li> <li>. Play includes clear rules and objectives (10)</li> <li>. Play involves feedback (11)</li> </ul>	<ul style="list-style-type: none"> <li>. Perceived to be useful and challenging (1)</li> <li>. Offers a realistic environment (7)</li> </ul>

Table 4.14: Design principles evidenced during the goods and services task

### Needs and services

During the focus group interviews students talked about needing to and calling the fire brigade when Jack's house was on fire and that this led to the fire brigade putting out the fire. This suggested that learning was part of game flow, that the environment was immersive (a design principle that was not intentionally included in this task), that meaning was situated, and that the task was perceived to be useful. Researcher observation and chat affirmed this. Students were observed calling the fire brigade and ambulance when needed and talking about what to do via chat. Students discussed collaboration during the task, specifically using chat to work together when the task required it, affirming the inclusion of this design principle. Observation of interaction with the needs and services task provided evidence that the design of the task respected cognitive load: students correctly navigated the task and discussion without asking for assistance, following instructions delivered via speech bubble in slow succession. Students tried both correct and incorrect actions, suggesting challenge and achievability; they then corrected incorrect answers in response to game feedback. Table 4.15 presents the design principles evidenced during the needs and services task.

<b>Task</b>	<b>Design principles evidenced in full</b>	<b>Design principles evidenced in part</b>
Needs and services	<ul style="list-style-type: none"> <li>. Perceived to be useful, achievable and challenging (1)</li> <li>. Learning is part of game flow (2)</li> <li>. Play involves collaboration (3)</li> <li>. Game play situates meaning (5)</li> <li>. Design respects cognitive load (6)</li> <li>. Play involves feedback (11)</li> </ul>	<ul style="list-style-type: none"> <li>. Offers an immersive environment (7)</li> <li>. Design supports teacher involvement (9)</li> </ul>

Table 4.15: Design principles evidenced during the needs and services task

### Needs and wants

For the needs and wants task, students affirmed the value and use of having access to experts within the task during the focus group interviews. Mark commented, *“when I was playing it said I wanted an Xbox, but he said ‘I don’t really need it but I just want it’”*; this information was provided by the computer-controlled avatar Jack via speech bubble. A statement from Emma indicated learning was part of game flow, situated, and that she experienced identity and agency in the game world through her avatar: *“When everything ran out on hunger and clothes, I needed to buy everything, so I went to see how much cash I had and I had \$100, so I went and I bought some clothes and some food”*. Furthermore, challenge, support for critical knowledge building and that an immersive, realistic and complex environment was evidenced when May said: *“If you’re freezing and you already have a couch and you want to buy another one, you should think about what you really need. You should buy the things you really need and then buy what you want; you should buy all the things that you need first and then what you want because you have lots of wants and if you don’t buy the things you need your person will get very hungry and very cold”*. In addition, May and Amy noted game feedback that contributed to this, also explaining how it was useful and achievable. May said, *“when my person got hungry I had to feed it, otherwise it would get really hungry”*; Amy said, *“you figure out the shops. You get to buy fun things. If you need to buy clothes you have to go to the right shop”*. There was no evidence of cognitive overload across the data sources for this task. Table 4.16 presents the design principles evidenced during the needs and wants task.

Task	Design principles evidenced in full
Needs and wants	<ul style="list-style-type: none"> <li>. Perceived to be useful, achievable and challenging (1)</li> <li>. Learning is part of game flow (2)</li> <li>. Players have identity and agency (4)</li> <li>. Game play situates meaning (5)</li> <li>. Design respects cognitive load (6)</li> <li>. Offers an immersive, realistic and complex environment (7)</li> <li>. Design supports teacher involvement and access to related resources (9)</li> <li>. Play involves feedback (11)</li> </ul>

Table 4.16: Design principles evidenced during the needs and wants task

#### 4.1.8.2 Production and distribution

The intended design principles included for the production and distribution tasks, as outlined in Chapter Three, are listed in Table 4.17. Against this, the data outlined in section 4.1 is examined to determine whether or not these principles functioned as intended.

Topic	Task	Intended design principles included in full	Intended design principles included in part
Production and distribution	Bread	<ul style="list-style-type: none"> <li>. Perceived to be useful, achievable and challenging (1)</li> <li>. Players have identity and agency (4)</li> <li>. Game play situates meaning (5)</li> <li>. Design respects cognitive load (6)</li> <li>. Offers an immersive, realistic and complex environment (7)</li> <li>. Play includes clear rules and objectives (10)</li> <li>. Play involves feedback (11)</li> </ul>	<ul style="list-style-type: none"> <li>. Involves self-paced student inquiry (8)</li> <li>. Design supports access to related resources (9)</li> </ul>
	Caged eggs	<ul style="list-style-type: none"> <li>. Perceived to be useful, achievable and challenging (1)</li> <li>. Players have identity and agency (4)</li> <li>. Game play situates meaning (5)</li> <li>. Design respects cognitive load (6)</li> <li>. Offers an immersive, realistic and complex environment (7)</li> <li>. Play includes clear rules and objectives (10)</li> <li>. Play involves feedback (11)</li> </ul>	<ul style="list-style-type: none"> <li>. Involves self-paced student inquiry (8)</li> <li>. Design supports access to related resources (9)</li> </ul>
	Organic eggs	<ul style="list-style-type: none"> <li>. Perceived to be useful, achievable and challenging (1)</li> <li>. Learning is part of game flow (2)</li> <li>. Players have identity and agency (4)</li> <li>. Game play situates meaning (5)</li> <li>. Design respects cognitive load (6)</li> <li>. Offers an immersive, realistic and complex environment (7)</li> <li>. Involves self-paced student inquiry, learning by doing and problem solving (8)</li> <li>. Play includes clear rules and objectives (10)</li> <li>. Play involves feedback (11)</li> </ul>	

Table 4.17: Intended design principles for the production and distribution tasks

## Bread

For the bread task, the focus group interviews provided evidence that students experienced identity and agency. May said: *“I learnt today how to make bread... I learnt that after you collect the wheat you have to mill the grain, and then you take it to the bread factory”*. Evidence that the task offered a realistic, complex and immersive environment, in which meaning was situated, was also provided during the focus group interviews. Harry said: *“I learned that first you have to plant the wheat, then you harvest it. And sometimes there can be so many seeds, and then you have to grow the wheat. When it’s done you have to put it in the flour mill, and mill the grain”* and *“You first make the bread. To make the bread you use dough, then you package it. No, no, no... Then you put it in the oven, not package it, then it’s bread. Then you package it and send it to the supermarket, and then you buy it”*. The noting of steps here also suggests the design respected cognitive load because all were noted and with respect to each other. Researcher observation revealed that players moved through the bread factory at different speeds, and some students listened to chunks of information more than once, providing evidence of self-paced student inquiry, challenge and that the design supported access to related resources. When the task had the player sort the steps involved in bread production into the correct order, students were observed talking to other students, often pointing at a word on the screen and clearly discussing the learning material and weighing their decisions, providing evidence that the design of this task supported collaboration, and unintended inclusion. Students did not ask for the researcher’s help to navigate, suggesting the task involved clear rules and was perceived to be achievable. Furthermore, students expressed their pleasure when they earned money via completion of the bread task, telling one another what they had earned, again providing evidence that the task was perceived to be useful and involved feedback. Table 4.18 presents the design principles evidenced during the bread task.

Task	Design principles evidenced in full	Design principles evidenced in part
Bread	<ul style="list-style-type: none"> <li>. Perceived to be useful, achievable and challenging (1)</li> <li>. Play involves collaboration (3)</li> <li>. Players have identity and agency (4)</li> <li>. Game play situates meaning (5)</li> <li>. Design respects cognitive load (6)</li> <li>. Offers an immersive, realistic and complex environment (7)</li> <li>. Design supports teacher involvement and access to related resources (9)</li> <li>. Play involves feedback (11)</li> </ul>	<ul style="list-style-type: none"> <li>. Involves self-paced student inquiry (8)</li> <li>. Play includes clear rules (10)</li> </ul>

Table 4.18: Design principles evidenced during the bread task

### Caged eggs

The focus group interviews provided evidence that the caged eggs task offered an immersive, realistic and complex environment. Harry said: *“It showed like chickens all in cages and then the cages getting the eggs, and then the farmers get the eggs, and they wash it and put it in the packages and send it to the supermarket. And then they sell it”*. Mark said: *“They have to cut their beaks off. Then they’re put in the cage. Then they give them food and water. Then they eat the food. Then they get the eggs from them. Then they clean the eggs. Then they package the eggs and then they take them to the supermarket”*. These contributions recalled the steps involved in the task, also suggesting the design respected cognitive load. The first person description offered by Emma provided evidence that students experienced identity and agency during the caged eggs task, and that meaning was situated. She stated: *“when you are in the caged eggs you have to cut their beaks off, they can’t run around, they have to stay in this little house”*. Observation revealed that players moved through the caged eggs factory at different speeds, and some students listened to chunks of information more than once, providing evidence of self-paced student inquiry, challenge and that the design supported access to related resources. The task was structured similar to the bread task, and students’ responses and engagement were also similar: students were observed clearly discussing the order of caged eggs production during the sorting task. Thus, collaboration was again evident, even

though it was an unintentional inclusion. As with the bread task, students did not ask for the researcher's help to navigate, suggesting the task involved clear rules and was perceived to be achievable. Earning money via finishing the caged eggs task was also seen positively by students, adding to the evidence that the task was perceived to be useful and involved feedback. Table 4.19 presents the design principles evidenced during the caged eggs task.

Task	Design principles evidenced in full	Design principles evidenced in part
Caged eggs	<ul style="list-style-type: none"> <li>. Perceived to be useful, achievable and challenging (1)</li> <li>. Play involves collaboration (3)</li> <li>. Players have identity and agency (4)</li> <li>. Game play situates meaning (5)</li> <li>. Design respects cognitive load (6)</li> <li>. Offers an immersive, realistic and complex environment (7)</li> <li>. Design supports teacher involvement and access to related resources (9)</li> <li>. Play involves feedback (11)</li> </ul>	<ul style="list-style-type: none"> <li>. Involves self-paced student inquiry (8)</li> <li>. Play includes clear rules (10)</li> </ul>

Table 4.19: Design principles evidenced during the caged eggs task

### Organic eggs

In relation to the organic eggs task, comments during the focus group interviews provided evidence that learning was situated. For example, one student noted, *“It showed me the house with the hens in it, and I had to press the house so the hens can come out”*. Another comment suggested that learning was part of game flow and that the task involved feedback: *“I turned the tap on so they can keep on drinking”*. This was affirmed via researcher observation, through which students were observed carrying out tasks on the organic eggs farm; actions dependent on establishing syllabus knowledge. That play involved identity and agency was also clear from this comment, with avatar and actions referred to in the first person. Evidence that scaffolding and clear rules, respecting cognitive load, were provided during the task was also provided via the focus group interviews. One student noted: *“And then [the game] said get all 12 eggs... after I collected them, it showed me this big place, and it's like a line and you can't just press the egg, you have to drag it and put it on the line, then it washes for you and then you put it in a little lid”*. This comment also suggests the task was immersive, realistic and

complex. Comments from May also provided information that the task was perceived to be useful and achievable, noting both what she did and the resultant learning. She said: *“I had to get the eggs from hen house, and get them washed, and feed the chickens. So I got of an idea of how a farmer would do it”*. Furthermore, evidence that self-paced student inquiry, learning by doing and problem solving was included in the task, was gained via researcher observation. Students were witnessed successfully carrying out tasks on the organic eggs farm; and at different paces, often making mistakes and taking multiple attempts to complete various activities. This also affirms achievability and suggests challenge. Finally, as with the other production and distribution tasks, students were observed to collaborate during the organic eggs task – an unintended inclusion. Students were observed talking to other students, often pointing at words on the screen and clearly discussing what they were doing, providing evidence that the design of this task supported collaboration. Table 4.20 presents the design principles evidenced during the organic eggs task.

Task	Design principles evidenced in full	Design principles evidenced in part
Organic eggs	<ul style="list-style-type: none"> <li>. Perceived to be useful, achievable and challenging (1)</li> <li>. Learning is part of game flow (2)</li> <li>. Play involves collaboration (3)</li> <li>. Players have identity and agency (4)</li> <li>. Game play situates meaning (5)</li> <li>. Design respects cognitive load (6)</li> <li>. Offers an immersive, realistic and complex environment (7)</li> <li>. Involves self-paced student inquiry, learning by doing and problem solving (8)</li> <li>. Design supports teacher involvement and access to related resources (9)</li> <li>. Play involves feedback (11)</li> </ul>	<ul style="list-style-type: none"> <li>. Play includes clear rules (10)</li> </ul>

Table 4.20: Design principles evidenced during the organic eggs task

#### 4.1.8.3 Technologies involved with monetary exchange

The intended design principles included for the technologies involved with monetary exchange task, as outlined in Chapter Three, are listed in Table 4.21. Against this, the data outlined in section 4.1 is examined to determine whether or not these principles functioned as intended.

Task	Intended design principles included in full
Technologies involved with monetary exchange	<ul style="list-style-type: none"> <li>. Perceived to be useful, achievable and challenging (1)</li> <li>. Learning is part of game flow (2)</li> <li>. Players have identity and agency (4)</li> <li>. Game play situates meaning (5)</li> <li>. Design respects cognitive load (6)</li> <li>. Offers an immersive, realistic and complex environment (7)</li> <li>. Involves self-paced student inquiry, learning by doing and problem solving (8)</li> <li>. Play involves feedback (11)</li> </ul>

Table 4.21: Intended design principles for the technologies involved with monetary exchange task

The focus group interviews provided data about how the technologies involved with monetary exchange task functioned during implementation. Students provided evidence that learning was part of game flow and that the task involved clear rules and objectives. During the focus group interviews on student commented: *“Enter your card where it’s supposed to go, then it says ‘type in your PIN’. You type in your PIN, but if you get it wrong, then it says ‘request PIN’. You press that and you go out and it says ‘you’ve got mail’. You get your mail and you get a new number”*. Here, and in other comments about the task, it can be seen that students talked about their avatar and actions in this task in the first person, providing evidence that identity and agency were experienced. Furthermore, discussion also provided evidence that the game involved self-paced student inquiry, learning by doing and problem solving. A student said, *“I typed in how much but first it said ‘failed, failed, failed’ and then I typed in \$100 and I actually got \$100”*. The presence of feedback during this task is also clear in this comment. Researcher observation provided similar evidence, with students observed working through ATM use at different paces, often making mistakes and taking multiple attempts to use the ATM correctly. From the focus group interviews it was also clear that this task was perceived to be useful, achievable and challenging. Students noted, *“if you press on the wrong number you got to do it all over again”*, and *“You get a credit card. If you go to the bank, you can get money out, and then you can go shopping and then you can use it”*. This comment also shows that learning was situated in an immersive, realistic and complex environment. Furthermore, the contribution of scaffolding, and respect for

cognitive load was also evidenced. May said: *“The only problem with having a bank card is, when I got my bank card and saw the PIN number, I thought I had it in my head and pressed close, but I forgot my PIN number. I tried to remember it but I don’t know whether it’s the right PIN number or not”*. Then, showing that collaboration was an unintended inclusion, she said: *“I have four PIN codes, but I forgot all four pin numbers. Because when you get your first one if you don’t use it then that becomes... you have to use your last one. I tried to use one I already had but I couldn’t use it. And then one of the other people taught me how to get another PIN number if I forgot”*. During game play students were also observed by the researcher asking one another how to use the ATM, bank card facility and bank, and watching one another use the ATM. Likewise, chat transcripts showed collaboration about the technologies involved with monetary exchange. For example, one student said *“i don’t have money”*, and others suggested: *“go to atm”* and *“go to bank”*. Table 4.22 presents the design principles evidenced during the technologies involved with monetary exchange task.

Task	Design principles evidenced in full	Design principles evidenced in part
Technologies involved with monetary exchange	<ul style="list-style-type: none"> <li>. Perceived to be useful, achievable and challenging (1)</li> <li>. Learning is part of game flow (2)</li> <li>. Play involves collaboration (3)</li> <li>. Players have identity and agency (4)</li> <li>. Game play situates meaning (5)</li> <li>. Design respects cognitive load (6)</li> <li>. Offers an immersive, realistic and complex environment (7)</li> <li>. Involves self-paced student inquiry, learning by doing and problem solving (8)</li> <li>. Play includes clear rules and objectives (10)</li> <li>. Play involves feedback (11)</li> </ul>	<ul style="list-style-type: none"> <li>. Design supports teacher involvement (9)</li> </ul>

Table 4.22: Design principles evidenced during the technologies involved with monetary exchange task

#### 4.1.8.4 Consumer rights

The intended design principles included for the consumer rights task, as outlined in Chapter Three, are listed in Table 4.23. Against this, the data outlined in section 4.1 is examined to determine whether these principles functioned as intended.

Task	Intended design principles included in full	Intended design principles included in part
Consumer rights	<ul style="list-style-type: none"> <li>. Perceived to be useful, achievable and challenging (1)</li> <li>. Learning is part of game flow (2)</li> <li>. Players have identity and agency (4)</li> <li>. Game play situates meaning (5)</li> <li>. Design respects cognitive load (6)</li> <li>. Play includes clear rules and objectives (10)</li> <li>. Play involves feedback (11)</li> </ul>	<ul style="list-style-type: none"> <li>. Involves-learning by doing (8)</li> </ul>

Table 4.23: Intended design principles for the consumer rights task

The focus group interviews provided information about the design principles included during the consumer rights task. Student comments suggested players found the task useful and experienced identity and agency, with discussion about exercising their rights in the first person: *“You have to like give it back, and then they have to replace it and give you another one, or you can get your money back”, “fix it”, “give you your money back”* and *“take it back to the shop and get your money back”*. These comments also reflect the three available options presented in the game world when players purchased a faulty product, providing evidence that learning was part of game flow, that students learned by doing and that the task included feedback. However, both researcher observation and the focus group interviews provided data suggesting that three other design principles included in the design of the consumer rights task did not function as intended. During the focus group interviews, student comments indicated they did not comprehend that the product they had purchased was faulty and/or that this was not their fault. When this happened, they did not seek to exercise their rights as a consumer. Emma incorrectly thought her ripped top was her fault, and Mark noted there was *“something wrong”* with a television he purchased so he *“lost some money because there was no TV”*. Similarly, while being observed, though some students successfully navigated the task, others were seen failing to exercise their rights as a consumer. In terms of task design, some simply did not register or comprehend the written message that they could do something if they purchased a defective product. Though they were told how they could exercise their rights as a consumer, many missed this, suggesting too much information was presented too quickly leading to learners’ experiencing cognitive overload and that,

as such, the rules during this task were unclear. The researcher observed multiple written pieces of information provided to students in quick succession via speech bubble. Related requests for support by students to teacher and researcher showed the task was perceived to be challenging, and that implementation supported access to the teacher and related resources, an unintended inclusion for this task. Table 4.24 presents the design principles evidenced during the consumer rights task.

<b>Task</b>	<b>Design principles evidenced in full</b>	<b>Design principles evidenced in part</b>
Consumer rights	<ul style="list-style-type: none"> <li>. Learning is part of game flow (2)</li> <li>. Players have identity and agency (4)</li> <li>. Game play situates meaning (5)</li> <li>. Play involves feedback (11)</li> </ul>	<ul style="list-style-type: none"> <li>. Perceived to be useful and challenging (1)</li> <li>. Involves learning by doing (8)</li> <li>. Design supports teacher involvement (9)</li> </ul>

Table 4.24: Design principles evidenced during the consumer rights task

#### 4.1.8.5 Coal or solar power

The intended design principles included for the coal or solar power task, as outlined in Chapter Three, are listed in Table 4.25. Against this, the data outlined in section 4.1 is examined to determine whether or not these principles functioned as intended.

<b>Task</b>	<b>Design principles included in full</b>	<b>Design principles included in part</b>
Coal or solar power	<ul style="list-style-type: none"> <li>. Perceived to be useful, achievable and challenging (1)</li> <li>. Learning is part of game flow (2)</li> <li>. Play involves collaboration (3)</li> <li>. Players have identity and agency (4)</li> <li>. Game play situates meaning (5)</li> <li>. Design respects cognitive load (6)</li> <li>. Offers an immersive, realistic and complex environment (7)</li> <li>. Play includes clear rules and objectives (10)</li> <li>. Play involves feedback (11)</li> </ul>	<ul style="list-style-type: none"> <li>. Design supports access to related resources (9)</li> </ul>

Table 4.25: Intended design principles for the coal or solar power task

Data collected during the focus group interviews provided information about how design principles performed during the coal or solar power task. That play involved collaboration was affirmed via a number of comments during the focus

group interviews, including: *“When I was voting I asked [Emma] ‘what did you vote?’ and she said ‘solar’, and I said ‘I will vote for solar as well’”; “We have to be together and work together”; and “If there is just one person there and you just vote there was not enough people are there, you won’t be able to vote because if you just vote for one thing, then the other thing has zero votes, and you just voted for one thing”*. This was also evidenced during researcher observation with much classroom discussion about what individuals were voting for. In both instances, challenge can be recognised in weighing the pros and cons and voting, though the action of voting was very simple and achievable. It was also perceived to be useful, as noted by Mark during the focus group interviews: *“solar power is much more healthier and coal power gives you pollution and can make you sick”*. A comment from Emma during the focus group interviews provided evidence that players experienced identity and agency. She said: *“I chose solar power because it’s much healthier for you”*. Data affirmed the task situated meaning and involved an immersive, realistic and complex environment. During the focus group interviews students noted:

- *“Coal causes air pollution and solar doesn’t do pollution. Coal is non-renewable and solar power is renewable because the sun is always there”*.
- *“The most expensive to build is solar power... But you just get sunlight, just like that, and you don’t have to pay anything. But when you do coal power, it’s cheap to build but then you have to pay more when using it”*.

Another comment during the focus group interviews provided evidence that the inclusion of clear rules and objectives for the task functioned as intended, that the design supported access to related resources, and that learning was part of game flow: *“I learned that there was this woman and man, and they were talking about how solar and coal power was working, and then you have to choose between coal power and solar”*. Furthermore, that this task involved feedback, particularly actions having consequences, was recognised: during both the focus group interviews and observation, students commented on the new solar plant constructed as a result of the vote. Finally, while being observed by the researcher participating in the coal or solar power task students displayed no signs of missing pieces of information, nor being overwhelmed by what was presented, suggesting the design respected cognitive load.

Table 4.26 presents design principles evidenced during the coal or solar power task.

Task	Design principles evidenced in full
Coal or solar power	<ul style="list-style-type: none"> <li>. Perceived to be useful, achievable and challenging (1)</li> <li>. Learning is part of game flow (2)</li> <li>. Play involves collaboration (3)</li> <li>. Players have identity and agency (4)</li> <li>. Game play situates meaning (5)</li> <li>. Design respects cognitive load (6)</li> <li>. Offers an immersive, realistic and complex environment (7)</li> <li>. Design supports teacher involvement and access to related resources (9)</li> <li>. Play includes clear rules and objectives (10)</li> <li>. Play involves feedback (11)</li> </ul>

Table 4.26: Design principles evidenced during the coal or solar power task

#### 4.1.9 CONCLUSION

An analysis of the various data sources showed which design principles were included for each task. For the needs and wants task, the intended design principles included in the design were all shown to be present during implementation. However, for all other tasks there were discrepancies between the intended design principles and what was found to be present. The differences between intended and evidenced design principles for the remaining tasks were:

- For goods and services, the task did not situate meaning, respect cognitive load, support a perception of achievability, or present an immersive and complex environment, as planned.
- For needs and services, the task was found to include all intended design principles, plus immersion and teacher involvement.
- For bread, the task was found to include all intended design principles, plus collaboration and teacher involvement.
- For caged eggs, the task was found to include all intended design principles, plus collaboration and teacher involvement.
- For organic eggs the task did not include clear objectives, as planned. However, it included the additional principles of collaboration, and teacher involvement and access to related resources.

- For technologies involved with monetary exchange, the task was found to include all intended design principles, plus collaboration, teacher involvement, and clear rules and objectives.
- For consumer rights, the task did not include achievability, respect for cognitive load nor clear rules and objectives, as planned. However, it included the additional principle of teacher involvement.
- For coal or solar power, the task was found to include all intended design principles, plus teacher involvement.

## 4.2 Technical problems during implementation

Several issues arose due to the age of the computers, operating systems and Internet speed. *GeoCity* functionality was slowed by the Internet speed and/or software and hardware. Primarily this resulted in a loss of students' time spent playing the game, remaining on the loading screen, with no activity possible. At times it also meant the game froze, logging out and back in addressed this most of the time; although it led to further loss of time and frustration in playing the game. However, when logging out and back in did not address the problem, the researcher supplied students with a laptop to replace their computer. This had implications for learning, motivation to learn and critical thinking, when students were unable to access the game – the instructional tool – students were frustrated by delays, and had difficulty accessing particular aspects of *GeoCity*. Of particular significance, during the third session of video game play, was the fact that the coal or solar power task failed to load for all but three students. Due to this issue this task had to be undertaken again during the fourth session of video game play. To help regain time lost playing the video game, students were given the link to *GeoCity* to play at home between video game sessions three and four. This was not part of the game design, but it marks an important design consideration for video game use in the classroom: consistency with Internet and hardware capacity.

Across all tasks, when *GeoCity* function was slowed by Internet speed and/or hardware, there were clear impacts on learning, motivation to learn and critical thinking; access to the game and content to be learned and critically engaged with was not supported. Furthermore, the intention to ensure *GeoCity* was perceived to be

useful, achievable and challenging was in part undermined by this. Students expressed that increased effort was required to play the game when interrupted by technical problems, and that the game was frustrating and not “do-able” at such times. This was not part of the game design, yet it marks an important design consideration: consistency with Internet and hardware capacity. Technical problems created a context for use of *GeoCity* that undermined access to the game.

### **4.3 Summary**

This chapter presented the findings from individual data collection instruments in relation to the two research questions. It also examined this data to assess whether or not the video game functioned as intended. This included the design principles in *GeoCity* generally and for each of the learning topics and tasks. Finally, the technical problems experienced during implementation were outlined. Synthesis and discussion of these findings, and resulting conclusions and recommendations of this study, follow in Chapter Five.

## **5 DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS**

### **Overview**

The findings presented in Chapter Four are discussed and synthesised here to provide evidence to answer the research questions, which were:

1. In what ways does an instructional video game based on best practice design principles support Stage Two students to achieve the geography outcomes specified by the NSW syllabus?
2. How does the use of a video game motivate learning and support critical thinking as a method of instruction?

This chapter critically analyses changes to student HSIE learning, motivation to learn and critical thinking, and the ways in which the video game supported these changes. Finally, this chapter presents the resulting conclusions and recommendations of this study.

### **5.1 Synthesis and discussion of data collected for Question One**

Taken together the worksheet results and teacher interviews show that a video game based on best practice design principles supports Stage Two students to achieve the geography outcomes specified by the NSW syllabus.

Student worksheets showed that across the syllabus outcomes included in *GeoCity* the average mark for the class went from 61% (or D) to 83% (or B) from pre-test to post-test – a 22% improvement in syllabus outcomes over the intervention. The focus group marks sat within this context, and the group's average mark went from 76% (or C) to 90% (or A) from pre-test to post-test, a 14% improvement over implementation. The focus group marks represented an above average cohort, though still included students performing at the lower end of the class.

These findings were affirmed by data from the teacher interviews. The teacher noted that assessment results for the unit “Who Will Buy?” showed stronger syllabus outcomes for the focus group than assessment results for the same cohort for other geography units over the previous five terms. The classroom teacher reported that traditional classroom teaching supported four of the six members of the focus group

to achieve Stage Two geography outcomes, and that *GeoCity* supported all six members of the focus group to achieve Stage Two geography outcomes.

However, the worksheet results and focus group interviews showed that support for syllabus outcomes provided by *GeoCity* was uneven across tasks and topics. The worksheets showed that average marks for the whole class for both the pre and post worksheets, and the change from pre to post, varied by task and topic. Data from the focus group interviews affirmed these findings, and provided further information on these post-test marks, with results recorded by topic and also by task. Specifically, the worksheet results for the class showed that the coal or solar power and technologies involved with monetary exchange tasks provided the greatest support for syllabus outcomes, as these were the areas of study with both the highest post-test marks (90.07% and 92.76% respectively) and greatest improvement from pre to post test (46% and 38% respectively). This was affirmed by the focus group interviews, during which students demonstrated A grade development of knowledge for these two areas of study, and only these two areas of study. In contrast, the worksheet results for the class showed that the goods, services and needs topic led to limited understanding of syllabus outcomes, with students achieving the lowest post-test mark (77.44%) and smallest improvement from pre to post test (13%) for content related to this areas of study. Again, this was affirmed by the focus group interviews, during which students demonstrated C grade development of knowledge for two of the three related tasks – the lowest grades recorded for *GeoCity* areas of study. Due to these variations, the particular ways in which principles were applied by task, and how particular applications impacted learning outcomes are explored below.

Data showed that all learning tasks were perceived to be useful and challenging, and all but the goods and services and consumer rights tasks were perceived to be achievable. It showed that students found the game useful as a means to learn due to parallels with the real world, and that individual tasks were perceived to be useful as a means to learn and to advance in the game world. Challenge was evidenced to be experienced via requests for support, time spent on tasks and students and teacher comments. The game was also perceived to be achievable during most tasks, and in relation to other principles, specifically agency and learning through doing, including

trial and error. This was evidenced via student and teacher comments and that students completed game tasks. However, cognitive overload was evidenced during the goods and services and consumer rights tasks, specifically due to the presentation of multiple written pieces of information in quick succession. This was evidenced to undermine student perception of achievability. As such, testing of *GeoCity* in the Stage Two classroom affirmed literature review findings that games that are perceived to be useful, achievable and challenging support learning and syllabus outcomes, consistent with Gee 2003, 2005a, 2005b; Habgood, Ainsworth and Benford 2005; Squire 2005. A perception of usefulness supported learning in two ways: learning being a clear objective of game play, and navigation of learning tasks being necessary to advance in the game world. A perception of achievability supported learning, via agency, learning by doing and treating mistakes as a way to learn; however, this was undermined by cognitive overload, specifically due to the presentation of multiple written pieces of information in quick succession. Finally, a perception of challenge supported learning via task difficulty, and responsibility, specifically situated decision-making that positioned the learner as agent. This suggests that a useful, achievable and challenging game experience is supported by an environment in which players have agency and decision-making powers, learn by doing, see mistakes as a way to learn, and avoid cognitive overload.

Data showed that general game play and all tasks, other than goods and services, bread and caged eggs, involved learning as part of game flow. The strongest evidence that learning as part of game flow supports syllabus outcomes related to the technologies involved with monetary exchange task; the task for which the class's highest average mark post-intervention was recorded. All students successfully navigated the relevant task, a requirement of buying things to meet avatar needs and wants. Furthermore, learning being a part of game flow relied on the task being situated and participation having consequences. Participation in the bread, caged eggs, organic eggs and/or consumer rights tasks provided evidence of this: players needed to access money to purchase the goods that triggered these tasks. This involved collecting mail and following written instructions from the bank to get a bank card and using the bank card to withdraw money, after which using this card, or cash withdrawn from the bank or ATM, was possible. Using the technologies

involved with monetary exchange was also a repeat occurrence, differentiating it from all but the needs and wants task, as students regularly needed to access and spend money to buy goods to meet needs and wants. This suggests that learning as part of game flow is assisted by situating syllabus content and making use of it a precondition of success in the game, as recommended by Aldinger et al. (2005), Habgood, Ainsworth and Benford (2005), and Villalta et al. (2011), and that making this a repeat occurrence enhances learning.

Collaboration not only occurred, but was evidenced by the data to support syllabus outcomes. This affirms literature review findings (Fisher & Baird 2005; Salmon 2000; Steel 2009; Vygotsky 1978) that collaboration supports syllabus outcomes. Skills development via collaboration was evidenced during the focus group interviews for the technologies involved with monetary exchange task. This was affirmed via chat transcripts and researcher observation. During the coal or solar power task, collaboration in class and via the chat function was also evidenced to support decision-making and knowledge sharing that informed decision-making. This showed that collaboration supports syllabus outcomes in three ways: via talking, the chat function, and watching others play. These features supported skills development, knowledge sharing and decision-making. However, in contrast, data collected from the goods and services and needs and services tasks, the tasks with the lowest average grades achieved (C), showed that the context for collaboration may impact the learning of syllabus outcomes. Collaboration was evidenced during these tasks, but did not always appear to support syllabus outcomes. Researcher observation during the goods and services task showed that the chat function was first discovered and used at the same time as information and instructions for the task were presented, adding cognitive load. During the focus group interviews, students noted that chat was annoying and distracting during the goods and services task. In addition, for the needs and services task, the sharing of incorrect information among students, without correction, undermined the learning of syllabus outcomes. This made teacher involvement essential to ensure correct concepts were learnt. So, support for syllabus learning is undermined when the inclusion of collaboration does not respect other principles, particularly respect for cognitive load and opportunities for self-paced student inquiry, and teacher involvement. While Nakasone et al.

(2009) similarly found that collaborative learning experiences are supported via textual chat, gesturing and voice transmission, use of *GeoCity* showed that collaboration beyond the game world, that is collaboration within the classroom, can support students learning of ideas to meet syllabus outcomes.

There was strong evidence that players experienced identity and agency throughout game play and during all tasks other than goods and services and needs and services. However, the contribution to syllabus outcomes was evidenced most strongly on particular tasks: needs and wants, organic eggs, coal or solar power, and technologies involved with monetary exchange. In relation to these four tasks, focus group students talked about syllabus learning in terms of participation by and what it meant for their avatar, also indicating a relationship to other principles: an immersive environment, situated meaning and feedback. This support and combination of principles is consistent with findings from Gee (2005a, 2005b), who asserts that learning improves when identities can take meaningful action that has consequences.

Data collected during implementation also affirmed literature review findings that learning improves when meaning is situated (Aldinger et al. 2005; An & Bonk 2009; Gee 2005a; Greeno & Moore 1993; Squire 2005; Shaffer et al. 2005; Villalta et al. 2011) and when there is support for the critical construction of knowledge (Castleford 1998; Gee 2005a; Lemberg & Stoltman 1999; McNail 1987; Rosario & Widemeyer 2009; Schraw 1998; Steel 2009). Observation and the focus group interviews provided evidence that meaning was situated during general game play for all tasks, and that this helped support students to achieve geography outcomes specified by the NSW syllabus. This was demonstrated by students describing situated syllabus content, particularly in relation to player agency and an immersive and complex environment that reflected reality. Furthermore, this situation of meaning related to player agency and feedback in an immersive, complex and realistic environment; focus group interviews and observation provided evidence that students examined and questioned learning content. This suggests a game based on best practice design principles supports the critical construction of knowledge by giving players choice in a realistic environment, choice that has consequences. It also affirms literature review findings that the construction of situated knowledge is

enhanced when students learn the metacognitive skills of identifying goals and monitoring, questioning and assessing oneself (Castleford 1998; Lemberg & Stoltman 1999; McNail 1987; Savery 1998; Schraw 1998).

The importance of video game design respecting cognitive load to support learning was illustrated most clearly when the game failed to do so. The resultant negative impacts on learning were clear. The goods and services and consumer rights tasks failed to respect cognitive load in different ways, as outlined in section 4.2.2. These were the tasks from game play for which students achieved C and B grades respectively. For the goods and services task, students were highly critical of interruptions from the chat function. Chat was observed interrupting a learner's attention on the task, and many students complained about the presence and persistence of chat use during the task, which they could not ignore. Similarly, for the consumer rights task, cognitive overload impacted participation. However, overload related to two pieces of information presented in written text in quick succession, rather than chat. For the goods and services task, the inclusion of collaboration via chat, and its position over written instructions, hindered learning outcomes. For the consumer rights task, cognitive overload impeded the function of other design features, namely clear rules and objectives. In contrast, cognitive load was respected during all other tasks. A clear practical example of how respect for cognitive load supported syllabus outcomes was the coal or solar task. The class achieved an average mark of 90.08% for the task, and the focus group achieved an A grade. Chat was prompted at the end of the task instead of the start, information and instructions were delivered verbally, and information was chunked during the task to take advantage of long-term memory. This affirms research findings that clear instructions and chunking information supports schema construction, and leads to stronger syllabus outcomes (Sweller, Van Merriënboer & Paas 1998; Hasler, Kersten & Sweller 2007; Sweller 2010).

Evidence of the *GeoCity* environment being immersive, realistic and complex, and this supporting geography syllabus outcomes, was strong. During the focus group interviews students discussed complex syllabus content in detail in relation to their experience of it in the game. Their comments also suggest that agency and learning

through doing play important related roles, with students detailing their experience of their action in the game world and the learning environment. This affirms research by Dittmer (2010), Litherland and Stott (2012) and Shaffer et al. (2005) that virtual immersion in the environment being studied supports geography learning.

Data showed that opportunities for self-paced student inquiry, learning by doing and problem solving were present in the game and supportive of geography outcomes, and that this principle is strongly related to an immersive, realistic and complex environment. Students' comments via the focus group interviews demonstrated geography knowledge related directly to students' experience in the game world, as well as self-paced student inquiry and learning by doing and problem solving. They also suggest a relationship between this learning principle and actions having consequences, situated meaning, learning as part of game flow, and identity in the game world. That is, the ability for students to pace their own learning and problem-solve works in conjunction with other principles functioning concurrently in the game. Finally, contrasting the three tasks for production and distribution also suggests the importance of learning by doing in particular. The production and distribution outcomes were strongest for the organic eggs task, the only one of the three tasks to include this principle, where moving through the task also involved active participation in production.

The data showed that having a design that supports teacher involvement and access to related resources contributes to syllabus outcomes. Computer-controlled avatars played the role of experts in *GeoCity* and the syllabus content they relayed was repeated by students during the focus group interviews. Furthermore, both the classroom teacher and the researcher were present in the classroom, and answered student questions about syllabus content, which contributed to students' capacity to complete tasks and advance in the game world, progression which required syllabus knowledge.

Data collected during implementation suggested that students understood game rules in relation to several tasks and ensuring that play includes clear rules and objectives supports syllabus outcomes. The contribution of this principle to learning was most

clear in relation to the needs and wants task. During the interviews with the focus group, students named the needs that had to be satisfied in the game – including food, community, clothing and shelter – and linked this knowledge to game rules that required they be satisfied. This shows that understanding about needs and wants was developed with respect to the game’s rules and objectives. Specifically, in the case of needs and wants, this took place in the context of situated meaning, player agency and game feedback; that is, through taking action in a game world governed by consistent rules.

The evidence discussed above also indicates that, in relation to a number of tasks, play involved feedback and that this principle supports syllabus outcomes. Students said during the focus group interviews that the need-satisfaction bar prompted them to address needs over wants – that is, simple onscreen information gave students feedback on their avatar that changed, going up or down, depending to their actions in the game. This is consistent with research by Santamarina et al. (2010) that links learning outcomes to both clear rules and objectives and short feedback cycles. Furthermore, it affirms research (Castleford 1998; Lemberg & Stoltman 1999; McNail 1987; Rosario & Widmeyer 2009; Savery 1998; Schraw 1998) that links agency and assessing oneself in response to feedback to strong learning outcomes.

## **5.2 Conclusion and recommendations for Question One**

Findings show that *GeoCity* supports Stage Two students to achieve the geography outcomes specified by the NSW syllabus. This is underpinned by the combination of the best practice design principles identified in the literature review, all of which were evidenced during game play, as outlined in section 4.2:

1. Perceived to be useful, achievable and challenging.
2. Learning is part of game flow.
3. Play involves collaboration.
4. Players have identity and agency.
5. Game play situates meaning.
6. Design respects cognitive load.
7. Offers an immersive, realistic and complex environment.
8. Involves self-paced student inquiry, learning by doing and problem solving.

9. Design supports teacher involvement and access to related resources.
10. Play includes clear rules and objectives.
11. Play involves feedback.

The data shows that support for syllabus outcomes in *GeoCity* was not consistent. Overall, topics and tasks that employed all or most of the design principles, in combination and without friction, were seen to best support syllabus outcomes.

Through an exploration of the interaction between design principles included in tasks, and the broader context of the game, it is also clear that some design principles and conditions are foundational, and others complementary. In other words, some are essential to syllabus outcomes, and others are helpful. In particular, if cognitive load is not respected, syllabus outcomes are undermined and students defer to the teacher or researcher. During implementation, tasks for which cognitive load was not respected, despite the broad inclusion of other principles, indicated students' learning was leading to poorer syllabus outcomes. Similarly, technical problems create a context that likewise undermines syllabus outcomes, and as such should be considered foundational. Finally, teacher or researcher involvement was essential at times during the study to support student participation or correct errors in knowledge and, as such, is considered a foundational design principle to support syllabus outcomes.

### **5.3 Synthesis and discussion of data collected for Question Two**

To answer research Question Two, the pre/post test of student motivation to learn and critical thinking (questionnaire) was principally used to measure motivation to learn and critical thinking before and after the intervention. All other data collection instruments, with the exception of the worksheets, were used to triangulate how the video game motivated learning and supported critical thinking.

The questionnaire showed the average overall motivation to learn for the six focus group students improved from pre to post video game use. In support of this finding, the classroom teacher reported that the video game supported students' motivation to

learn. As such, it can be seen that a video game based on best practice design principles supports an increase in student motivation to learn.

Motivation was also measured by category, with students asked an equal number of questions relating to: intrinsic goal orientation, extrinsic goal orientation, task value, control of learning beliefs, self-efficacy for learning and performance, and test anxiety. Changes in individual student motivation by category were inconsistent across the six focus group students. The data showed, on average, improvements in intrinsic goal orientation, extrinsic goal orientation, task value, control of learning beliefs, and self-efficacy for learning and performance. However, in the context of an overall increase in motivation to learn, the questionnaire also showed an average decrease in test anxiety. This suggests that a video game based on best practice design principles – on average – supports intrinsic goal orientation, extrinsic goal orientation, task value, control of learning beliefs, and self-efficacy for learning and performance, and weakens test anxiety.

The questionnaire also showed the average overall critical thinking for the six focus group students improved from pre to post video game use. In support of this finding, the classroom teacher reported that the video game supported students' motivation critical thinking. As such, it can be seen that a video game based on best practice design principles supports an increase in student critical thinking.

The verbal questionnaire also showed average changes to critical thinking by category for the six focus group students. Critical thinking was measured before and after video game use by category, with students asked an equal number of questions relating to: rehearsal, elaboration, critical thinking, and metacognition. Changes in student critical thinking by category showed an average decrease for rehearsal and an average increase for elaboration, critical thinking and metacognition. It also showed that each of the focus group students decreased their rehearsal from pre to post video game use, and increased or maintained their score for elaboration, critical thinking and metacognition from pre to post video game use. As rehearsal relates to repeating learning content over and over to oneself to help recall information (Duncan & McKeachie 2005; Pintrich & De Groot 1990), the decrease in this category suggests

the fall in a learning strategy that does not involve critical thinking. Similarly, the increases across all other categories suggest support for critical thinking, as they all involve applying previous knowledge to a new situation. This suggests that a video game based on best practice design principles on average supports elaboration, critical thinking and metacognition, but not rehearsal.

In terms of contributing principles, data collected during implementation affirmed literature review findings that games that are perceived to be useful, achievable and challenging underpin motivation to learn and assist critical thinking (DiSessa 2000; Gee 2003, 2005a, 2005b; Habgood, Ainsworth & Benford 2005). The design features present throughout game play were evidenced to support the perception that *GeoCity* was useful, achievable and challenging. Specifically, data showed that all learning tasks were perceived to be useful and challenging, and that all but the goods and services and consumer rights tasks were perceived to be achievable. The focus group interviews provided evidence that students found the game useful, achievable and challenging and that this motivated learning. This was affirmed by the classroom teacher, who attributed increases in motivation to learn and critical thinking to achievability and challenge, specifically noting that students being comfortable with and not defeated by the game was vital to motivation. Likewise, the chat transcripts provided evidence of motivation to learn and question in relation to this principle. They suggested that motivation to learn due to challenge is directly linked to gaining information to navigate a game world, also showing the importance of the environment closely reflecting reality and learning being part of game flow.

Implementation showed that learning that was part of game flow and that this principle supported motivation to learn and critical thinking. For example, learning was shown to be part of game flow for the coal or solar power task; and motivation to learn about coal and solar power was evidenced during the focus group interviews, and both critical thinking and motivation to learn in relation to the task was observed. This finding was consistent with the findings of the literature review (Baek 2008; Habgood, Ainsworth & Benford 2005; Kirriemuir & McFarlane 2004; Squire 2003; Villalta et al. 2011). The focus group interviews, observation and chat also suggested how the game implemented this principle to best support motivation to learn and

critical thinking; these were sparked by students being keen to advance in the game world, test out new experiences, and meaningfully impact the game world, for example, voting for coal or solar power.

Data collected also affirmed literature review findings that collaboration during game play assists motivation to learn (El-Nasr et al. 2010; Fisher & Baird 2005; Habgood, Ainsworth & Benford 2005; Villalta et al. 2011; Voulgari, Komis & Sampson 2014) and creates an environment conducive to critical thinking (Ally 2004). Students were observed looking at one another's monitors and seeking to then access the learning tasks observed. Students were also observed asking one another how to use the ATM, bank card facility and bank and watching one another use the ATM and navigate the organic eggs task. The importance of collaboration to critical thinking was also evidenced. The teacher reported that students demonstrated and prompted critical thinking via collaboration: "questions", "comments" and "answers". Thus, the evidence suggests that collaboration during game play supports motivation to learn, specifically via verbal communication, watching and a chat function; and drives critical thinking, specifically via verbal communication.

During the focus group interviews, students attributed motivation to play a game that included learning content to having identity and agency, specifically feeling embodied in the game world and being able to make choices. Likewise, students' comments during focus group interviews that showed critical thinking also suggest a link to agency and decision-making, with students talking about their weighing of options to make decisions in the game world. For example, student comments about the caged eggs task linked identity and agency to motivation to learn and critical thinking simultaneously. Students communicated their sense of identity during the task, talking about content in the first person. They also asked critical questions that showed their motivation to learn more. These findings affirm literature review findings that motivation to learn and critical thinking are supported by the experience of identity and agency in games (Thomas 2009; Turkay et al. 2014; Wilson et al. 2009).

Students noted motivation and demonstrated critical thinking in the context of meaning being situated. Data showed that motivation to learn how to use an ATM was grounded in the context of the purpose it served in the game world. In other words, students were motivated to learn to use an ATM because the meaning of the skill was situated and enabled players to purchase goods. This also meant the principle worked hand-in-hand with learning as part of game flow. Furthermore, correct examples given by students of goods and services and how one could exercise their rights as a consumer were all goods, services and options available in *GeoCity*. Motivation to learn this content related to its role in the game world. As with the ATM, both the goods and services and consumer rights content was of interest as they helped players advance in the game world. Finally, students critically engaged with what they were doing in the game world. For example, they asked critical questions from the position of an organic eggs farmer, and relayed that they needed to understand coal and solar power because they had to make a decision about electricity provision in *GeoCity*. In these examples it was meaning that was situated, coupled with agency, that was evidenced to support motivation to learn and critical thinking.

Implementation provided some evidence in support of literature findings that motivation to learn and critical thinking are supported via design that respects cognitive load (Ang, Zaphiris & Mahmood 2007; Gee 2005a; Turkay et al. 2014; Villalta et al. 2011). This evidence presented in the context of tasks that triggered cognitive overload, and the resultant negative impact on motivation to learn and critical thinking. Cognitive overload was evidenced in relation to the goods and services and consumer rights tasks. The former provides a case study warranting further exploration. For the goods and service task students were highly critical of interruptions from the chat function; a de-motivating feature that did not respect cognitive load. Chat was observed interrupting learner's attention on the task, and many students complained about the presence and persistence of chat use during the task, which they could not ignore. The reduced access to learning material logically meant reduced understanding of material with which to critically engage. However, students still made comments about goods and services, specifically weighing the role of a soup kitchen, that demonstrated critical thinking in relation to goods and

services. Thus, the data confirmed the negative impact of cognitive overload on motivation to learn and critical thinking, while also showing that it was foundational for motivation to learn it did not rule out critical thinking.

As with meaning being situated, evidence of the *GeoCity* environment being complex, immersive and realistic, and this supporting motivation to learn and critical thinking, was strong. The classroom teacher attributed increases in critical thinking and motivation to learn to students making connections between the game environment and the world and what they already knew. This affirms literature review findings that a complex, immersive and realistic game environment lays the foundation for motivation to learn and critical thinking (Adams 1998; Dittmer 2010; Gaber 2007). Comments during focus group interviews, observation and chat also suggest that immersion in particular is supported by identity and agency and learning through doing. Furthermore, the data showed that contrast in a complex, immersive and realistic environment is particularly supportive critical thinking. For example, students talked, asked questions and made comments about caged and organic eggs and coal and solar power that indicated critical thinking. Comments compared and evaluated the production of caged versus organic eggs, and coal versus solar power.

Evidence that *GeoCity* involved opportunities for self-paced student inquiry, learning by doing and problem solving, and that this principle supports student motivation to learn and critical thinking, was strong. The classroom teacher noted that the opportunity for students to problem solve and make and learn from mistakes, assisted motivation to learn and grounded critical thinking. During observation, two questions focussed on how to define the soup kitchen, a problem to be solved, weighing the fact that soup kitchens offer goods, but also a service, providing evidence of evaluation. This support for critical thinking also happened in relation to discussion with the researcher and teacher and other students. Observation also suggested how this principle supported motivation to learn. For the ATM and the production and distribution tasks, students worked through these activities at different paces, and often made mistakes and took multiple attempts to complete them. For the bread and caged eggs tasks students also moved through factories at different speeds; some students listened to chunks of information more than once, affirming and showing

the value of opportunities for self-paced student inquiry. They demonstrated correct navigation of the tasks at various speeds, particularly in relation to ATM use. There did not appear to be a difference in concentration levels observed by the researcher, between students who completed the tasks slowly, and those who completed them quickly. So the opportunity for self-paced learning clearly supported participation and engagement from students with varied capacities.

Data collected during implementation showed that motivation to learn and critical thinking are underpinned by a design that supports teacher involvement and access to related resources. It also provided information about how the design did this, and how this supported other design principles, particularly achievability. Comments to the researcher, probing and evaluating the learning material during observation and focus group interviews, provided evidence of motivation to learn and critical thinking. The presence of the classroom teacher and the researcher in the classroom, as well as the teacher online, and the researcher during focus group interviews, was regularly drawn on by students as a source of support, information and reflection. Students asked questions, in the classroom, online via chat and during interviews, to assist navigation and progress in the game world and learning and critical engagement. So this support happened both within and adjacent to game play. In addition, students opted to access related resources within *GeoCity*, indicating a motivation to learn. This was observed to be specifically supported via the option to hover over objects to find out more about them, and for the bread and caged eggs tasks, the willingness to listen to chunks of information more than once. Taken together, these findings affirm literature review findings that video game design should include teacher involvement and access to related resources to support motivation to learn and critical thinking (Gaber 2007; Woerner 1999). In fact, and of particular importance for both motivation to learn and critical thinking, the involvement of the researcher and teacher was essential at times to support student participation or correct errors in knowledge.

Evidence suggested that motivation to learn was assisted via the inclusion of clear rules and objectives in *GeoCity*, affirming literature review findings drawn from Gaber (2007), Torrente and Manjón (2010), and Woerner (1999). Evidence showed

that the game achieved this through the production and distribution and coal or solar power tasks. Motivation with respect to the monetary reward at the end of the production and distribution tasks was observed by the researcher, with students telling others about their reward and motivating them to seek further learning tasks that offered this. Students sought tasks once they knew rewards were available, expressly to obtain them. Similarly, the rules and objectives around voting on the source of electricity generation, coal or solar power, supported student motivation to learn. Students asked the researcher, the teacher and one another questions to consolidate and further their learning. The data also showed a relationship between these clear rules and objectives and student agency in the game world. Students' comments were made in the first person, and students indicated that knowledge about coal and solar power was important to them because they had to make a decision in the game world, weighing their choices in the context of these questions and making statements. Likewise, evidence showed there is a relationship between critical thinking and clear rules and objectives, affirming research by Garris, Ahlers and Driskell (2002) and Shin et al. (2012). The data suggested that clear rules that reflected reality provided a framework for critical thinking.

Finally, the data showed that motivation to learn was assisted and critical thinking was underpinned by regular feedback, particularly that actions had consequences, during game play. This is consistent with literature review findings that motivation to learn is supported by a short feedback cycle (Torrente & Manjón 2010) and that regular feedback creates a context for critical thinking (Friedman 1999; Adams 1998). Students were observed trying both correct and incorrect actions during tasks. Researcher observations and teacher comments affirmed that students did not give up in response to feedback when incorrect; in fact, students were motivated students to revise their answers for further feedback. As such, it can be seen that coupling regular feedback with opportunities for self-paced learning through doing supported student motivation to learn. Moreover, during focus group interviews students' verbalised critical evaluation and thinking in the context of feedback. For example, they evaluated goods purchased in the context of game feedback about whether or not they satisfied a need. The importance of feedback reflecting reality to create a supportive context for critical thinking was also affirmed when the game failed to do

so. As such, the evidence suggests that clear and realistic feedback is a requirement to support critical thinking.

#### **5.4 Conclusion and recommendations for Question Two**

Findings show that *GeoCity* motivates learning and supports critical thinking as a method of instruction. This is underpinned by the combination of best practice design principles identified in the literature review, all of which were evidenced during game play, as outlined in section 4.2:

- Perceived to be useful, achievable and challenging
- Learning is part of game flow
- Play involves collaboration
- Players have identity and agency
- Game play situates meaning
- Design respects cognitive load
- Offers an immersive, realistic and complex environment
- Involves self-paced student inquiry, learning by doing and problem solving
- Design supports teacher involvement and access to related resources
- Play includes clear rules and objectives
- Play involves feedback

Through an exploration of the interaction between design principles included in tasks, and the broader context of the game, it is also clear that some design principles and conditions are foundational, and others complementary. For both motivation to learn and critical thinking, teacher involvement and access to related resources, and a lack of technical problems, are a requirement of participation and accessing the support provided by the game. Both require a clear context, including a complex, immersive and realistic environment and situated meaning. To support motivation to learn, content must also be perceived to be useful, achievable and challenging and respect cognitive load. Finally, support for critical thinking is predicated on the greatest number of principles. In addition to those already mentioned, collaboration, in which content can be reflected upon in discussion with others, appears

foundational. So too are opportunities for self-paced student inquiry, learning by doing and problem solving; and regular feedback, particularly actions having consequences.

### **5.5 Recommendations for future studies**

The study undertaken provides sound evidence for the inclusion of video games in the primary school level to enhance learning. A number of areas which could be included in future studies include:

- The use of video games in secondary classrooms
- The use and success of video games to enhance learning across disciplines. Such as in the English syllabus or the Science syllabus or the Arts syllabus
- Broad factors that motivate learning comparing traditional methods to technology enhanced methods
- The amount of time that should be devoted to video game learning across the curriculum
- Gender differences in relation to self-regulation and motivation in learning
- Age difference in relation to technology immersion e.g. video game engagement
- The role of video gaming, recreational vs educational
- The level of cognitive load in relation to learning with video games
- The role of video games in learning for motivation for students with learning difficulties, e.g. students with ADHD (attention deficit hyperactivity disorder)

This study has established that video games produce better learning conditions, motivate students to learn and enhance critical thinking skills.

In this case, the video game specifically developed for the study, provided an alternative to traditional learning and enhanced the problem solving capacity of the students involved. In an age where students are confronted more with technology based learning, it is vital that students develop different skills, specifically critical thinking, enabling learning independence.

The students involved displayed increased motivation to learn, attained the correct learning outcomes and enjoyed the experience. The study successfully fulfilled a gap in current literature in the area of motivation, learning design and the role of technology to enhance learning outcomes.

The study achieved its aims to identify how instructional video games could achieve specific learning outcomes. An important aspect of the study was the identification of best practice design principles that can be applied to a variety of contexts.

The important relationship between learning outcomes, critical thinking and motivation was highlighted as a result of the study. Drawing on a strong theoretical base this study has contributed to the research field of technology and learning. Teachers and education policy makers can now use research based arguments to develop syllabus and programs which include video games confident that learning outcomes will be achieved.

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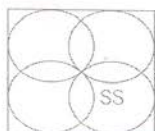
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## APPENDIX A: HSIE K-6, UNIT OF WORK: WHO WILL BUY?

## Human Society &amp; Its Environment K-6

Who Will Buy?

## Units of Work



## Who Will Buy?

This unit provides opportunities for students to explore the goods and services that provide for needs and wants and the responsibilities of producers and consumers. It explores the changes that have occurred and the influences of technology.

**Unit Duration** Approximately 8–10 weeks

**Subject Matter Focus** In this unit, students learn about:

- goods, services and facilities in communities
- contributions of paid and unpaid workers and voluntary organisations in the community
- services and contributions made by community organisations and groups
- consumer and producer rights and responsibilities.

**Implications for Learning** In this unit, students have opportunities to:

- use flow charts and diagrams to demonstrate connections between elements of systems that provide goods and services, and explore consequences when elements change
- evaluate systems in their community that have been designed to meet community needs
- examine the contribution of paid and unpaid services in the community to community life
- consider their responsibilities within and towards a community system of goods and services
- be aware of, and reflect on, changes to the provision of goods and services.

## Literacy Notes

This unit provides opportunities for students to explore information reports, descriptions, explanations and procedural recounts.

The HSIE teaching strategies/practices in this unit include flow charts, retrieval charts, concept maps, interviews, moral dilemmas and labelling.

## Links with Other Key Learning Areas

**English:** The structure and language features of the text types students create and interpret (see above).

**Mathematics:** Notions of profit and loss, prices, change, measurement units used to sell goods, wholesale and retail prices, specials, shopping lists, using calculators, estimating, money, 3D models.

**Science and Technology:** Content from the Products and Services strand.

**Personal Development, Health and Physical Education:** Positive relationships between consumers and producers.

## Resources

The Board's website (<http://www.boardofstudies.nsw.edu.au>) lists current available resources such as some selected background information sheets, websites, texts and other material to support this unit.

Spoken, written and visual texts about shopping and shops. Include examples from other countries in the world as well as different cultural communities in Australia.

Resources for a class 'business', including plastic money, uniforms and possible 'goods'.

## Human Society &amp; Its Environment K-6

## Units of Work

## Who Will Buy?

## Who Will Buy?

## Outcomes and Indicators

## SSS2.7

Describes how and why people and technologies interact to meet needs and explains the effects of these interactions on people and the environment.

- identifies the components of a system that provides goods and services and how the components need to interlink
- examines a variety of systems that have been designed to meet needs in communities and identifies the advantages and disadvantages of their use, eg sewerage treatment works, postal system, electricity system
- examines possible consequences if a system changes in some way, eg if components are missing or break down, if technology improves
- explains the changes to a system over time and the advantages and disadvantages of these changes, eg shops, market gardens
- examines the goods and services provided within the community and by community organisations to meet needs
- makes statements about the social and environmental responsibilities of producers and consumers
- describes how changes in technology have affected lifestyles and the environment, eg media technologies
- identifies the different technologies involved with monetary exchange.

## SSS2.8

Investigates rights, responsibilities and decision-making processes in the school and community and demonstrates how participation can contribute to the quality of their school and community life.

- explains the processes involved in civic action within the community
- investigates current community issues
- investigates consumer rights and responsibilities.

## Learning Experiences

Key assessment opportunities are marked: ☆

## Learning Sequence 1: The Need to Shop

- Provide opportunities to investigate the students' basic needs, as well as their wants, for food, clothing and housing. Ask them to complete a retrieval chart that distinguishes between food, clothing and housing needs and wants.
- Have students investigate the possible sources for satisfying needs and wants, eg shops, farms, factories, home produce, community organisations, government organisations, and complete a retrieval chart.
- Discuss the importance of shopping as a means of satisfying needs and wants. Jointly compile a list of a variety of shops, then have students complete a concept map that categorises the list in some way. ☆
- Organise for students to gather information from newspaper and magazine advertisements about buying and selling and to categorise these according to needs and wants, goods and services.
- Organise for students to interview adults and friends about the importance of shopping in their lives. Jointly formulate questions such as: How often do you visit a local shop? What items do you buy most often? What is bought in different shops? How far would you go to buy something you need?
- Organise for students to interview elders (eg grandparents, senior citizens) about how they used to shop when they were younger, and the changes that have occurred: Which changes are they happy about, and which ones would they rather had not happened? What changes in technology they have observed (eg the growth of shopping centres and malls, the use of bar codes, credit cards, EFTPOS)?
- Jointly construct retrieval charts that categorise the differences between then and now. Discuss the advantages and disadvantages of shopping then and now. Ask students to predict future developments. ☆
- Jointly complete a concept map that will demonstrate ways of characterising and distinguishing between shops, other businesses associated with goods and services, local council offices and other community organisations, eg the veterinary practice, a factory, the council chambers, the CWA, local Aboriginal organisations. ☆

## Human Society &amp; Its Environment K-6

Who Will Buy?

## Units of Work

- Encourage students to use a variety of sources and resources to write information reports about shopping in other communities/other countries. ☆
- Ask students to investigate what can be, or is, produced at home and ways of 'shopping' that do not involve money, eg subsistence farming, bartering, cooperatives. Investigate bulk buying.
- Ask students to investigate different options that provide for needs (community organisations, government), especially for people who cannot pay for goods or services.
- Pose a moral dilemma about obtaining goods that you might need, such as food or clothing, when you don't have any money. What options would be available and which options would be fair or unfair? Ask students to form opinions about options for people.

*Learning Sequence 2: Doing Business – Shops and Services*

- Ask students to investigate and write a description of a local shop, including: why the shop is located where it is; the layout; shop design; location of furniture and equipment; stock available and stock control; packaging, storage and display; methods of delivery; use of technology; repair needs and methods; energy use; people who work there; customers and customer service; typical purchases and methods of payment; wholesale and retail prices of different products.
- Provide opportunities for students to observe the location of shops in the local area, locate them on a directory, map them or make a 3D model. Ask them to label the shops according to type. Ask them to consider the differences, similarities, advantages and disadvantages of shopping locally instead of in a large central shopping centre, and complete a retrieval chart. To gather information, they will need to interview consumers and formulate questions such as: Which shops provide for your preferred method of purchase (eg EFTPOS, credit card, account, cash, cheque)? Which is the most convenient location? Which packaging would you prefer? What customer service provides best for your needs? ☆
- Discuss and jointly design a 'shop/business': establish a shop management team; make decisions about what stock to use and where to get it; plan procedures for obtaining stock; decide how to attract customers, store, display and package the stock; decide on the allowable methods of purchase.
- Visit a supermarket, a shopping centre or a market and ask students to observe and pose questions for people who work there about how the system works. Questions they could ask are: Who works here? What are their roles? Where does the produce come from? How is it delivered? What type of produce is there? How does the selling of goods work? Do you advertise? What happens when you have specials or sale periods? How do your customers buy goods? What can go wrong? What happens if the system breaks down in some way? What happens if a delivery doesn't arrive or industrial action taken by your suppliers? What happens if there is a disaster such as a fire or a flood? When do you have to call the police? Ask students to prepare a checklist to record their observations and answers.

*Learning Sequence 3: Where Do the Goods Come from?*

- Organise students to gather and present information to show the production and distribution of food. They will need to formulate and answer questions such as: Where do the goods come from (eg dairy, orchard, factory, home garden, market garden)? Are they natural or processed? How are they prepared for distribution (eg refrigeration, cleaning, packaging)? Where are they processed? Where are they stored before they go to the shop (eg a warehouse)? How are they delivered? ☆
- Have students visit the school canteen and interview the people who work there. They can complete flow charts on how the food/produce gets to the canteen and where it comes from. They should investigate the roles and responsibilities of the canteen staff. They could also investigate how 'green' the canteen is, eg reducing waste, conserving energy. ☆

*Learning Sequence 4: Responsibilities of Consumers and Producers*

- Have students investigate issues that relate to energy use, care of the environment, waste management and the responsibilities of consumers and producers. Ask them to provide alternative plans of action in situations where there is obvious misuse. ☆

**APPENDIX B: THE FULL LIST OF GAME OBJECTS**

- 3 x ATMs (interaction: “use ATM”)
- Bank (interaction: “withdraw money” and “check balance”)
- Bushland (no interactions available)
- Clothing shop (interaction: can browse products and buy them)
- Coal-fired power station (no interactions available)
- Crisis housing (no interactions available)
- Electrical shop (Bank card facility) (interaction: can browse products and buy them)
- Fire brigade (interaction: can “call the fire brigade”. Nb: When there is a fire in the game, a player must call the fire brigade for it to be put out)
- Furniture shop (Bank card facility) (interaction: can browse products and buy them)
- Hospital (interaction: can “call ambulance”)
- Market garden (shop and garden) (interaction: can browse fresh produce and buy)
- Pet shop (interaction: can browse pets and buy them)
- Police (no interactions available)
- Post office (no interactions available)
- School (no interactions available)
- Soup kitchen (no interactions available)
- Sports shop (interaction: can browse products and buy them)
- Supermarket (Bank card facility) (interaction: can browse products and buy them)
- Town Hall (interaction: can go into meeting room)

**APPENDIX C: THE NAMES AND DESCRIPTIONS OF ALL GAME OBJECTS**

<b>Object name</b>	<b>Goods or services</b>	<b>Description</b>
ATM	Service	Where you can check how much money you have in your bank account or withdraw it.
Bank	Service	Where money is kept and where you can check how much money you have in your bank account or withdraw it.
Clothing shop	Goods	Sells clothes.
Coal-fired power station	Service	Where coal is burnt to make electricity.
Crisis housing	Service	Provides housing for people who are homeless.
Electrical shop	Goods	Sells items that work using electricity.
Fire brigade	Service	Prevents and puts out fires.
Furniture shop	Goods	Sells furniture.
Hospital	Service	Treats the sick or injured.
Market garden	Goods	Grows fruit, vegetables and nuts and sells them to the public.
Pet shop	Goods	Sells pets.
Police	Service	Prevents and detects crime.
Post office	Service	Takes, sorts and delivers mail.
School	Service	Provides teaching to students.
Soup kitchen	Service	Gives free food to those who are homeless or cannot afford to buy it.
Sports shop	Goods	Sells sporting gear.
Supermarket	Goods	Sells food and household items.
Town Hall	Service	Where town meetings take place.

APPENDIX D: RELATIONSHIP BETWEEN GAME CONTENT AND SYLLABUS OUTCOMES  
AND INDICATORS

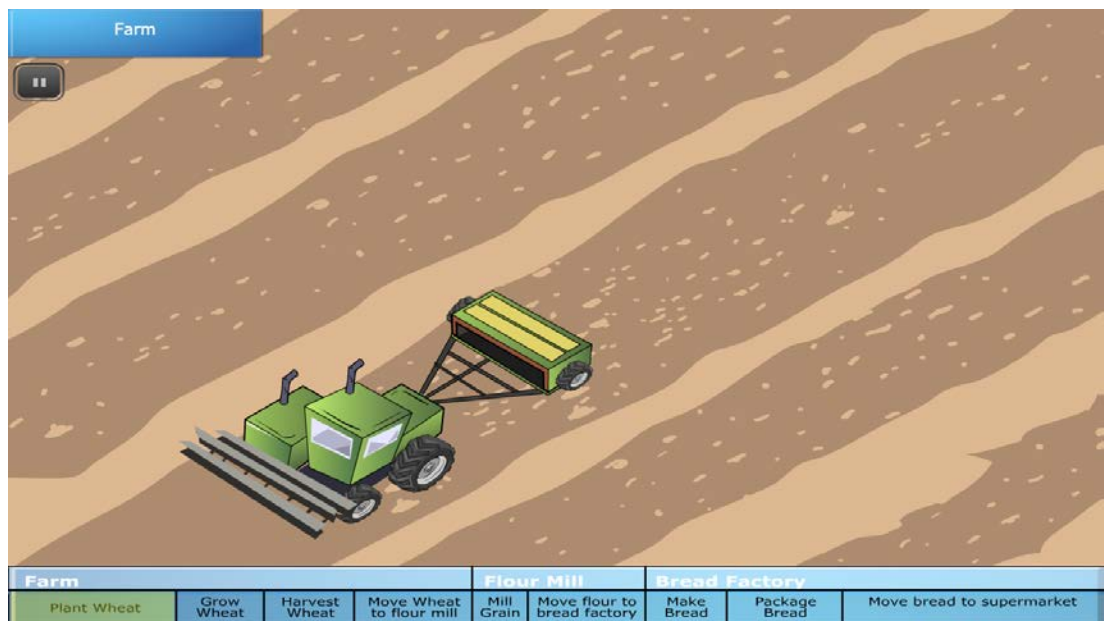
**APPENDIX D: RELATIONSHIP BETWEEN GAME CONTENT AND  
SYLLABUS OUTCOMES AND INDICATORS**

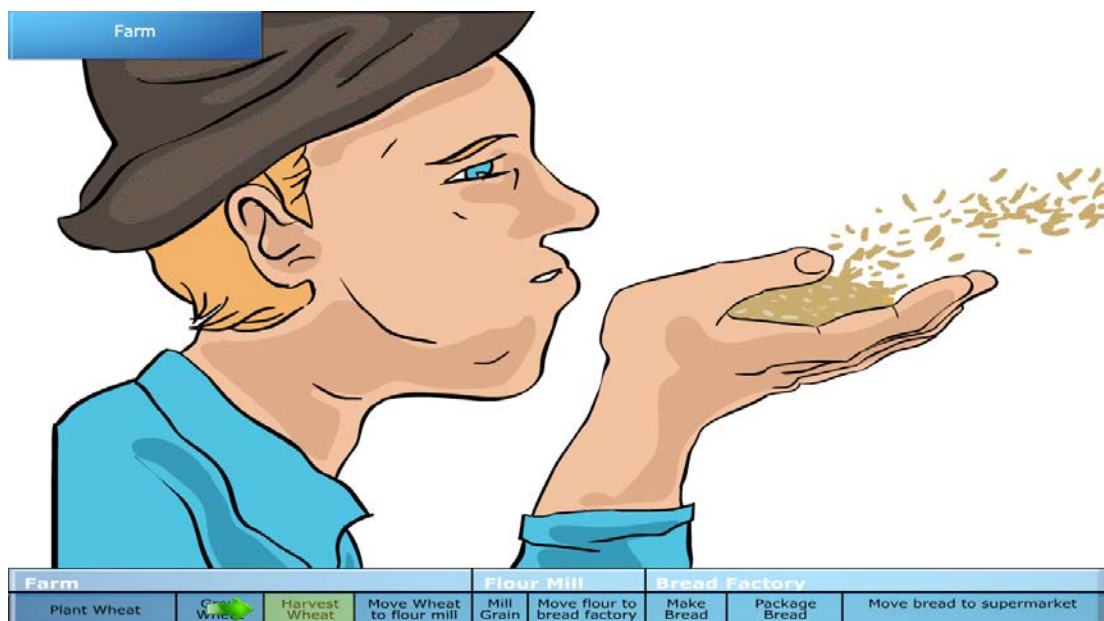
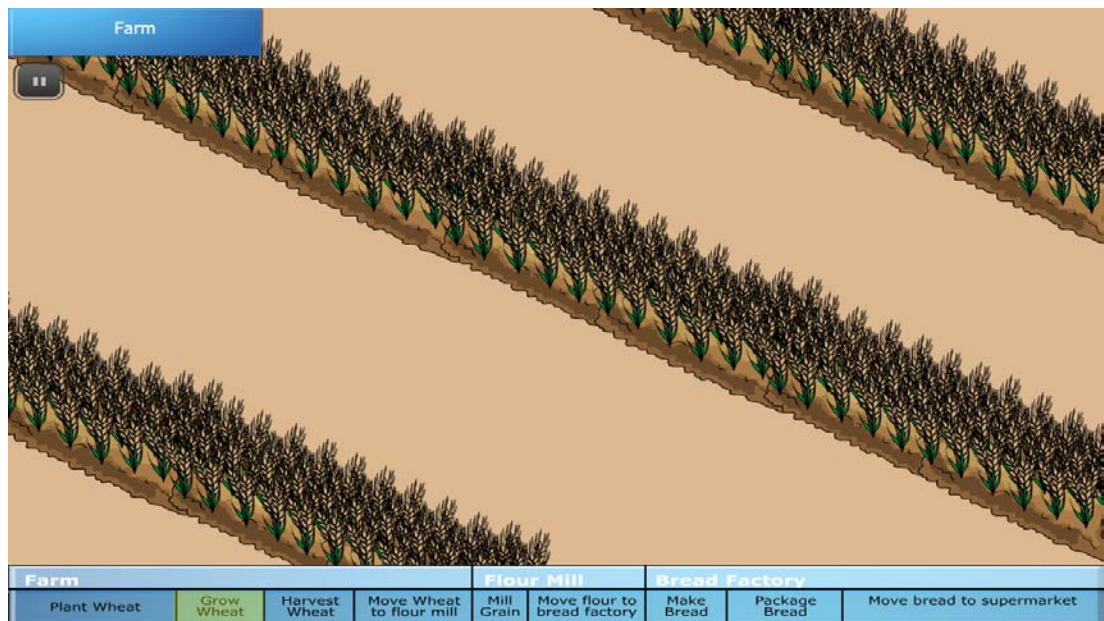
Topic	Task	Description of task	Evidence of student learning	Syllabus 1- 11
<b>Goods, needs and services</b>	Goods and services	Players are presented with a definition of “goods” and “services”, as well as familiar providers. They must label features in the city as providers of goods or services. Players are prompted to chat and share their understandings, given definitions of “goods” and “services”, and are able to get an explanation of the function of each feature should they need it. When they have labeled all features, correct answers are accepted but incorrect answers require that those features be re-labeled.	All features must be identified correctly as providers of goods or services, in order to proceed in game.	<b>5</b>
	Needs and Services	During game play a fire breaks out, an avatar is injured, and an avatar faces destitution. Players must identify the appropriate community services that can address the resulting needs.	Players correctly identify the services that can meet Jack’s needs, and that players chat about the services that can meet needs.	<b>5</b>
	Needs and wants	Game play requires that players satisfy their needs through the purchase of goods, but have enough money to also satisfy limited wants. Large goods purchased must be delivered to avatar’s homes.	Avatars needs are met, and players chat about needs and wants.	<b>5</b>
<b>Production and distribution</b>	Bread, caged eggs and organic eggs	Players must produce and distribute, or view production and distribution of bread, caged eggs and organic eggs.		<b>1, 5, 6, 10 &amp; 11</b>
<b>Technologies involved with monetary exchange</b>		Players must use the bank, an ATM and their cash and bank card in order to access money and buy things. Some shops accept cash only (withdrawn from ATM or bank), others cash and bank card.	Players use the bank and ATM correctly, and use payment options when	<b>8</b>

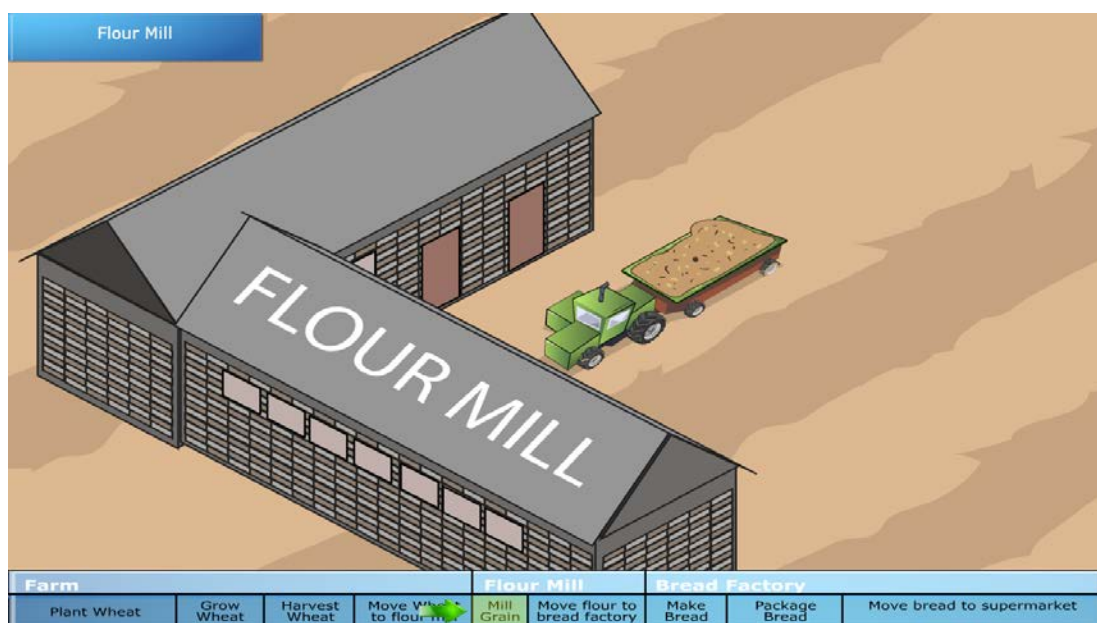
APPENDIX D: RELATIONSHIP BETWEEN GAME CONTENT AND SYLLABUS OUTCOMES  
AND INDICATORS

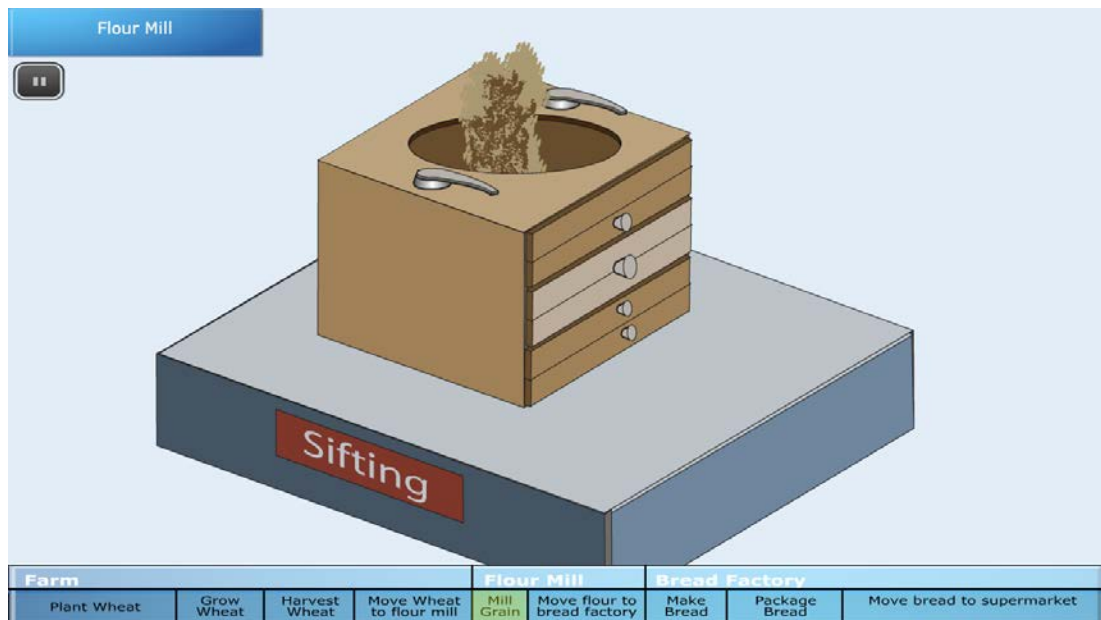
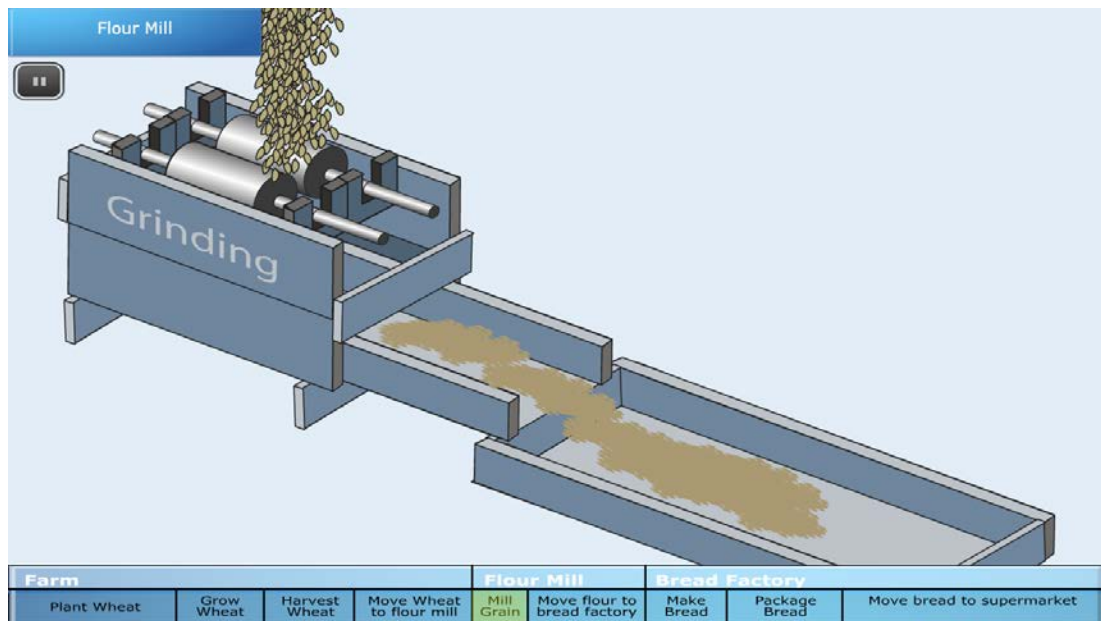
		making purchases.	
<b>Consumer rights</b>	Two goods purchased by each avatar are faulty. When they go to use them they are told so and that they have certain rights as a consumer: to have the goods fixed or replaced, or their money refunded.	Players visit the stores the faulty goods came from and decide how to exercise their rights as a consumer.	<b>11</b>
<b>Coal or solar power</b>	During play, <i>Geocity</i> 's electricity stops working because the city's coal-fired power plant has broken down and is in need of replacement. Players are told they must vote to decide what it is replaced with: another coal-fired power plant or a solar power plant. They must listen to the pros and cons of each option, chat about their thoughts and knowledge and vote to decide.	Students chat about the options will reflect levels of engagement and critical interaction with the task. They will necessarily participate in the process of voting in order to proceed in the game.	<b>2, 5, 9 &amp; 10</b>

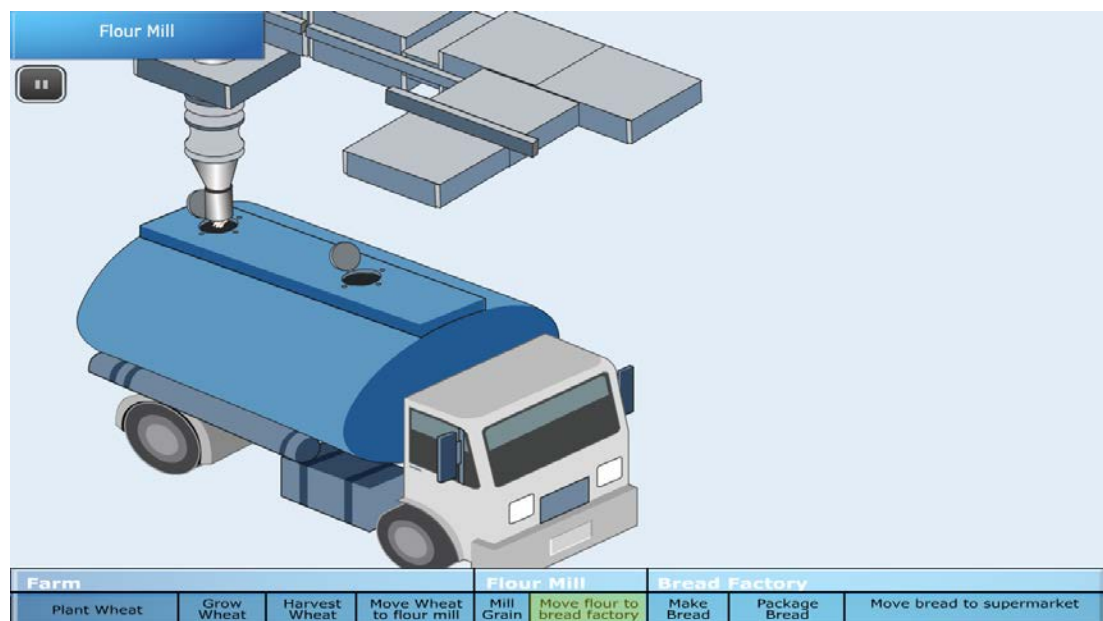
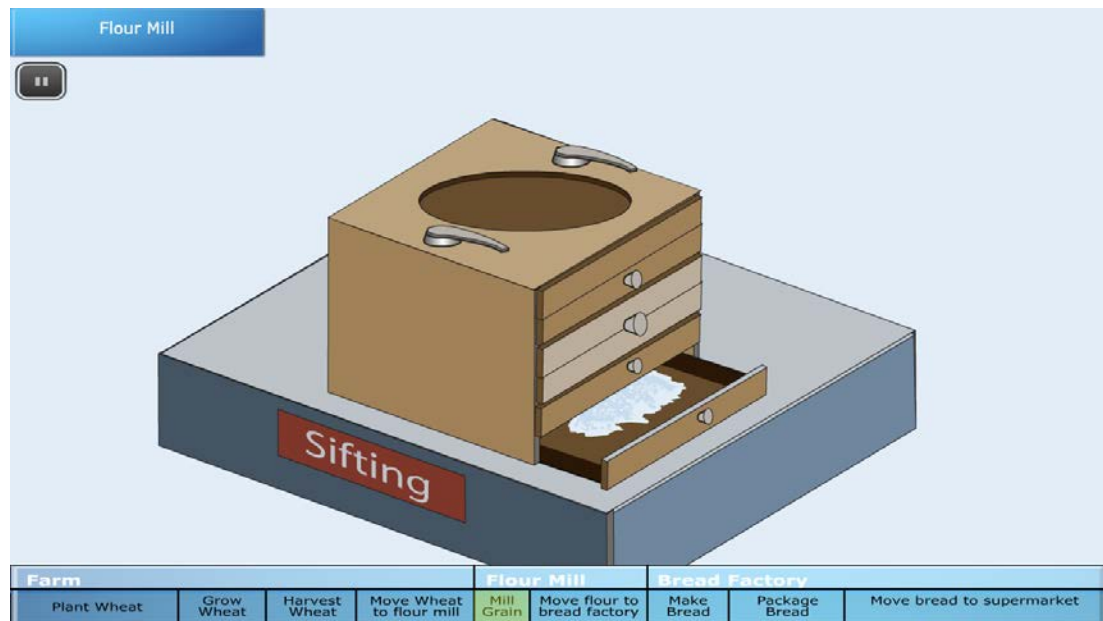
## APPENDIX E: BREAD TASK

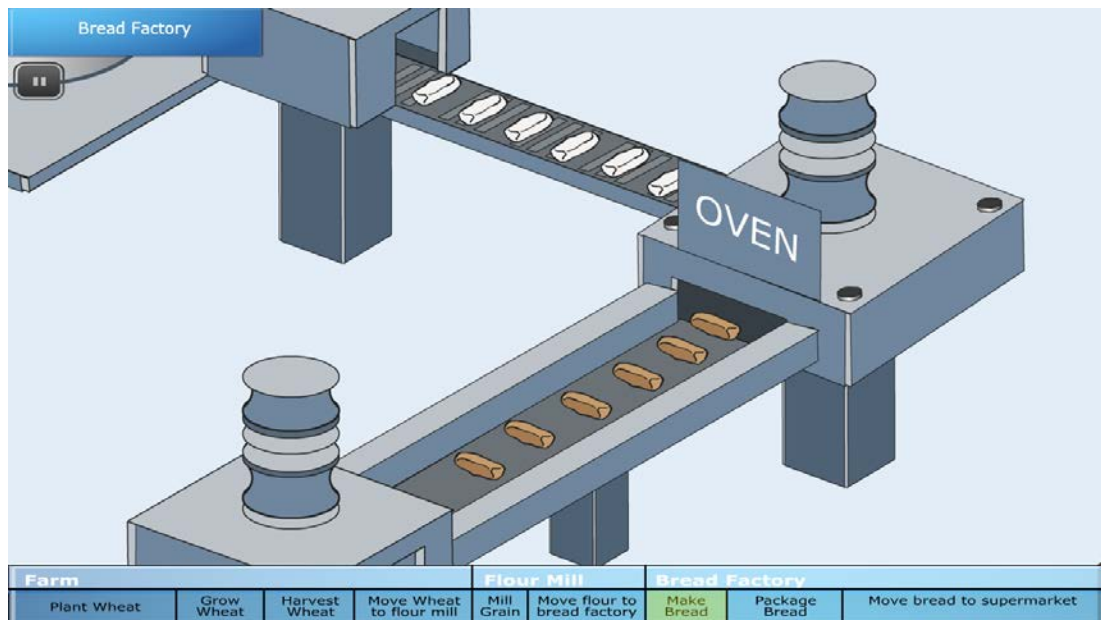
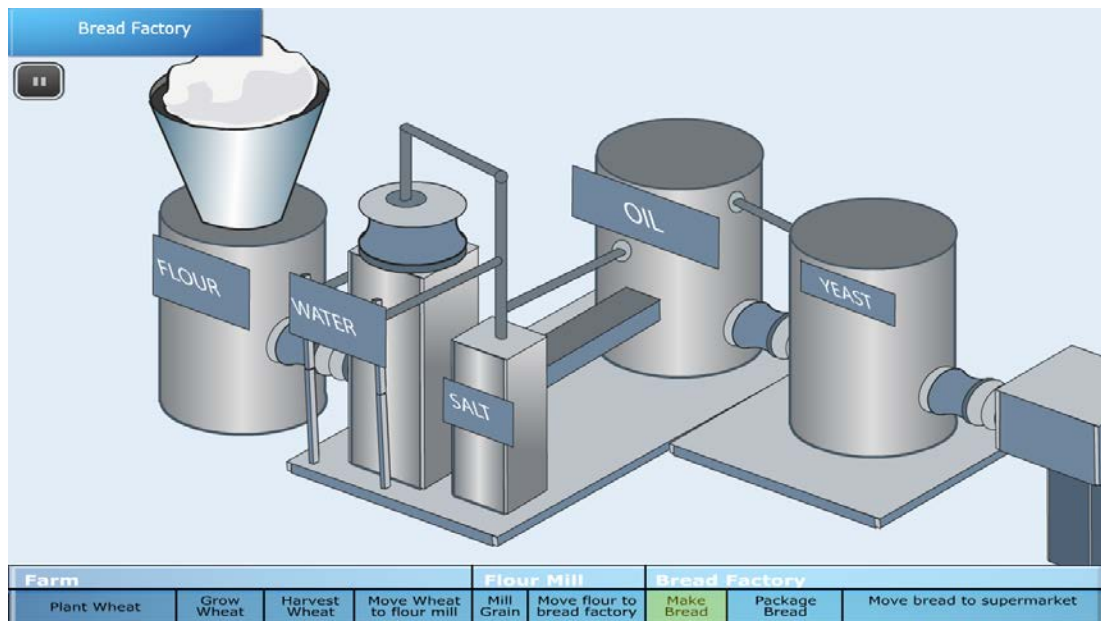


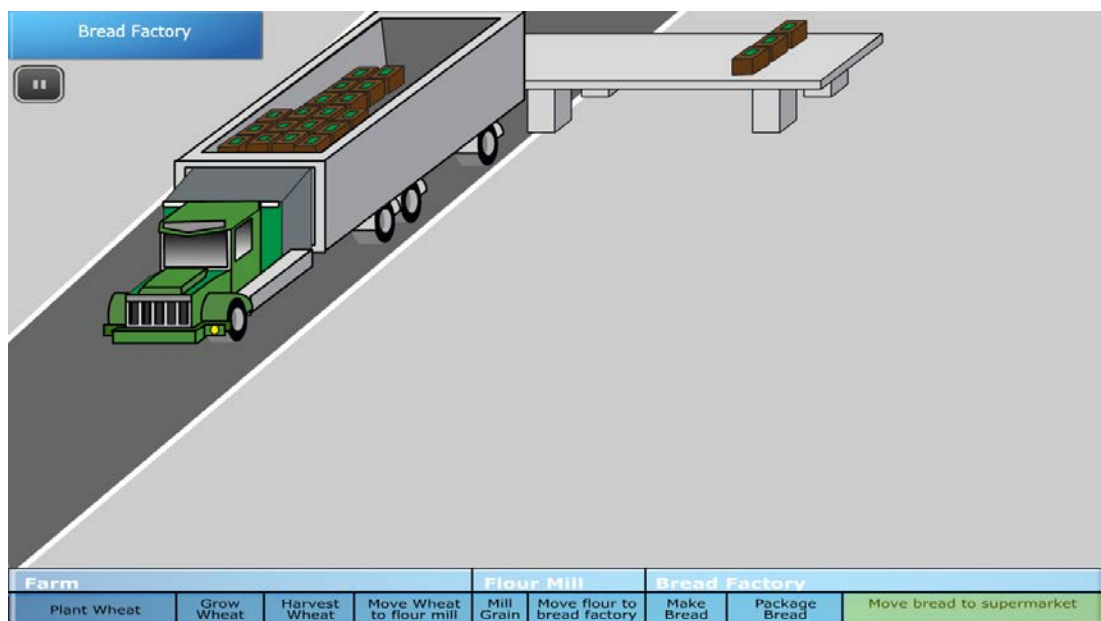
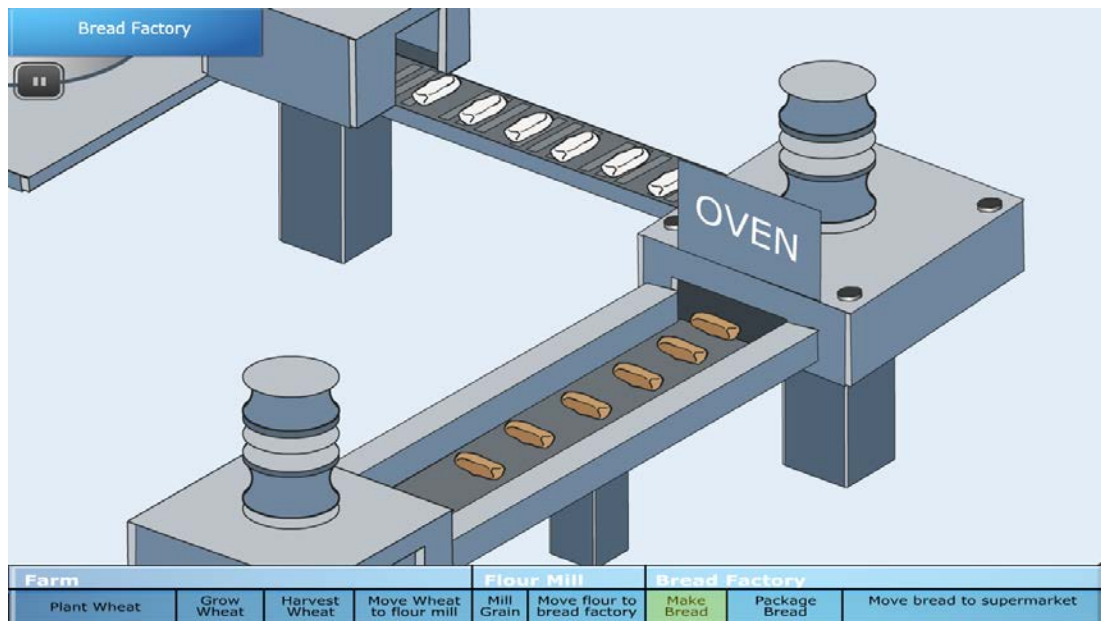






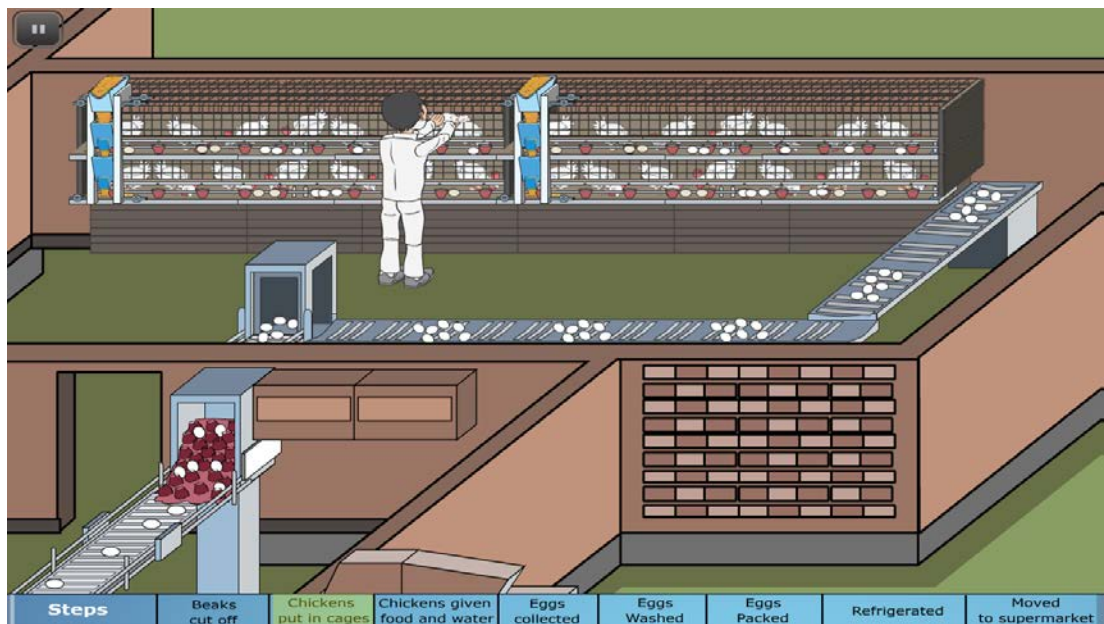
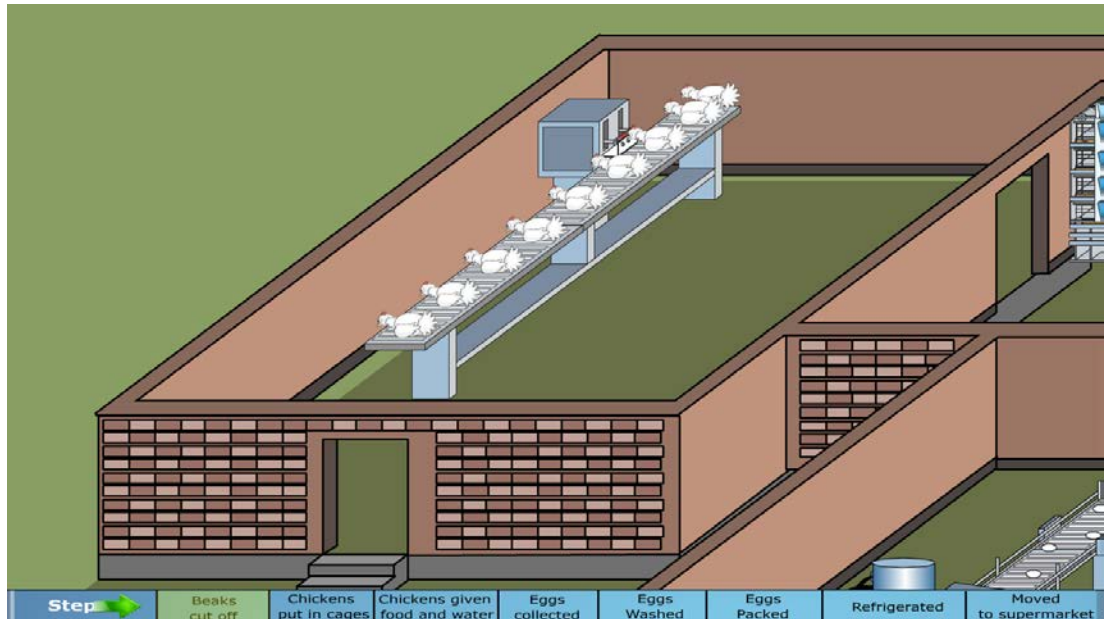


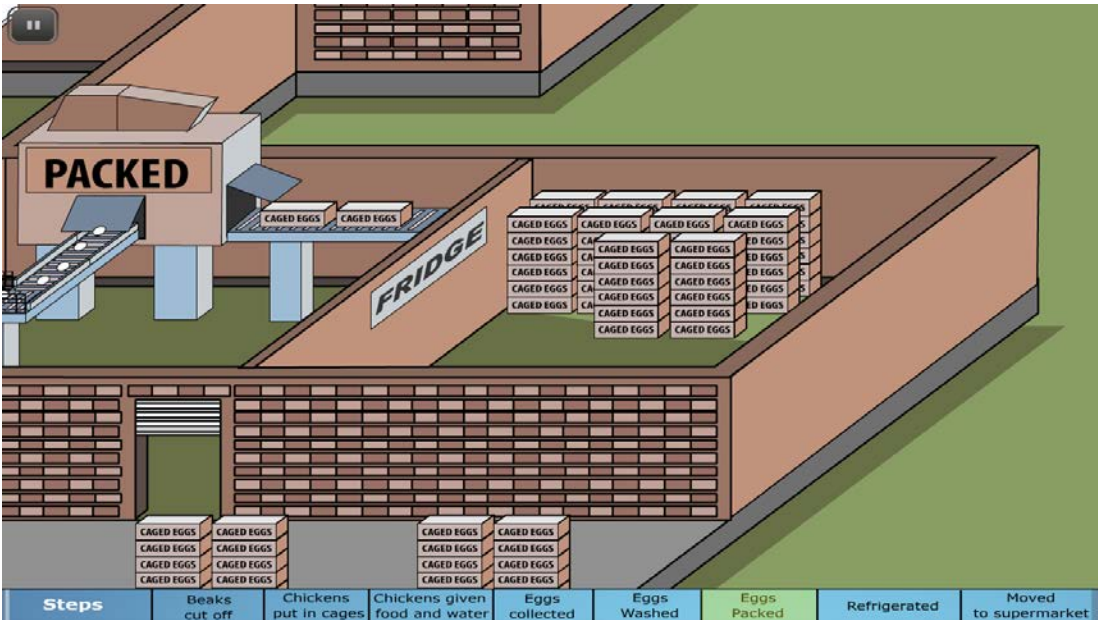
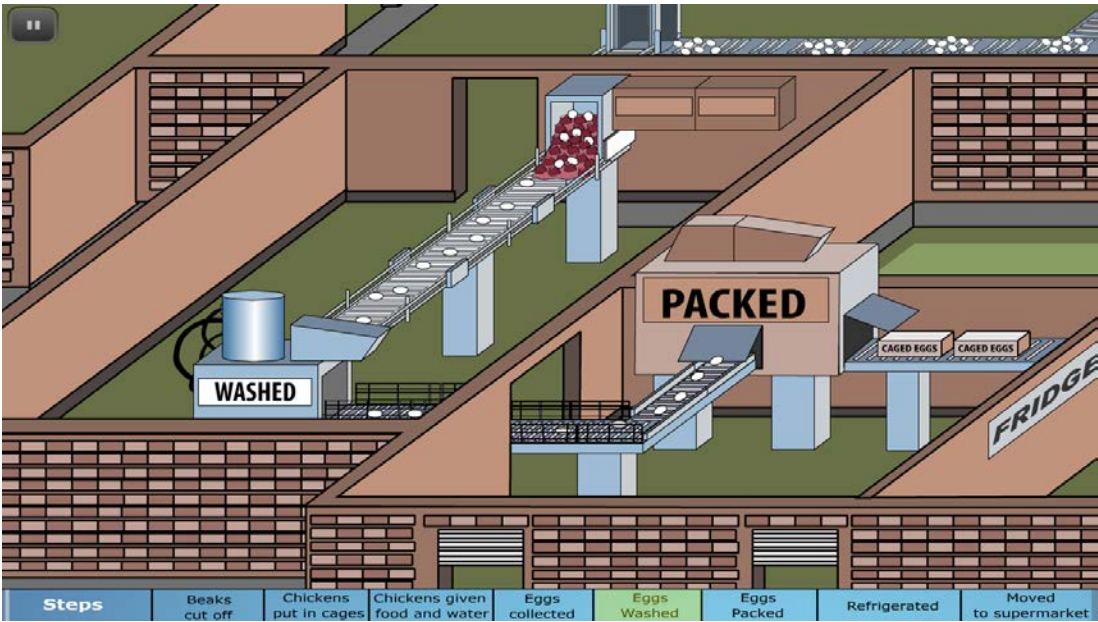


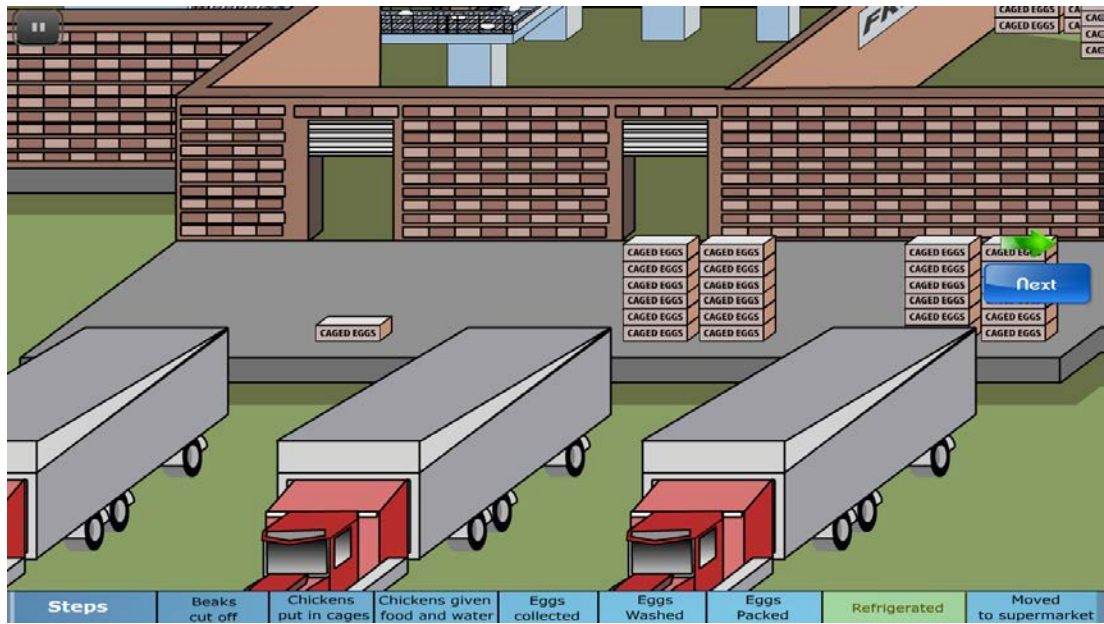


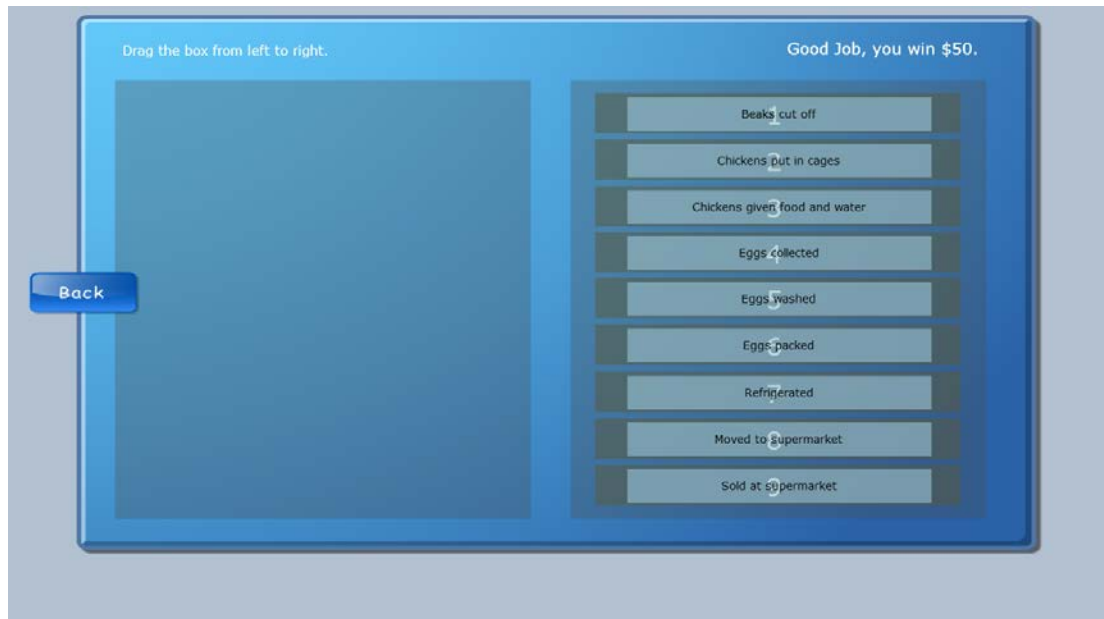


## APPENDIX F: CAGED EGGS TASK





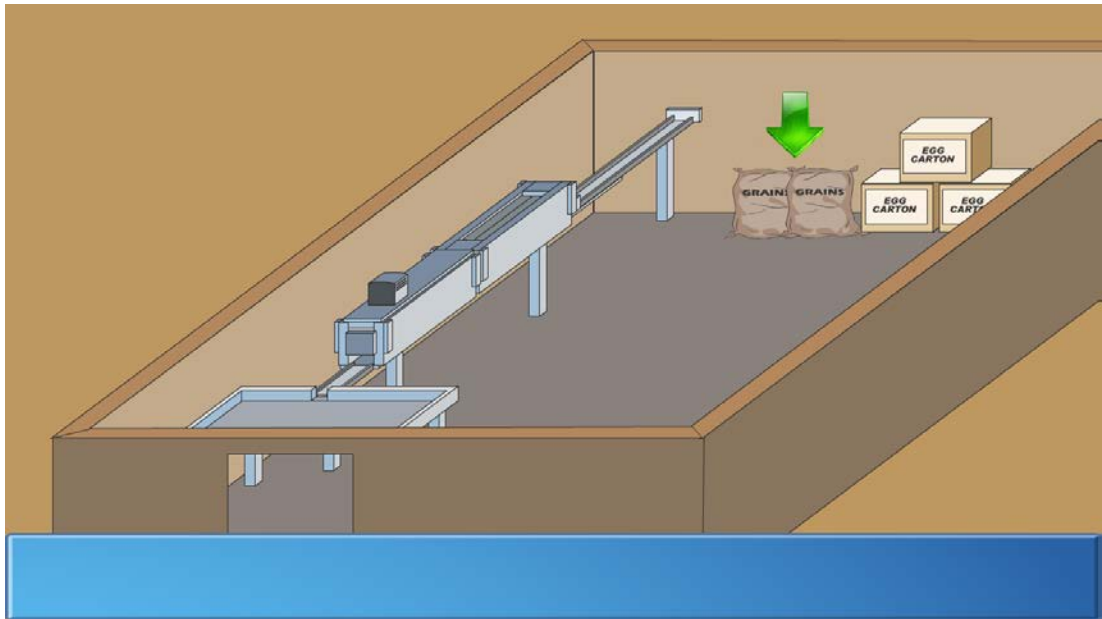


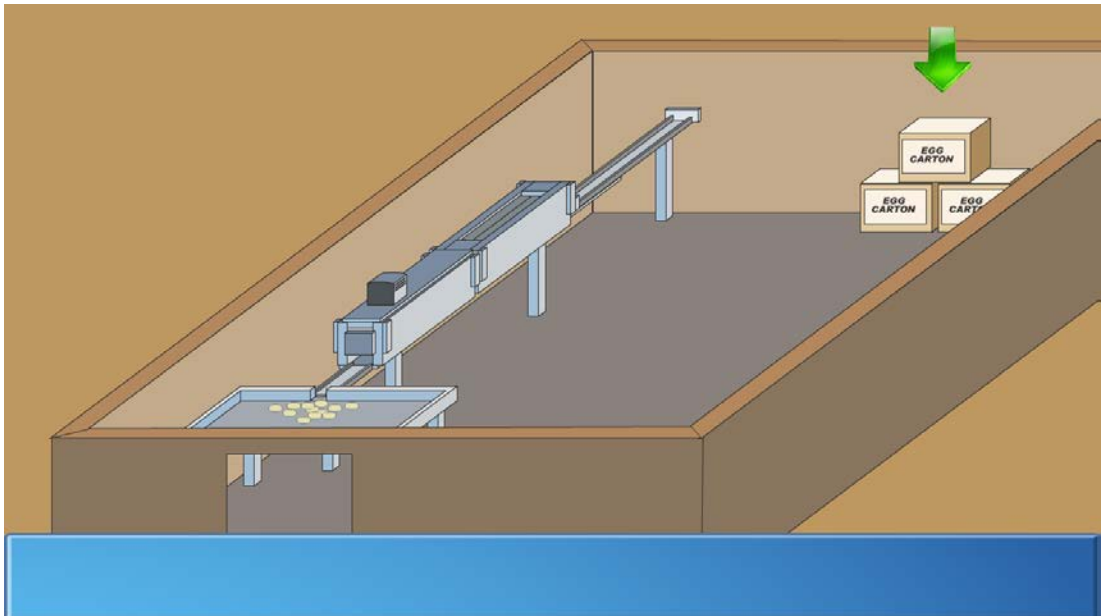


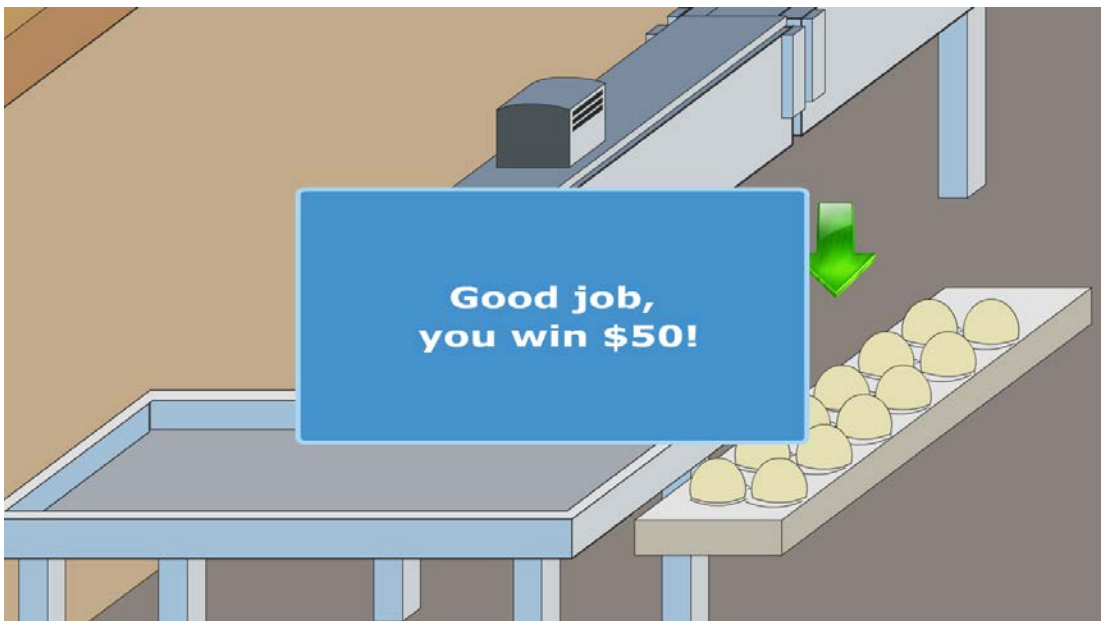
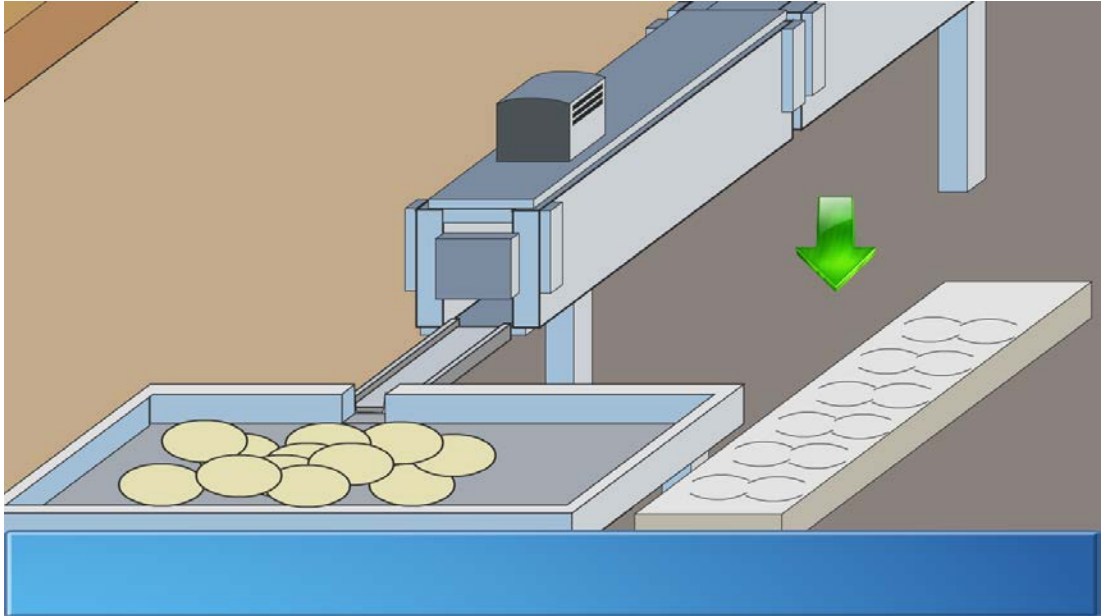
APPENDIX G: ORGANIC EGGS TASK











## APPENDIX H: USING AN ATM

- No more than \$100 can be withdrawn at any one time. Players click on ATM and select “use ATM” in order to use it. When avatar arrives at ATM the screen appears, which reads:

WELCOME TO GEOBANK

PLEASE INSERT YOUR CARD

Bank card appears in avatars hand (controlled by mouse) and players must insert bank card into card slot (top right) by moving card over slot and clicking on it. ATM takes bank card at this point.

- Once card is inserted the screen reads “PLEASE ENTER YOUR PIN AND THEN PRESS ENTER”. Players must type in correct pin and press enter. They do this by using the mouse and clicking on buttons on keypad on screen. An incorrect PIN prompts the following response: “PIN INCORRECT” and two options: “TRY AGAIN” or “REQUEST NEW PIN” (selected by pressing arrows on the side of the screen). If players elect to request a new PIN, a message then appears on screen: “A NEW PIN HAS BEEN POSTED TO YOU”. When the player arrives at their house next, they are told “YOU’VE GOT MAIL” and they receive another PIN letter. A correct pin prompts four options (selected by pressing arrows on side of screen, as per example): “BALANCE ON SCREEN” (when hovered over, explanation is provided: “Find out how much money is in your account”), “CASH AND BALANCE ON SCREEN” (when hovered over, explanation is provided: Withdraw money and find out how much money is still in your account), “CASH WITHOUT BALANCE” and “CHANGE PIN”. The ATM enables each of these functions. Upon completion of any of them, the ATM confirms it worked (by providing balance or “PIN CHANGED” etc) and:

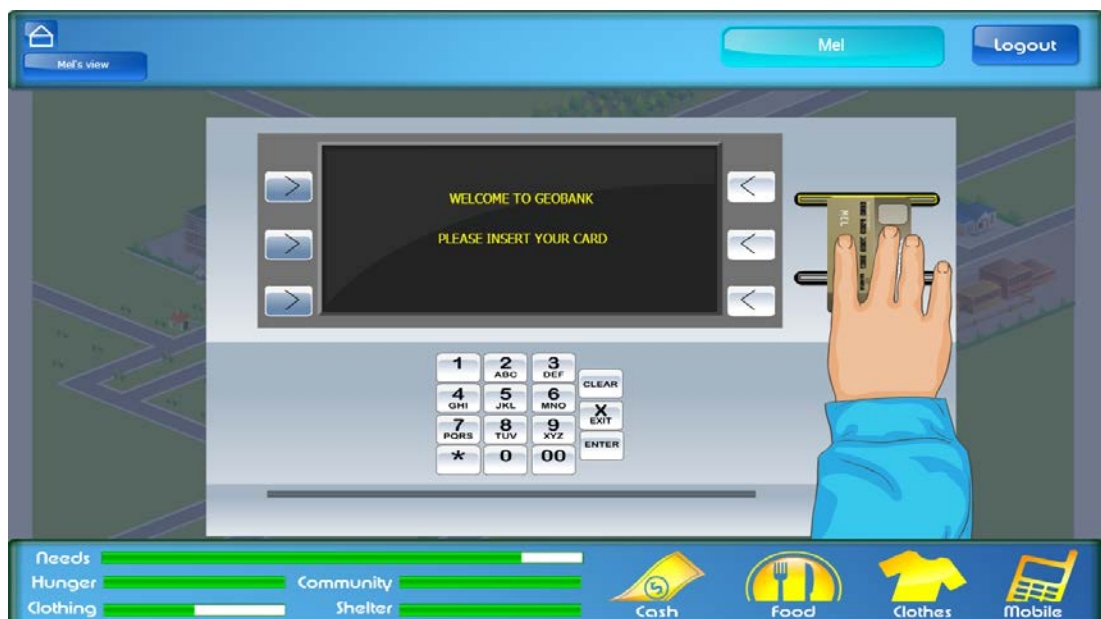
PRESS ENTER TO RETURN TO MAIN MENU

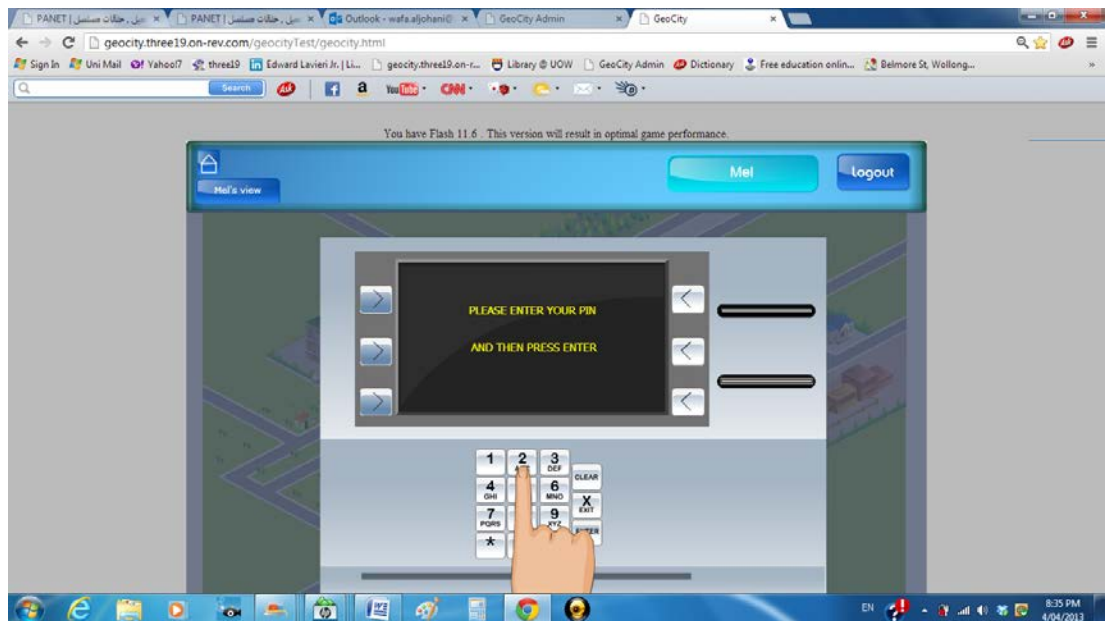
PRESS EXIT TO LEAVE ATM

These options cycle through until user withdraws money or presses EXIT

- At this point user is instructed: “REMOVE CARD”. The bankcard appears in slot and user clicks on it to remove it.
- If money has been withdrawn the user is instructed: “TAKE CASH”. Cash appears in the slot below the keypad, and user clicks on it to remove it.
- If user has opted to get a receipt they are now instructed: “TAKE RECEIPT” and receipt appears at the slot below the card slot, and user clicks on it to remove it, at which point it appears on screen. If hovered over, it states: “CLICK TO PUT AWAY RECEIPT”.

Throughout this process there is a cross in the top right corner. When hovered over, it states “Leave ATM”. This must be clicked on to leave the ATM.



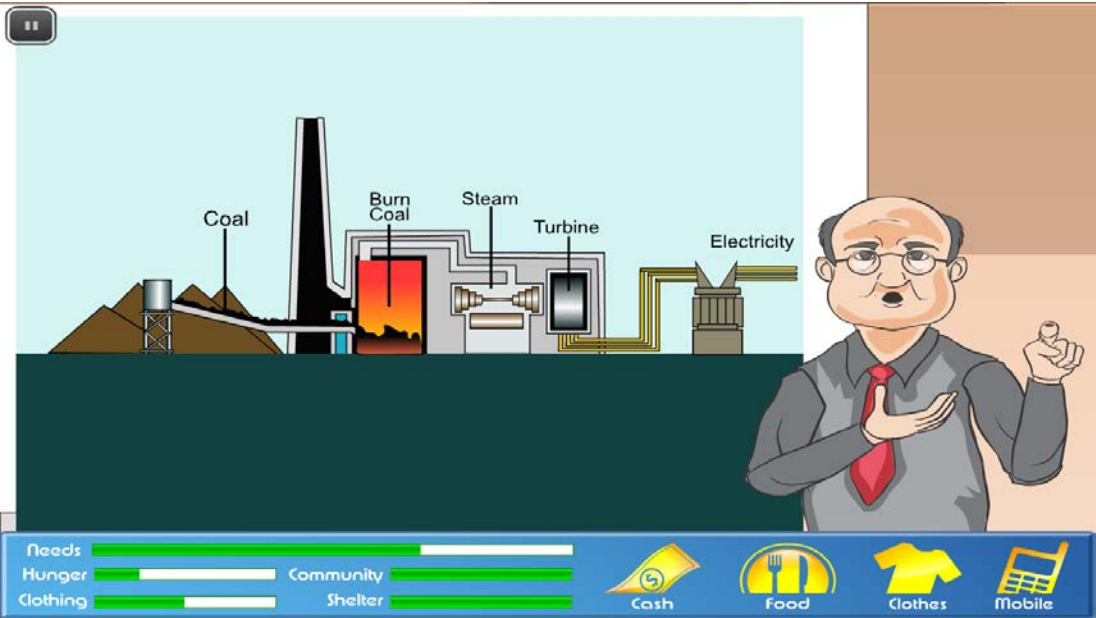


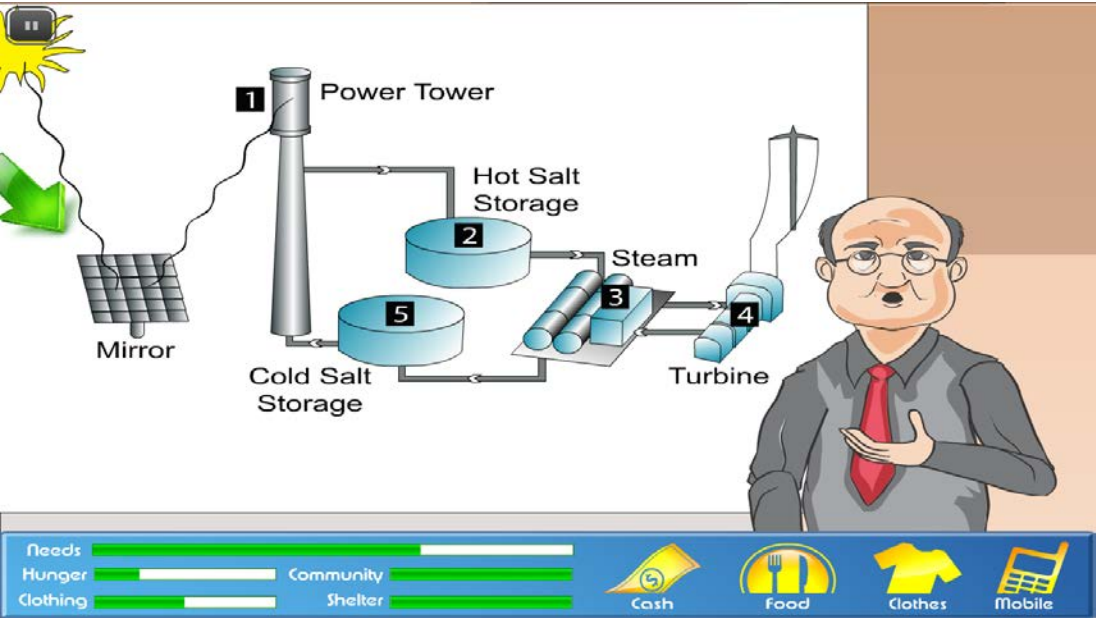
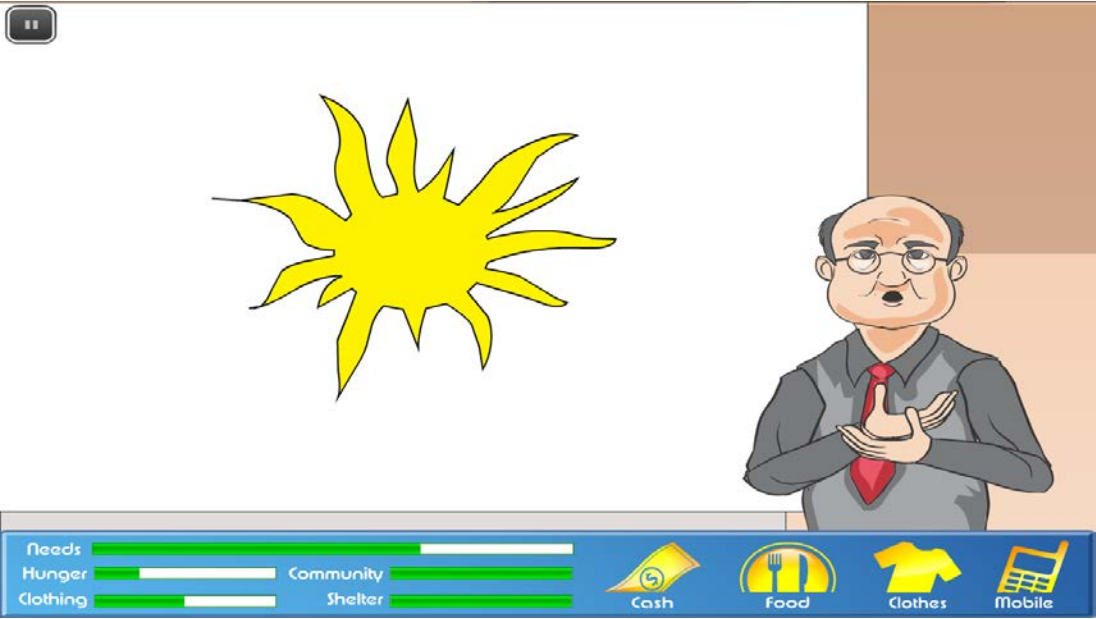




APPENDIX I: COAL OR SOLAR POWER TASK








**Town Hall Meeting**

Coal power	Solar thermal power
Cheap to build	More expensive to build
More expensive to run	Cheap to run
There's lots of coal	There's lots of sun
Non-renewable - can run out	Renewable - does not run out
Bad for the environment	Very little damage to the environment
Adds to climate change	Does not add to climate change
Causes health problems	Does not cause health problems



Needs

Hunger

Clothing

Community

Shelter


Cash

Food

Clothes

Mobile

**Town Hall Meeting**



**Game Chat**

Romeo sdf

Romeo asdfef

Sally Jo test

Jess Again

Jess Test

Jess Hello?

Jess Does this impact my need for community? It should.

Jess Call the fire brigade

Jess Test

Jess Why is my need for dothing not satisfied?

Jess Hello

Foffa Hi

Send

Needs

Hunger

Clothing

Community

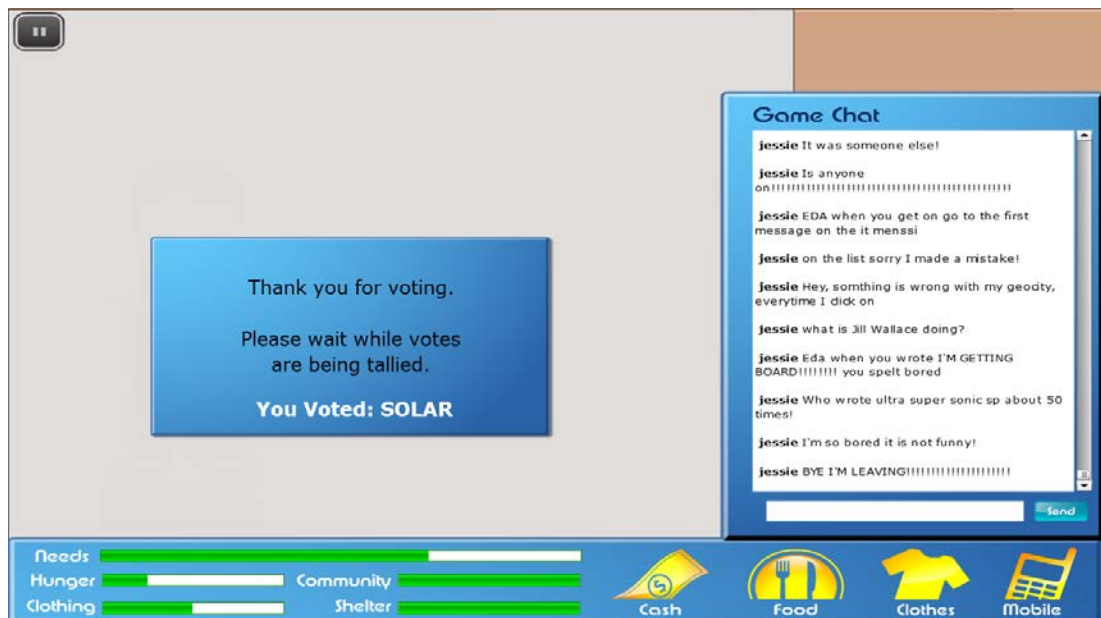
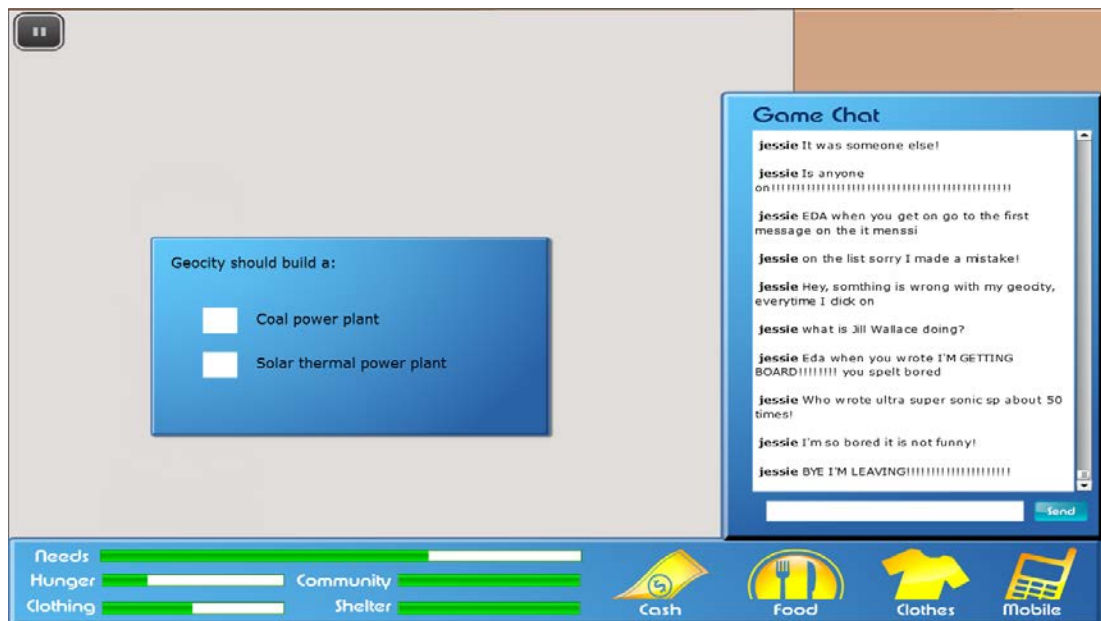
Shelter

Cash

Food

Clothes

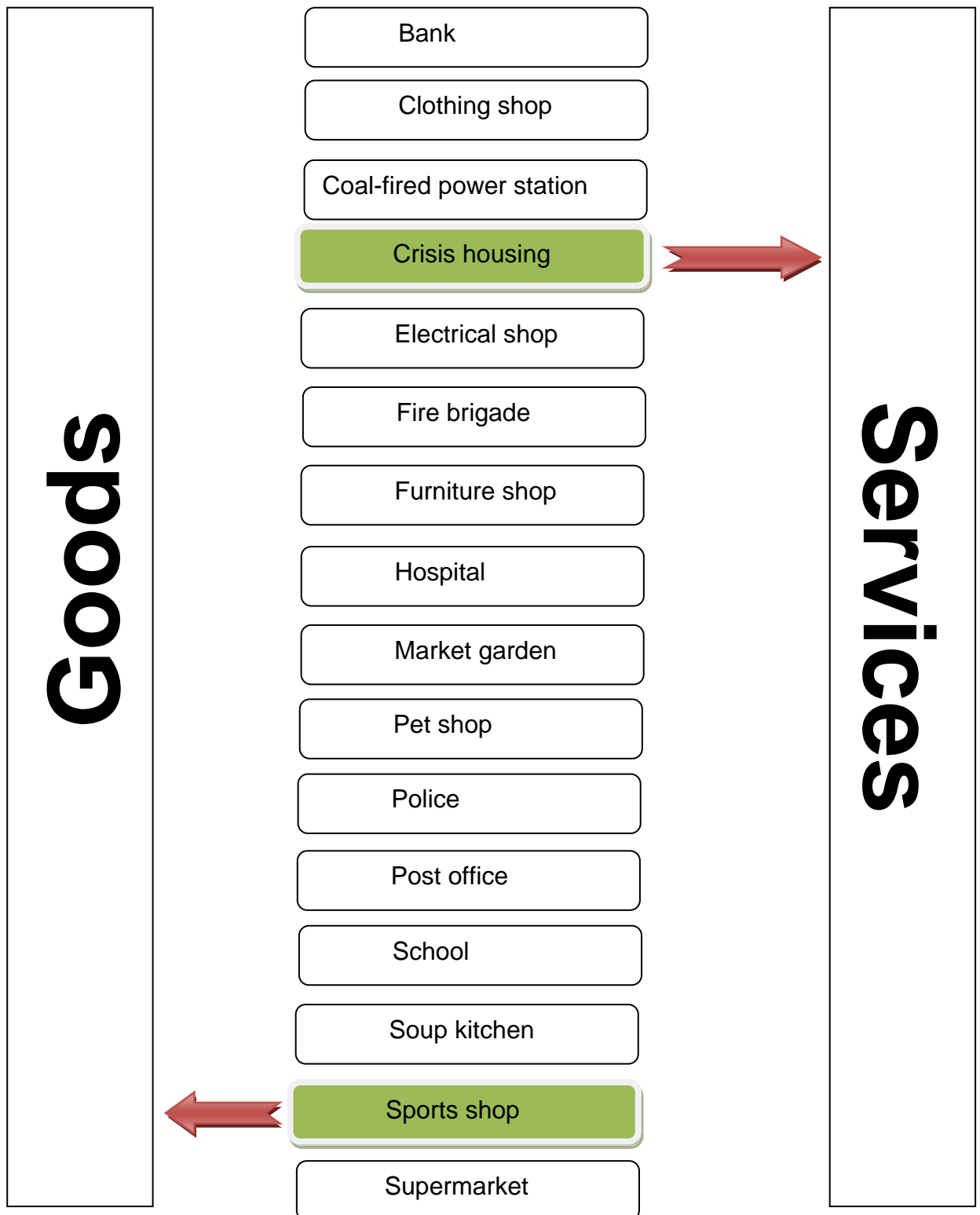
Mobile





**APPENDIX J: PRE/POST TEST OF STUDENT KNOWLEDGE  
(WORKSHEETS)**

Sort the **list of places** based on if they provide **goods or services**, using arrows.



What's the difference between a **good** and a **service**?

---

---

---

---

What three shops in the list can help meet the **need of hunger**?

---

---

---

---

What service in the list can help meet the **need of shelter**?

---

---

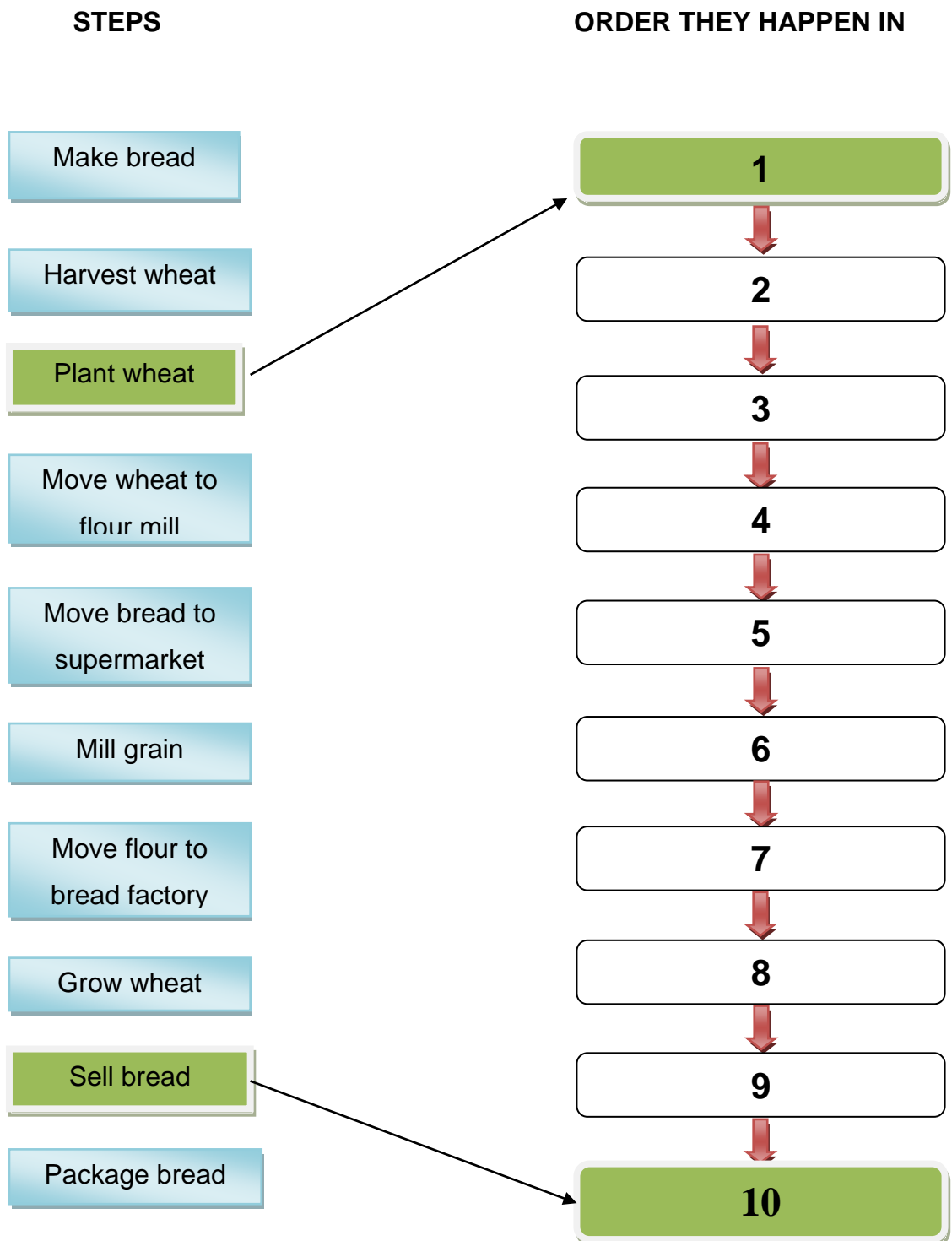
What shop in the list can help meet the **need of clothing**?

---

---

## Bread

How do we make bread and get it to people? Put the **steps** in the correct order they happen in.



APPENDIX J: PRE/POST TEST OF STUDENT KNOWLEDGE  
(WORKSHEETS)

The pictures below show different steps to get **organic** and **caged** eggs. For each picture, say if it shows organic or caged eggs farming.



- ☐ Organic
- ☐ Caged



- ☐ Organic
- ☐ Caged



- ☐ Organic
- ☐ Caged



- ☐ Organic
- ☐ Caged



- ☐ Organic
- ☐ Caged



- ☐ Organic
- ☐ Caged

APPENDIX J: PRE/POST TEST OF STUDENT KNOWLEDGE



- ☐ Organic  
☐ Caged



- ☐ Organic  
☐ Caged



- ☐ Organic  
☐ Caged



- ☐ Organic  
☐ Caged

If you were an eggs farmer would you farm organic or caged eggs? Why?

---

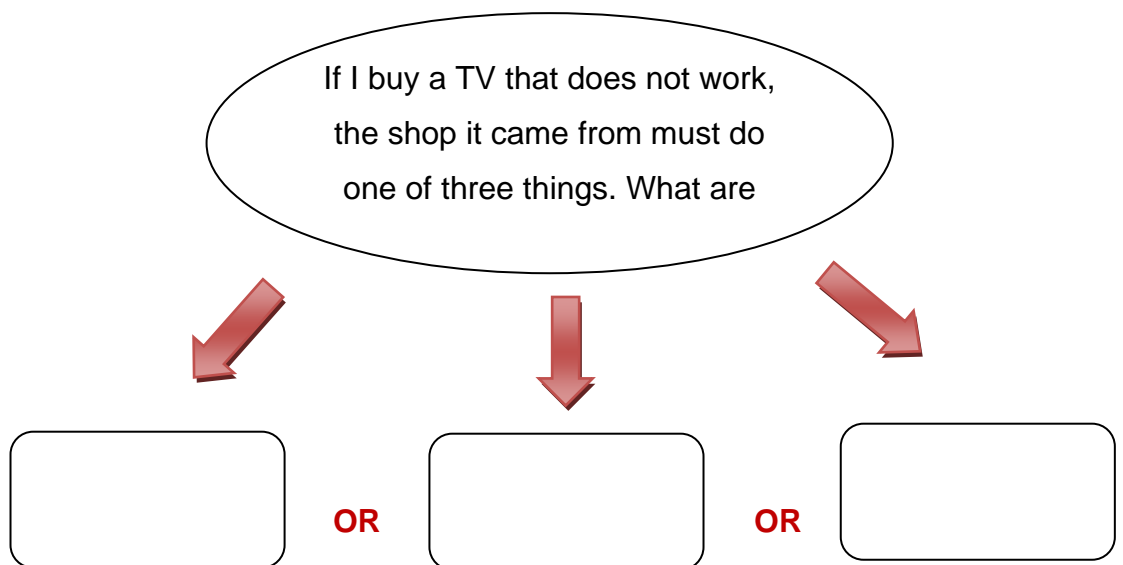
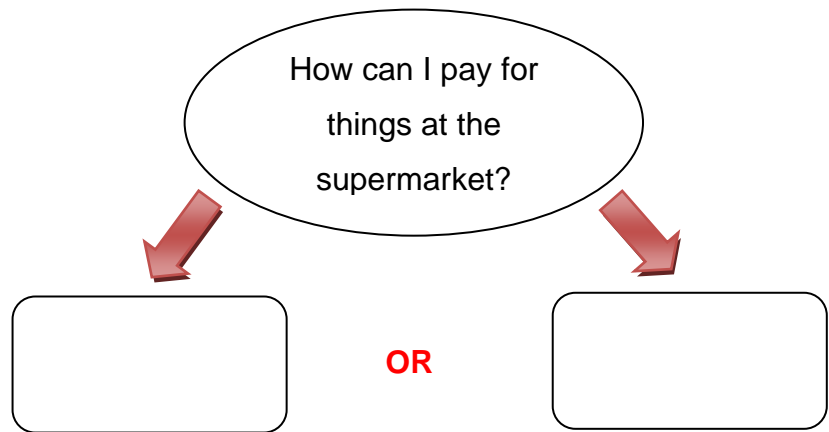
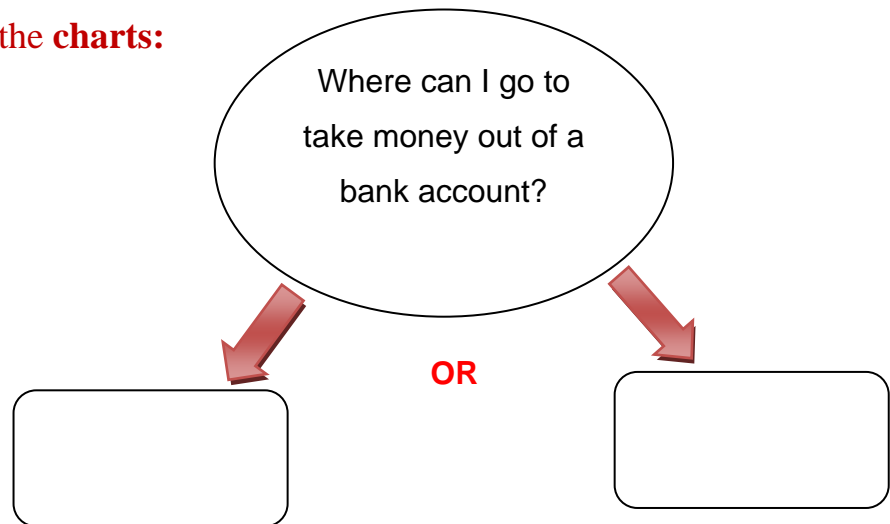
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What type of eggs would you buy from the supermarket? Why?

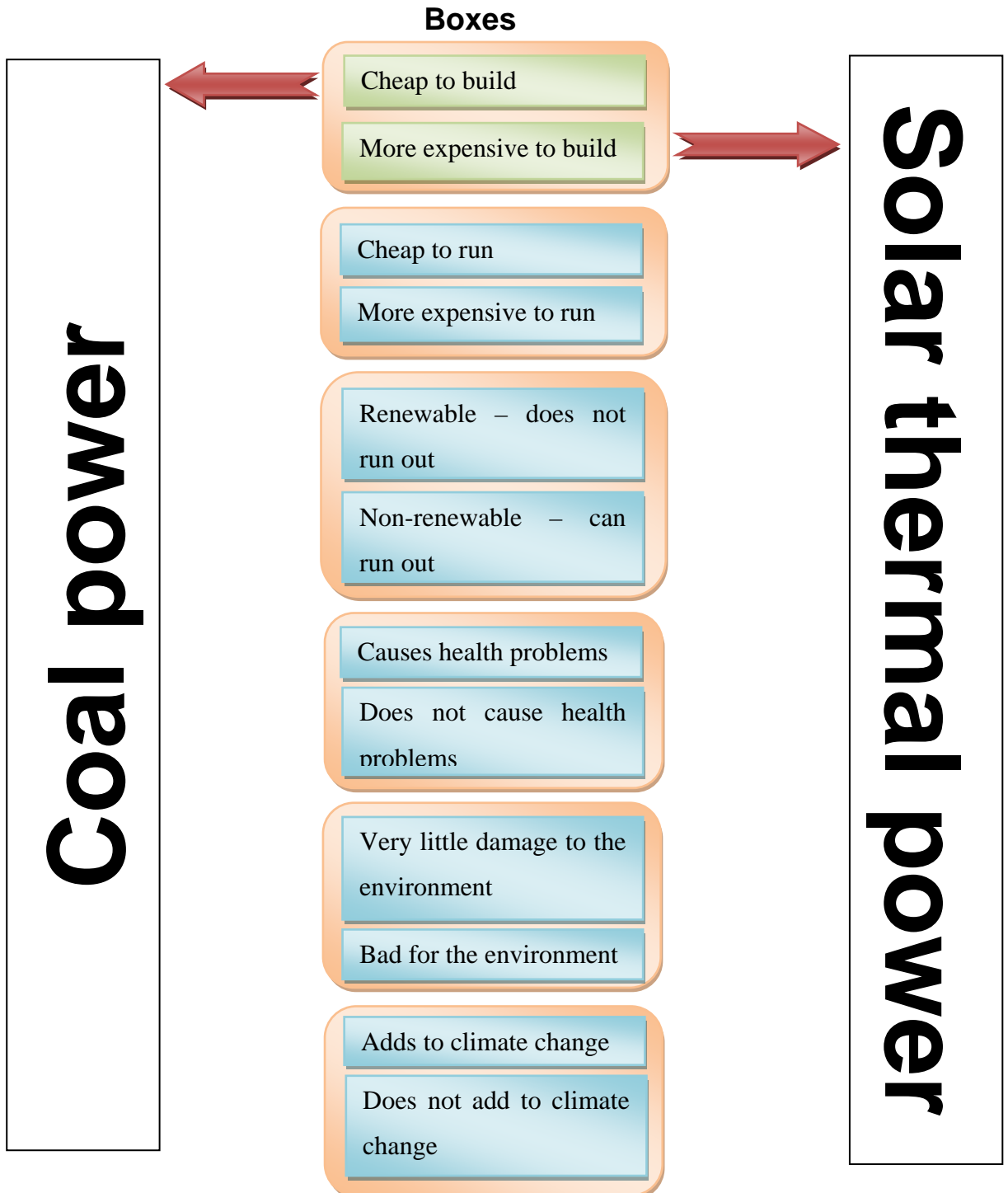
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---

Complete the **charts**:



Each box has two statements. One describes coal power and the other describes solar thermal power. Use arrows to show what the statements in each box describes: **coal power** or **solar thermal power**.



Which would you build and why?

---



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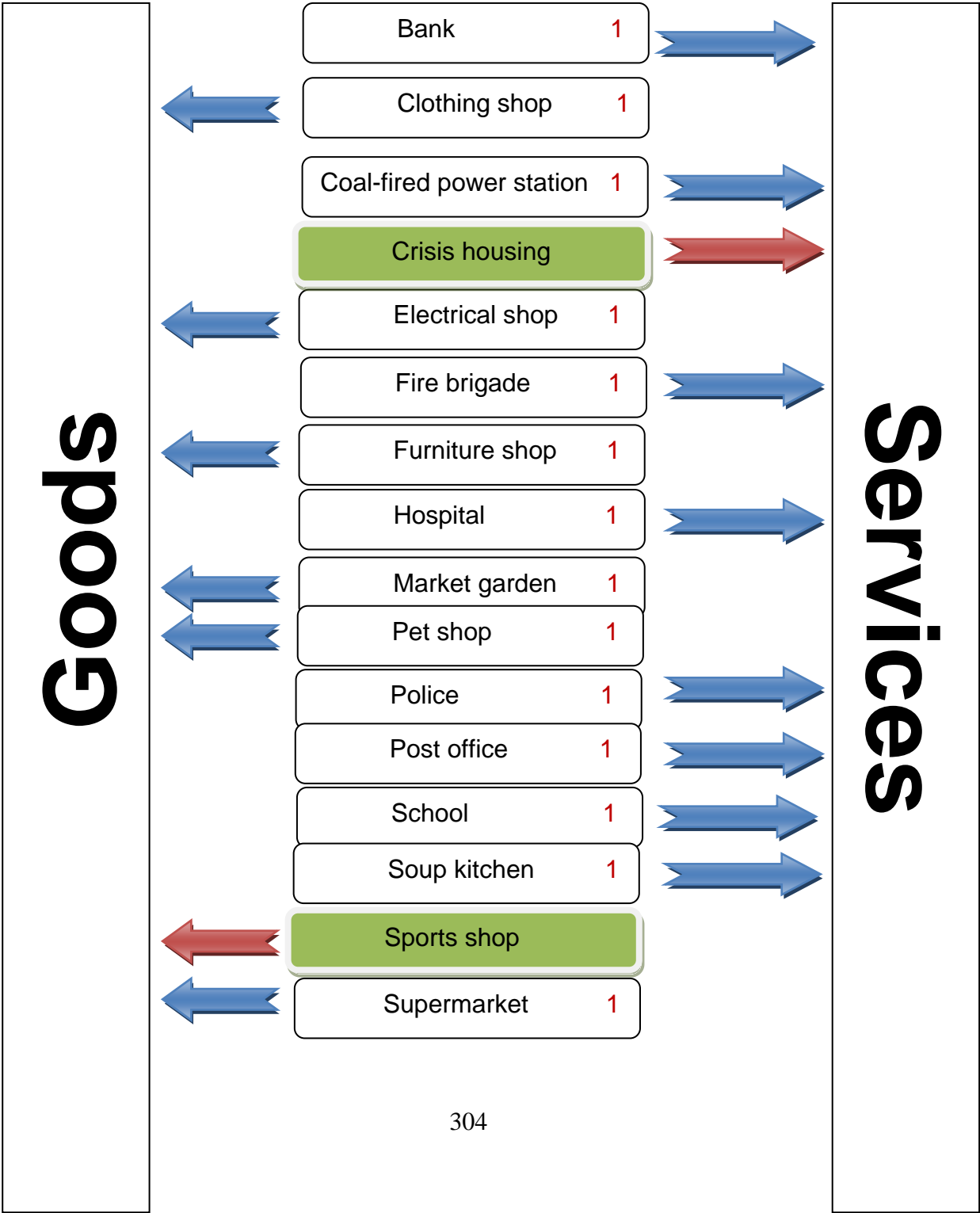
APPENDIX K: SAMPLE PRE/POST TEST OF STUDENT KNOWLEDGE  
(WORKSHEETS) WITH FULL MARKS

21
21

1. Goods/ needs and services

Sort the **list of places** based on if they provide **goods or services**, using arrows.

14



What's the difference between a **good** and a **service**?

Goods are things you can see and touch. They are **features** such as apples, televisions and hats.

2

Services are **actions** provided for you, such as teaching, banking and health care.

What three shops in the list can help meet the **need of hunger**?

Market garden, soup kitchen and supermarket.

3

What service in the list can help meet the **need of shelter**?

Crisis housing

1

What shop in the list can help meet the **need of clothing**?

Clothing shop

1

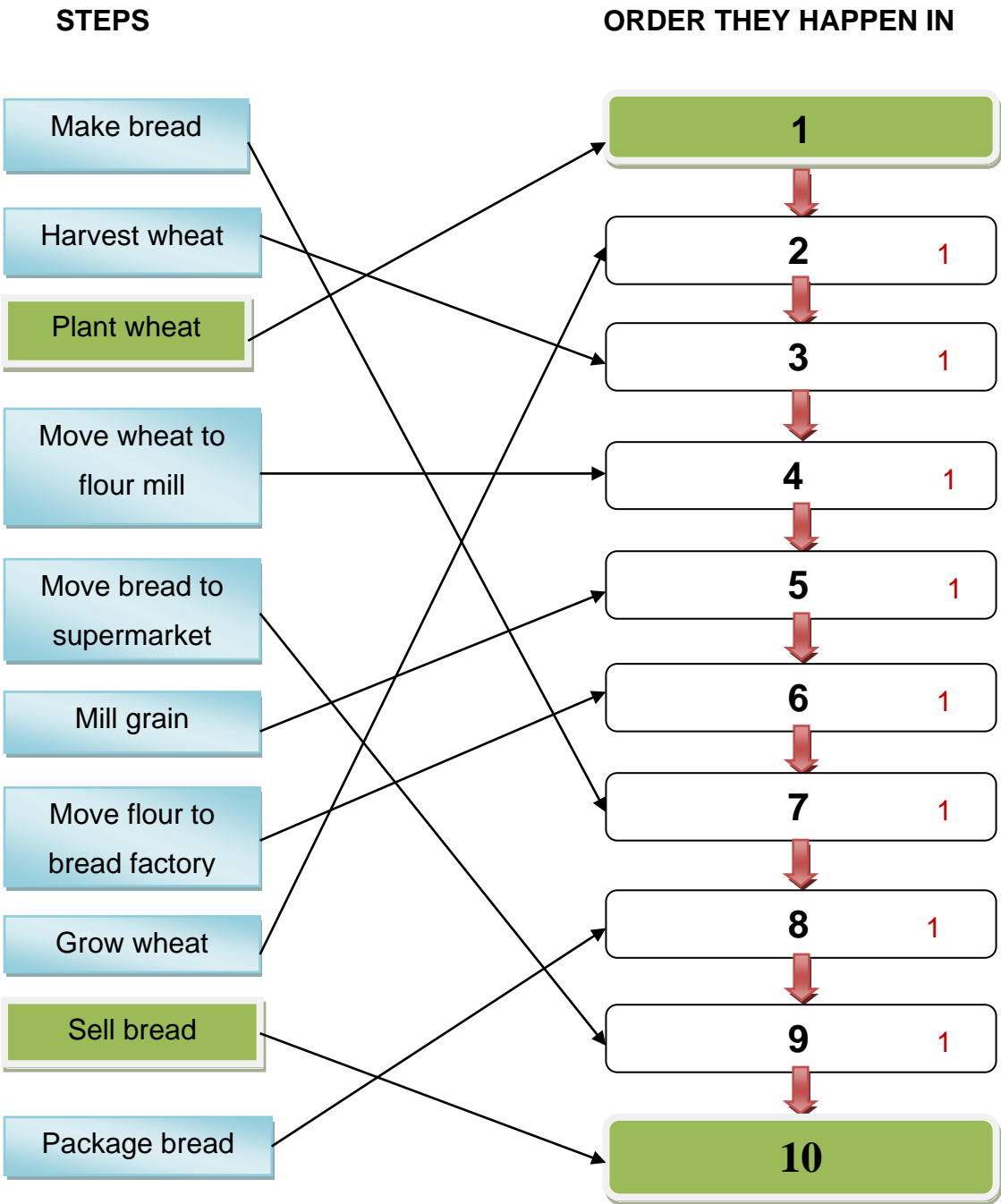
2. Production and distribution

24
24

Bread

How do we make bread and get it to people? Put the **steps** in the correct order they happen in.

8



The pictures below show different steps to get **organic** and **caged** eggs. For each picture, say if it shows organic or caged eggs farming.



1

☐ Organic  
☒ Caged



1

☒ Organic  
☐ Caged



1

☐ Organic  
☒ Caged



1

☒ Organic  
☐ Caged



1

☒ Organic  
☐ Caged



1

☒ Organic  
☐ Caged



1

<input type="checkbox"/> Organic
X Caged



1

<input type="checkbox"/> Organic
X Caged



1

<input type="checkbox"/> Organic
X Caged



1

X Organic
<input type="checkbox"/> Caged

If you were an eggs farmer would you farm organic or caged eggs? Why?

3

Yes or No (1) and two reasons that are both factually correct and logically point to the answer give: “yes or “no” (2). \_\_\_\_\_

What type of eggs would you buy from the supermarket? Why?

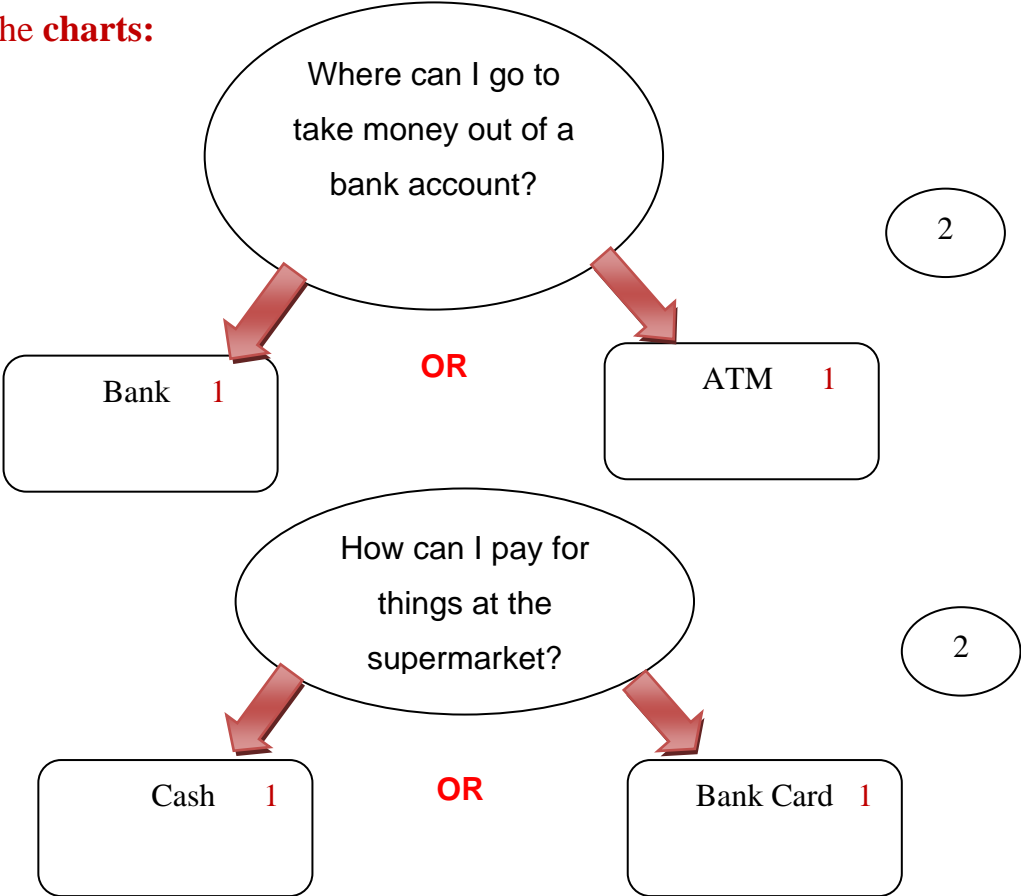
3

Organic or caged eggs (1) and two reasons that are both factually correct and logically point to the answer given: “organic eggs” or “caged eggs” (2) \_\_\_\_\_

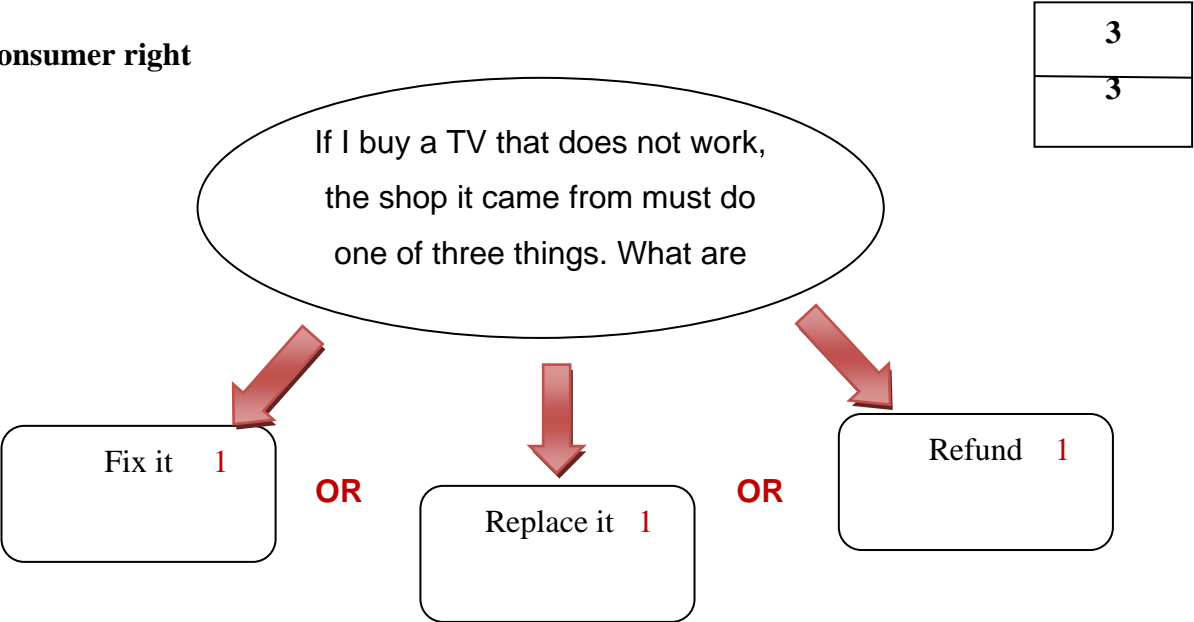
3. Different technologies involved with monetary exchange

4
4

Complete the **charts**:



**4. Consumer right**

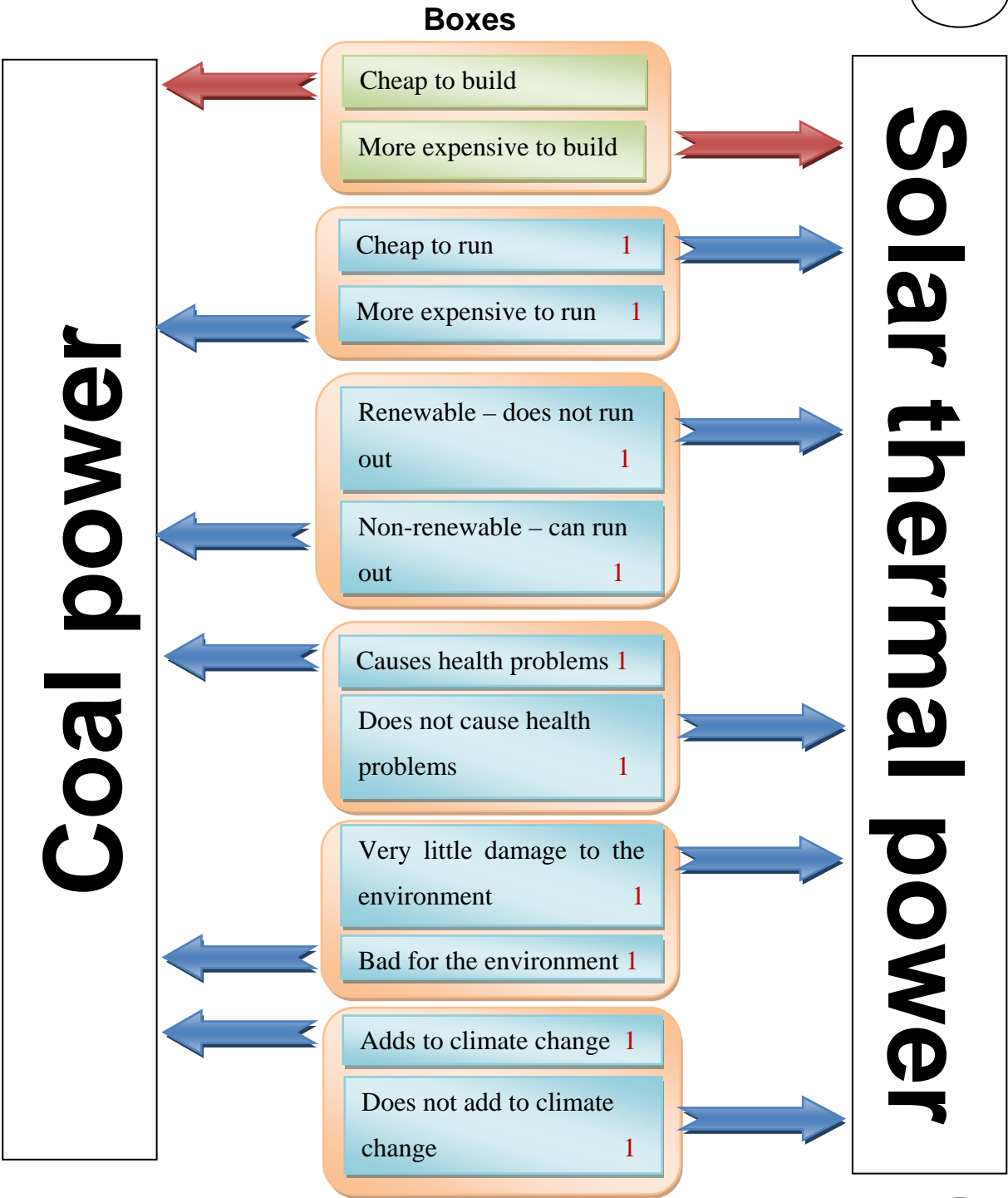


13
13

5. Coal or solar power

Each box has two statements. One describes coal power and the other describes solar thermal power. Use arrows to show what the statements in each box describes: **coal power** or **solar thermal power**.

10



Which would you build and why?

Coal or solar power (1) and two reasons that are both factually correct and logically point to the answer give: “coal power” or “solar power” (2). \_\_\_\_\_

3

**APPENDIX L: PRE/POST TEST OF STUDENT MOTIVATION TO LEARN  
AND CRITICAL THINKING (QUESTIONNAIRE) AND MARKING  
MATRIX**

Questions:

Rate	1	2	3
	disagree	neutral	agree

1. I am able to learn in this subject.
2. I think I know less than other students.
3. I think I will be able to use what I learn in this subject in other subjects.
4. I'm sure I can understand the hardest things in this subject.
5. What I enjoy most in this subject is getting a good grade.
6. It is my fault if I don't learn in this subject.
7. It is important for me to learn in this subject.
8. I'm sure I can learn the basic things in this subject.
9. I want to get better grades in this subject than most other students.
10. When I am asked questions I think about what will happen if I don't know the answer.
11. I prefer to learn stuff that is interesting, even if it is hard.
12. I am very interested in what is taught in this subject.
13. If I try hard enough I will understand this subject.
14. I have an upset feeling when I have to answer questions.
15. The most pleasing thing for me in this subject is trying to understand things well.
16. I take time to do tasks that I can learn from, even if they don't mean a good grade.
17. I want to do well in this subject to show my family, friends, and others.
18. I think I will do well in this subject.

APPENDIX L: PRE/POST TEST OF STUDENT MOTIVATION TO LEARN AND CRITICAL  
THINKING (QUESTIONNAIRE) AND MARKING MATRIX

Marking matrix:

Rate	1	2	3
	disagree	neutral	agree

Motivation Subscales	Items in the Subscale	Rate	Total
1. Intrinsic Goal Orientation	11		
	15		
	16		
2. Extrinsic Goal Orientation	5		
	9		
	17		
3. Task Value	3		
	7		
	12		
4. Control of Learning Beliefs	1		
	6		
	13		
5. Self-Efficacy for Learning & Performance	4		
	8		
	18		
6. Test Anxiety	2		
	10		
	14		
	Total ÷ 6 =		

APPENDIX L: PRE/POST TEST OF STUDENT MOTIVATION TO LEARN AND CRITICAL  
THINKING (QUESTIONNAIRE) AND MARKING MATRIX

Questions:

Rate	1	2	3
	disagree	neutral	agree

1. In class I often miss important things as my mind is on other things.
2. To learn in class, I say key things to myself over and over.
3. When I am told something, I try to decide if there is proof it is true.
4. I try to have my own ideas about things I learn in this subject.
5. I ask questions to make sure I understand things.
6. I try to remember key words in this subject.
7. In class I try to decide what's most important to learn.
8. I try to link ideas in this subject to what I already know.
9. I try to link new ideas in this subject to past lessons.
10. When I hear things in this class, I think about possible alternatives.
11. I make lists of things I should remember for this subject.
12. I like to discuss the things I learn in this subject.

APPENDIX L: PRE/POST TEST OF STUDENT MOTIVATION TO LEARN AND CRITICAL  
THINKING (QUESTIONNAIRE) AND MARKING MATRIX

Marking matrix:

Rate	1	2	3
	disagree	neutral	agree

r = reverse coded

Learning strategy	Items in the Subscale	Rate	Total
1. Rehearsal	2		
	6		
	11		
2. Elaboration	8		
	9		
	12		
3. Critical thinking	3		
	4		
	10		
4. Metacognitive	1r		
	5		
	7		

### APPENDIX M: PRE/POST INTERVIEW WITH TEACHER

1. Is [the student] learning Stage Two geography outcomes?
  - How do you know this?
  - In what ways does the current method of instruction support this?
  
2. Is [the student] motivated to learn geography?
  - How do you know this?
  - How does the current method of instruction support this?
  - Does [the student] demonstrate critical thinking in the geography classroom?

➤ Definition of critical thinking:

‘Critical thinking’, refers to the process of identifying questions about knowledge, contextualizing them, and engaging in cycles of understanding, testing, evaluation and reflection (Freire 1972). It is “not the intellectual reproduction of what already exists” (Adorno 1998, pp. 291-292), but is situated in dialogue and the construction of new knowledge (Daniel & Gagnon 2011).

- How do you know this?
  - How does the current method of instruction support this?
3. Do you have any further comments on the interactions or behaviour of [the student] worth noting?

REPEAT QUESTIONS FOR EACH OF THE SIX STUDENTS BEING STUDIED

## APPENDIX N: OBSERVATION GUIDE

The following points will be used to guide – though not limit – observation notes. As such the researcher will adopt a combination of structured and unstructured observation.

### Context of the intervention

- **Student profile**
  - Which students are present?
- **Session and delivery**
  - Describe the way in which teacher explains use of the video game.
  - Describe the clarity of instructions given.
  - Apparent confidence of teacher in discussing the video game.
  - Is the video game integrated into teaching mode or treated as a stand-alone activity?
  - Describe room layout.
- **Technical considerations**
  - Describe the hardware being used by students.
  - Describe student and teacher confidence in using hardware and software generally.

### Experience of the intervention

- **Student activity**
  - What are the major components and activities of the observed lesson?
  - Are students clear about what they are supposed to do?
  - Can students navigate the video game?
  - Are students able to correct errors?
  - What were the main issues that seemed to surround use of the video game?
  - What are the characteristic elements of the classroom behaviour of individuals?
  - What are the apparent patterns in terms of student–student, student–teacher, student–technology, and teacher–technology discourse and interaction?
  - To what extent were students engaged with the video game?
  - Is there any evidence of students learning Stage-two geography

- outcomes?
  - Is there evidence of contributing factors?
  - Is there any evidence of student motivation to learn?
  - Is there evidence of contributing factors?
  - Is there any evidence of critical engagement by students?
  - Is there evidence of contributing factors?
- **Unexpected problems encountered**
  - Description of the problem.
  - Who experienced the problem?
  - What was the solution?

## APPENDIX O: ETHICAL APPROVAL



APPROVAL after review  
In reply please quote: HE12/319  
Further Enquiries Phone: 4221 3386

9 November 2012

Professor Ian Brown  
Faculty of Education  
University of Wollongong NSW 2522

Dear Professor Brown

Thank you for your letter responding to the HREC conditional approval letter. I am pleased to advise that the Human Research Ethics application referred to below has been **approved**.

**The consent form attached to this response appears to be the original from a participant. Please be advised that originals must be securely stored with other research material.**

Ethics Number:	HE12/319
Project Title:	Using and instructional video game designed on best practice principles to support, motivate and develop Stage 2 students' critical thinking skills so as to meet NSW Board of Studies geography outcomes
Researchers:	Professor Ian Brown, Dr Sharon Tindall-Ford, Mrs Wafa Aljohani
Approval Date:	25 October 2012
Expiry Date:	24 October 2013

The University of Wollongong/Illawarra Shoalhaven Local Health District Social Sciences HREC is constituted and functions in accordance with the NHMRC National Statement on Ethical Conduct in Human Research. The HREC has reviewed the research proposal for compliance with the National Statement and approval of this project is conditional upon your continuing compliance with this document.

A condition of approval by the HREC is the submission of a progress report annually and a final report on completion of your project. The progress report template is available at <http://www.uow.edu.au/research/rso/ethics/UOW009385.html>. This report must be completed, signed by the appropriate Head of School, and returned to the Research Services Office prior to the expiry date.

Ethics Unit, Research Services Office  
University of Wollongong NSW 2522 Australia  
Telephone (02) 4221 3386 Facsimile (02) 4221 4338  
Email: [rso-ethics@uow.edu.au](mailto:rso-ethics@uow.edu.au) Web: [www.uow.edu.au](http://www.uow.edu.au)

As evidence of continuing compliance, the Human Research Ethics Committee also requires that researchers immediately report:

- proposed changes to the protocol including changes to investigators involved
- serious or unexpected adverse effects on participants
- unforeseen events that might affect continued ethical acceptability of the project.

Please note that approvals are granted for a twelve month period. Further extension will be considered on receipt of a progress report prior to expiry date.

If you have any queries regarding the HREC review process, please contact the Ethics Unit on phone 4221 3386 or email [rso-ethics@uow.edu.au](mailto:rso-ethics@uow.edu.au).

Yours sincerely,

A/Professor Garry Hoban  
Chairp, Social Sciences  
Human Research Ethics Committee

Ethics Unit, Research Services Office  
University of Wollongong NSW 2522 Australia  
Telephone (02) 4221 3386 Facsimile (02) 4221 4338  
Email: [rso-ethics@uow.edu.au](mailto:rso-ethics@uow.edu.au) Web: [www.uow.edu.au](http://www.uow.edu.au)

**APPENDIX P: PARTICIPANT INFORMATION SHEET FOR TEACHER**

University of Wollongong

**PARTICIPANT INFORMATION SHEET FOR TEACHER**

**TITLE:** *Using an instructional video game to support geography outcomes, critical thinking and motivation to learn in a Stage Two primary classroom.*

**PURPOSE OF THE RESEARCH**

This is an invitation for you to participate in a study conducted by researchers at the University of Wollongong. The purpose of the research is to identify:

- In what ways a video game based on best practice design principles supports Stage Two students to achieve the HSIE outcomes specified by the NSW syllabus; and
- How the use of a video game motivates learning and supports critical thinking as a method of instruction.

**INVESTIGATORS**

Assoc. Prof. Ian Brown  
(Primary Supervisor)

Dr. Sharon Tindall-Ford  
(Supervisor)

Mrs. Wafa Aljohani  
(Researcher, Doctoral Student)

Faculty of Education

Faculty of Education

Faculty of Education

[ian\\_brown@uow.edu.au](mailto:ian_brown@uow.edu.au)

[sharontf@uow.edu.au](mailto:sharontf@uow.edu.au)

[wmha705@uowmail.edu.au](mailto:wmha705@uowmail.edu.au)

0435 847 153

**WHAT WE WOULD LIKE YOU TO DO**

If you choose to be included, you will be asked to participate in eleven sessions, over six weeks, based on the following plan:

Week	Session	Tasks	Duration ( All in school time)
1	1	- Conduct pre interview with you and provide access to the video game. - Set up audio and visual recording equipment.	30 mins
2	2	- Give you instruction on the video game and worksheet. - Withdraw six students from class to conduct individual verbal questionnaires (pre test of student motivation and critical thinking).	30 mins 15 mins per student
	3	- You issue worksheet to whole class (pre test of student knowledge).	45 mins

3 - 6	4 - 10	<ul style="list-style-type: none"> <li>- Conduct seven video game sessions with whole class.</li> <li>- Withdraw six students from class after each video game session to conduct group interviews, to gauge student learning, critical thinking and motivation to learn and how the video game impacted these outcomes.</li> </ul>	40 mins x 7 20 mins x 7
6	11	<ul style="list-style-type: none"> <li>- You issue worksheet to whole class (post test of student knowledge).</li> <li>- Withdraw six students from class to conduct individual verbal questionnaires (post test of student motivation and critical thinking).</li> <li>- Post interview with you.</li> <li>- Pack up audio and visual recording equipment.</li> </ul>	45 mins 15 mins per student 30 mins

### POSSIBLE RISKS AND INCONVENIENCES

We can foresee no risks for you. Apart from the one hour and thirty minutes of your time for interviews and instruction, withdrawing six students from your class for individual and group interviews over approximately five hours in total, and observing your class over six weeks, we can foresee no risks for you. Your involvement in the study is voluntary and you may withdraw your participation from the study at any time, including use of any data that you have provided to that point. Refusal to participate in the study will not affect your relationship with the University of Wollongong.

### FUNDING AND BENEFITS OF THE RESEARCH

This study is funded by the Saudi Arabian Cultural Mission. The research will provide valuable information about how video games assist learning of syllabus outcomes and enhance motivation to learn and critical thinking. The research will also provide a new online video game with content based on the Stage Two HSIE syllabus. This video game can be used in Stage Two classrooms and/or for further research.

The outcome of this research will be submitted to the University of Wollongong. The school, staff and students will be given pseudonyms for anonymity and will not be identified in any part of the research. Confidentiality is assured.

### ETHICS REVIEW AND COMPLAINTS

This study has been reviewed by the Human Ethics Committee (Social Science, Humanities and Behavioural Science) of the University of Wollongong. If you have any concerns or complaints regarding the way this research has been conducted, you can contact the University of Wollongong Ethics Officer on (02) 4221 4457 or [rso-ethics@uow.edu.au](mailto:rso-ethics@uow.edu.au).

Thank you for your interest and support of this study.

## APPENDIX Q: LETTER OF INFORMATION TO PARENT/CAREGIVER

University of Wollongong



## LETTER OF INFORMATION TO PARENT/CAREGIVER

Dear parent/caregiver,

Your child has been invited to participate in a research project conducted by the University of Wollongong. The project is entitled *Using an instructional video game to support geography outcomes, critical thinking and motivation to learn in a Stage Two primary classroom* and the Principal has provided support for the research to proceed.

We write to seek your approval and assistance to conduct research and to involve your child as a participant.

## PURPOSE OF THE RESEARCH

The purpose of the research is to identify:

- In what ways a video game based on best practice design principles supports Stage Two students to achieve the HSIE outcomes specified by the NSW syllabus; and
- How the use of a video game motivates learning and supports critical thinking as a method of instruction.

## INVESTIGATORS

Assoc. Prof. Ian Brown  
(Primary Supervisor)

Dr. Sharon Tindall-Ford  
(Supervisor)

Mrs. Wafa Aljohani  
(Researcher, Doctoral Student)

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Faculty of Education

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[wmha705@uowmail.edu.au](mailto:wmha705@uowmail.edu.au)

0435 847 153

## METHOD AND DEMANDS ON PARTICIPANTS

Whole class: If you agree for your child to participate, your child will play an educational video game based on best practice design principles. This will support your child's understanding of the Stage Two HSIE unit "Who Will Buy" and the outcomes specified by the NSW syllabus. Your child will play the game in class over seven 40 minute sessions and complete related worksheets in the classroom.

Six students will be invited to be interviewed for their opinions on learning with the video game.

All students will complete related worksheets and be video and audio recorded while playing the educational video game, and when interviewed. Non-participating students will attend normal classes with another teacher.

#### POSSIBLE RISKS, INCONVENIENCES AND DISCOMFORTS

Apart from using your child's class time and collecting records of their work and engagement, we foresee no risks for them. Their participation will involve learning a compulsory component of the NSW curriculum using a new and engaging technology. Your child's participation in this study is voluntary and they may withdraw from the study at any time. You may also request that the data collected from your child not be included in the research. If you choose not to involve your child as a participant this will not affect their relationship with the school or the University of Wollongong.

#### FUNDING AND BENEFITS OF THE RESEARCH

This study is funded by the Saudi Arabian Cultural Mission. The research will provide valuable information about how video games assist learning of syllabus outcomes and enhance motivation to learn and critical thinking. The research will also provide a new online video game with content based on the Stage Two HSIE syllabus. This video game can be used in Stage Two classrooms and/or for further research.

The outcome of this research will be submitted to the University of Wollongong. The school, staff and students will be given pseudonyms for anonymity. Confidentiality is assured, and your child will not be identified in any part of the research.

#### ETHICS REVIEW AND COMPLAINTS

This study has been reviewed by the Human Ethics Committee (Social Science, Humanities and Behavioural Science) of the University of Wollongong. If you have any concerns or complaints regarding the way this research has been conducted, you can contact the University of Wollongong Ethics Officer on (02) 4221 4457 or [ethics@uow.edu.au](mailto:ethics@uow.edu.au).

Thank you for your interest and support of this study.

## APPENDIX R: CONSENT FORM FOR TEACHER

University of Wollongong



## CONSENT FORM FOR TEACHER

**Research Title:** Using an instructional video game to support geography outcomes, critical thinking and motivation to learn in a Stage Two primary classroom.

**Researchers' Names:** Assoc. Prof. Ian Brown, Dr Sharon Tindall-Ford, and Wafa Aljohani.

I have been given information about *Using an instructional video game to support geography outcomes, critical thinking and motivation to learn in a Stage Two primary classroom* and discussed the research project with Wafa Aljohani who is conducting this research as part of a Doctor of Education supervised by Assoc. Prof. Ian Brown and Dr Sharon Tindall-Ford of the Faculty of Education at the University of Wollongong.

I have been advised of the potential risks and burdens associated with this research, which include three hours of my time for interviews and instruction, withdrawing six students from my class for individual (verbal questionnaires) and group interviews over approximately five hours in total, and observing my class over six weeks.

I have read the participant information sheet for teachers and have had the opportunity to ask the researcher any questions I may have had about the research and my participation.

I understand that my participation in this research is voluntary and I may withdraw at any time from the research. My refusal to participate or withdraw consent will not affect my treatment in any way with the Faculty of Education or my relationship with the University of Wollongong, or the researchers.

If I have any enquires about the research, I can contact Wafa Aljohani at [wmha705@uowmail.edu.au](mailto:wmha705@uowmail.edu.au) If I have any concerns or complaints regarding the way the research is or has been conducted I can contact the Ethics Officer, Human Research Ethics Committee, Office of Research, University of Wollongong on 02 4221 4457 or [rso-ethics@uow.edu.au](mailto:rso-ethics@uow.edu.au).

By signing below I am indicating my consent to:

- The whole class video game learning experiment taking place over eleven sessions in six weeks.

- A pre and post interview and instruction session with the researcher.
- Issuing the related worksheets in class, which will be collected.
- Six students being withdrawn (in my sight) from class time for individual pre and post tests of critical thinking and motivation, the responses to which will be collected; and seven short group interviews discussing course content and learning, which will be video and audio recorded.

I understand that information collected will be published in a Doctoral Thesis and may be published in journal articles, and I consent to it to be used in this manner. My name will not be used in the study, to reduce the likelihood of being identified.

Signed

Date

.....

...../...../.....

Name (please print)

.....

## APPENDIX S: CONSENT FORM FOR PARENT/CAREGIVER

University of Wollongong



### CONSENT FORM FOR PARENT/CAREGIVER

**Research Title:** Using an instructional video game to support geography outcomes, critical thinking and motivation to learn in a Stage Two primary classroom.

**Researchers' Names:** Assoc. Prof. Ian Brown, Dr Sharon Tindall-Ford, and Wafa Aljohani.

I have read the letter of information to parents/caregivers about *Using an instructional video game to support geography outcomes, critical thinking and motivation to learn in a Stage Two primary classroom*, a research project being conducted by Wafa Aljohani as part of a Doctor of Education supervised by Assoc. Prof. Ian Brown and Dr Sharon Tindall-Ford of the Faculty of Education at the University of Wollongong and approved by the Sule College Board and School Principal.

I understand that my child will be video and audio recorded while playing an educational video game in class over seven sessions; and my child will complete related worksheets in the classroom. I understand that this game is based on best practice design principles and will support their understanding of the Stage Two HSIE unit "Who Will Buy" and support students in meeting outcomes specified by the NSW syllabus.

I also understand that my child may also be invited to be interviewed for their opinions on learning with the video game, which will be video and audio recorded.

I have been advised of the potential risks and burdens associated with this research, which include using my child's class time to learn a compulsory component of the NSW curriculum using an educational video game, collecting records of their work, and that it may also involve approximately two hours in total for interviews on their opinions on learning with the video game.

I have read the letter of information to parents/caregivers and have had the opportunity to ask the researcher any questions I may have had about the research and my child's participation.

I understand that my child's participation in this research is voluntary and they may withdraw at any time from the research. Their non-participation or withdrawal of consent will not affect their school results.

APPENDIX S: CONSENT FORM FOR PARENT/CARGIVER

If I have any enquires about the research, I can contact Wafa Aljohani at [wmha705@uowmail.edu.au](mailto:wmha705@uowmail.edu.au) If I have any concerns or complaints regarding the way the research is or has been conducted I can contact the Ethics Officer, Human Research Ethics Committee, Office of Research, University of Wollongong on 02 4221 4457 or [rso-ethics@uow.edu.au](mailto:rso-ethics@uow.edu.au).

I understand that information collected will be published in a Doctoral Thesis and may be published in journal articles, and I consent to it to be used in this manner. My child's name will not be used in the study, to reduce the likelihood of being identified.

-----

I give permission for my child..... (Please insert your child's name) to be involved in:

The whole class study taking place over seven, in class, video game play sessions, which will be video and audio recorded.

☐

Completing the related worksheets which will be collected.

☐

Interviews for their opinions on working with the video game for approximately two hours in total, which will be video and audio recorded.

☐

Signed

Date

.....

...../...../.....

Name (please print) .....