STUDENTS' USE OF SOCIAL AND COGNITIVE AFFORDANCES IN VIDEO GAME PLAY WITHIN EDUCATIONAL CONTEXTS: IMPLICATIONS FOR LEARNING

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We certify that we have read this dissertation and that, in our opinion, it is satisfactory in scope and quality as a dissertation for the degree of Doctor of Philosophy in Communication and Information Sciences.

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Abstract

Matthew J. Sharritt (PhD Communication and Information Sciences)

Students' Use of Social and Cognitive Affordances in Game Play within Educational Contexts: Implications for Learning

Directed by Dr. Daniel D. Suthers, Professor, Department of Information & Computer Sciences, University of Hawai'i at Mānoa

Extensive literature has shown that games can provide an engaging, dynamic, and authentic learning context. Many of the studies on the use of games in education indicate that games can support teaching standards and outcomes; however, they do not describe actual uses of video games for learning. Through the analysis of affordances employed by student gamers, an understanding of how learning takes place can inform the design of effective educational games and aid their integration into contemporary classrooms. Informed by ethnomethodology, this study used methods of grounded theory provided a

detailed description of the use of video games for learning in educational contexts.

Results demonstrate that learning occurs across multiple levels: the mastery of the *computer interface*, followed by the mastery of the *game interface* and upon which students can achieve *advanced strategy* aimed at goal achievement.

Learning also occurs across multiple granularities: occurring either in *short episodes*, *sequences of episodes*, or *trends*. Learning can be triggered by multiple *cues*, such as failure, game visualizations or specific representations, as well as by peers or teachers in the social environment.

Students used affordances provided by the game interface and learning environment, specifically: the visual representations of games afford particular actions; the persistent display of historical context as well as present and future potentials motivates learning; specific cues can grab attention, helping to focus efforts on new or underutilized game tasks; consistent and well organized visualizations encourage learning; and information presented in a plurality of channels is most effective for learning.

The use of social peers in collaborative learning had several effects on the learning process: peers disclosed information to achieve shared meaning of objects' purposes, and negotiated to collaboratively choose game strategies. Peer

teams served cooperative roles as information sources and competitively as a performance gauge.

Implications for students, educators, and game designers are offered to better play, implement, and design games for learning. A brief comparison of findings with existing theory discusses similarities among collaborative learning and activity theory, and suggests opportunities for future work. Overall, findings indicate a great potential for the use of games in education for learning.

DEDICATION

To Michel Ann Sharritt, my wife, for her unconditional love and support.

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CREDITS AND COPYRIGHTS

This research was conducted by videotaping dyads (pairs) of high school students working collaboratively to learn from educational video games. There were no educational video games designed for collaborative learning that met criteria at the time the research was conducted. Therefore, a key element of the research was to select three best-in-class video games that were commercially available. Game selection criteria are discussed in Chapter 3.

The following three PC educational video games were purchased by the researcher to use with the study participants.

Roller Coaster Tycoon 3 (http://www.atari.com/rollercoastertycoon)

Making History: The Calm & The Storm (http://www.making-history.com/edu)

Muzzy Lane develops Smart Games for education and commercial release. MAKING HISTORY: The Calm & The Storm is their most recent product, developed for both education and retail audiences. To learn more about the company, visit www.muzzylane.com.

Sid Meier's Civilization IV (2K Games) (http://www.2kgames.com/civ4)

CHAPTER 1:

INTRODUCTION

1.1 *General Introduction*

Schools, especially at high school and college levels, are "still, to a large degree, structurally nineteenth century institutions" (Foreman et al., 2004, p. 53). Foreman suggests that "kids today are seeing more power-performance learning in their popular culture than they're seeing in their schools" (Foreman et al., 2004, p. 52) and that games have the opportunity to provide authentic, intellectually engaging learning environments (Annetta, Murray, Laird, Bohr, & Park, 2006; Federation of American Scientists [FAS], 2006a; Foreman et al., 2004; Prensky, 2001; Shaffer, 2006; Squire, 2005; Stokes 2005; Zyda, 2005). Games are "the most engaging intellectual pastime that we have invented" (Foreman et al., 2004, p. 58).

Research shows that video games can provide a rich experience while providing game players the ability to navigate a virtual world, in which complex decision making and the management of complex issues might resemble the cognitive processes that they would employ in the real world (Ducheneaut, Yee, Nickell, & Moore, 2006a; FAS, 2006a; Squire, 2005; Stokes, 2005). Games are engaging, because they: "give us enjoyment and pleasure; give us intense and passionate involvement; give us structure; give us motivation; give us doing;

give us flow; give us learning; give us ego gratification; give us adrenaline; they spark our creativity; give us social groups; and give us emotion" (Prensky, 2001, p. 144). Further research will be presented in section 2.1 of the literature review.

In a recent survey of over 319,223 students, 25,544 teachers, 19,726 parents and 3,263 school leaders in the United States, Project Tomorrow (2008) reports that more than half of students in grades 3 through 12 believe games would help them learn, and average 8-10 hours per week playing games. Only 3% of elementary school students say they do not play games of any kind. While only 11% of teachers reported that they were already using video games in class, many teachers feel that games could increase student engagement, address different learning styles, and teach critical thinking skills. Over half of the teachers surveyed were interested in learning more about integrating gaming technologies, with only 6% of teachers saying that they saw no value in exploring games within education (Project Tomorrow, 2008, p. 4).

1.2 *PROBLEM STATEMENT*

The literature suggests that games provide a rich learning context, in which gamer strategizing and the management of complex problems can foster creative thinking skills and show players how their decisions have dynamic outcomes (Squire, 2005; Stokes, 2005; Zyda, 2005). Additionally, gamers can experience social learning through group membership and leadership situations in order to achieve goals within a game (Foreman et al., 2004; Socially Intelligent Agents at CARTE, 2006; Zyda, 2005).

Kirriemuir & McFarlane (2004) and the Federation of American Scientists (FAS, 2006b) discuss directions for research, outlined and summarized in Appendix B (primarily based on the Federation of American Scientists' 2006 report from the Educational Games Summit). While many opportunities exist, several have already been explored and are discussed in the first section of the literature review. However, much of the research that has been completed focuses on general introductions to gaming and their application in a classroom, broad case studies, and learning outcomes associated with using games in the classroom. There exists an opportunity for a thorough investigation into the

actual uses of games in an educational setting, focusing on the *collaborative learning process* and how students make use of both *cognitive and social affordances* of gaming. Affordances can be used to focus on what opportunities are offered (afforded) to an actor by the environment (use of games in educational contexts) being studied. The term *cognitive affordance* is used to discuss a potential for cognitive action; and *social affordance* to describe a potential for social action. In this study both the use of the video game interface and peer group cultures are the focus of analysis (Kirriemuir & McFarlane, 2004). This descriptive analysis of the use of video games in educational contexts can inform both game design and sound pedagogy: improving the game content and interface, as well as aiding in the design of instructional content and learning curriculums.

Kirriemuir & McFarlane (2004) discuss the need for further research that investigates collaborative learning in the use of gaming environments to support learning:

> The value of collaborative learning and the role of computers in promoting such activity have been thoroughly researched. ... How this collaboration translates into a multiplayer gaming environment and how these environments might be used to support learning, remain some of the most interesting areas for potential further research and development. (Kirriemuir & McFarlane, 2004, p. 27)

According to Squire (2005), "it seems the important question is not can games be used to support learning, but how" (Squire, 2005, p. 1).

1.3 *OBJECTIVE*

While current literature on gaming in education discusses the ways in which games are used as learning tools in a classroom and their associated benefits for learning, much detail is left out on how students actually make use of the affordances provided by games in their learning process (through collaboration with peers and interaction with the interface, as shown in Figure 10 of the literature review).

"What these studies suggest is that one of the more interesting relationships between computer games and learning is not simply the interaction between the player and the game; rather, through processes of discussion, collaboration and reflection on games embedded in peer team cultures" (Kirriemuir & McFarlane, 2004, p. 16). Much of the literature discusses the properties of games along with their potential uses in supporting learning outcomes. Kirriemuir & McFarlane (2004) suggest the need for an in-depth study of collaborative learning and the learning process when using video games to support learning.

The objectives of this study are to:

(a) Analyze the social and cognitive affordances of games in education

(b) Study how these affordances influence and are appropriated by students and teachers to support learning in the context of peer team interaction

(c) Inform future design, selection and use of games in educational contexts

Following are the research questions to be answered by this study. The conceptual and operational definitions of key terms, such as cognitive and social affordances, are provided in the literature review. A conceptual diagram is presented in the literature review (Figure 10) that highlights relationships among participants and games.

1.4 *Research Questions*

The following two research questions are addressed by this study:

1. *In what ways does learning take place in the context of collaborative video game play by high school students?*
2. *In what ways do students make use of the cognitive and social affordances of collaborative gaming for the learning that takes place?*

The study takes an open-ended, emergent approach drawing from ethnomethodology and grounded theory for a descriptive analysis that enabled a qualitative, inductive case study to be conducted. Results present the actual use of games in an educational context to support the learning process.

The first research question was addressed at two levels: first, a macro-level analysis that identifies properties and categories of learning; second, an interaction analysis, focusing on the play-by-play of indexical actions during instances of learning during collaborative game play.

The second research question was addressed by examining the ways in students actually use the game interface, and how they utilize their peers and

mentors in a collaborative manner. Literature suggests that both peer collaboration and mentor guidance can encourage learning; this analysis sheds light on exactly how. Empirical work identified how and why peer collaboration takes place while playing video games and attempts to expose the affordances of video games essential for learning.

1.5 *Discussion Questions*

In the discussion chapter, guidelines to game designers and educators are offered based on the study outlined above in the two research questions. These guidelines are not evaluated empirically, but will be derived from the results of the first two research questions and provide testable hypotheses for future work. The following discussion questions are addressed based on the results of the foregoing analyses:

1. *What are the implications for selection, use, and design of video games for learning? Specifically,*
    a. *How can teachers, instructional designers, and game designers make use of the cognitive and social affordances of video games in order to create learning opportunities and support educational goals?*
    b. *How could students have made better use of game affordances to learn?*
2. *How do the emergent theories generated in our inductive inquiry compare with existing theory of collaborative learning and activity theory?*

The first discussion question makes claims for relevant stakeholders, focusing on the actual uses of video games for learning, how games might be better designed, and offer guidelines for better implementation by educators. The second discussion question compares the empirically-driven analysis with theoretically motivated analyses, drawing on activity theory and other approaches attempting to understand the mediational role of artifacts in the social processes of learning.

The dissertation is organized as follows: Chapter 2 reviews literature on educational aspects of gaming, and relevant theory from the behavioral and social sciences; and Chapter 3 outlines the methodology of the research. Chapter 4 provides findings related to the first research question (what learning takes place in collaborative gaming), and Chapter 5 to the second (what affordances of collaborative gaming are involved in this learning). The final chapter, Chapter 6, mentions implications of the findings (focusing on the discussion questions outlined above) as well as areas for future work.

CHAPTER 2:

REVIEW OF THE LITERATURE

This literature review has two sections: Section 2.1 introduces the literature on video games and their uses in educational settings; and Section 2.2 discusses the theoretical stance that was applied to the methodology that provides an in-depth investigation to the learning process of playing video games in an educational setting. Affordances, collaborative learning, and socio-cognitive theories dealing with collaborative learning in an educational context are discussed. Section 2.2 of the literature review contains conceptual and operational definitions for the research questions of this study.

2.1 *Literature Review: Gaming in Education and Serious Games*

Section 2.1 of the literature review is broken into five parts examining research in educational gaming from a Serious Games perspective:

(a) A discussion of learning, learning styles, and pedagogical differences between traditional classroom instruction and the use of games

(b) A focus on literature that discusses issues related to how educational gaming might be implemented in the classroom

(c) A discussion of game features and how they might be leveraged in education

(d) The properties of MMOGs (Massively Multiplayer Online Games) and MMORPGs (Massively Multiplayer Online Role-Playing Games), the formation of social groups, and interaction among virtual identities

(e) A variety of literature and theory addressing additional benefits of games for learning: from cognitive psychology, communication, human-computer interaction (HCI), and social psychology;

focusing on building complex human emotion, communication and artificial intelligence into educational games

2.1.1 *A Serious Games Perspective*

The Serious Games initiative is a new perspective on analyzing the power of games in the public sector, and aims to foster the links between games and education, training (including military and business applications), health care, and public policy. As stated on the Serious Games home page, the aim of Serious Games is as follows:

> The Serious Games Initiative is focused on uses for games in exploring management and leadership challenges facing the public sector. Part of its overall charter is to help forge productive links between the electronic game industry and projects involving the use of games in education, training, health, and public policy. (Serious Games Initiative, 2008).

While the health care and public policy aims of Serious Games seem fruitful, this review focuses on the Serious Games perspective that focuses on the link between gaming and education.

Much of this literature review is based on the work of the Federation of American Scientists (2006b), that resulted from discussion among approximately 100 participants at the Educational Games Summit, including "business

executives from the gaming industry and the education software industry, researchers and academic experts on technology and pedagogy, teachers, game developers, experts on competitiveness policy, and government policy makers." At the summit, participants "were asked to react, critique, and offer additions and modifications to a preliminary [LS&T] R&D roadmap distributed to the Summit participants. The roadmap was subsequently revised and expanded to reflect the discussions at the Summit."

Appendix B outlines research questions proposed from their work (FAS, 2006b). Their work utilized the many professionals attending the Educational Games Summit:

> The research priorities described here are derived as a subset of the research priorities identified in the 2003 Learning Science and Technology (LS&T) R&D Roadmap produced by the Federation of American Scientists' Learning Federation Project, www.fas.org/learningfederation. The LS&T Roadmap describes a vision for next-generation learning systems, and outlines a national research plan to radically improve approaches to teaching and learning through information technology. The LS&T R&D Roadmap was produced over a two-year period with input and advice from over seventy researchers from industry, academia, and government through their participation in focused workshops, interviews, and preparation of technical plans. Comprised of a series of five

> component roadmaps, the Roadmap provides as assessment of R&D needs, identifies key research questions and outlines a chronology of R&D activities designed to spur innovation in technologies for education and training. (FAS, 2006b, p. 1)

The research questions outlined in Appendix B are an excellent summary of the research areas in educational games that need work, and are in line with the goals of the Serious Games initiative.

An area of research that was not specifically mentioned by the Federation of American Scientists (FAS, 2006b) was that of group learning, such as what occurs in Massively Multiplayer Online Games (MMOGs). This is an expanding area of gaming, so it has been added to the list of research questions at the end of Appendix B under the heading "Areas of Research related to Educational Gaming that were not specifically mentioned by FAS".

2.1.2 *Traditional Schooling and Game-Based Learning*

This section of the literature review discusses the application or practical side of educational gaming, which deals with classroom integration, politics, and pedagogy (instructional technique), and provides insight to some of the current problems being encountered in many of today's classrooms with traditional instructional techniques. In many instances, a different pedagogical approach such as educational gaming may solve some of the problems associated with traditional instruction.

2.1.2.1 *Traditional Schooling vs. Educational Games*

When looking at today's schools, a certain culture and pedagogy exists. Schools, especially at high school and college levels, are "still, to a large degree, structurally nineteenth century institutions" (Foreman et al., 2004, p. 53). Foreman suggests that "kids today are seeing more power-performance learning in their popular culture than they're seeing in their schools" (Foreman et al., 2004, p. 52). The author suggests that today's popular culture, including video games and other forms of computer technology, are more advanced in comparison to what is being taught in many school systems. Squire (2005) points out that:

> As challenging as it is to design a good educational game, it may be more challenging to design a good educational system for an educational games to flourish in. ... it is not certain that such a [well designed] game could even survive in today's educational environment as our contemporary educational systems do not know how to sustain a curricular innovation built on the properties that make games compelling. (Squire, 2005, p. 6)

Squire (2005) first mentions the difficulty in creating a good educational game, but claims that the main issue that needs to be addressed is the culture within today's schools. The author follows in saying that "the real challenge is not so much in bringing games, or any technology into our schools, but rather changing the cultures of our schools to be organized around learning, rather than the current form of social control." Examining school systems as societal institutions, the author finds that there are socio-cultural problems that need to be addressed before an environment exists that supports a different pedagogical approach. Some of the processes required to change schools' learning environments are to change or update educational standards and redesign curriculum; to educate the schools' communities and various stakeholders; and to train teachers to use gaming and new methods of teaching in their classrooms (FAS, 2006b).

Squire (2005) discusses two pedagogical models: the 'factory model', referring to traditional instruction in which standards-based learning and standardized tests are frequently emphasized (Eisner, 1984); and the 'gaming model', an envisioned form of learning utilizing games and focusing around the learner. Stapleton (2004) describes games as "rich learning environments with applications beyond entertainment" where the locus of control resides in the player (learner-oriented) rather than the teacher (focusing on knowledge transfer). Table 1 has characteristics of both of these learning models:

Gaming Model	**Traditional / Factory Model**
better for 'new economy' problem-based learning hands-on yields creative thinkers	best for getting through higher-education structured tasks hands-off memorization of facts

Table 1: Squire's 'Gaming Model' vs. 'Factory Model' of instruction

Squire (2005) discusses the 'new economy' as the economy of the future, assuming the progression of technology where today's learners might be best prepared using an alternative to traditional schooling models. The Federation of American Scientists (2006b) argues that:

> Gaming environments were viewed by many of the LS&T R&D Roadmap contributors as an opportunity to break the "tell-test" paradigm prevalent in education today and vastly improve the more elusive aspects of the educational process; namely, motivation to learn and to continue learning over one's lifetime. (FAS, 2006b, p. 1-2)

The factory (traditional) model of learning outlined in Table 1 (Squire, 2005) is employed by most of today's schools, and places value on standardization (tests, homework, etc), often obsessing over the memorization of facts. An alternative model of learning that makes use of games could be employed to take advantage of other kinds of learning that support creative thinking and problem solving. James Gee (2003) summarizes some of these benefits in his "36 Learning Principles", which highlight particular ways that games can support learning. These 36 principles are outlined in Appendix K.

Additionally, theories of situated cognition (Brown, Collins & Duguid, 1989) and situated learning (Lave & Wenger, 1991) could be leveraged so that learning is not abstracted away from the social environment in which it occurs and is used (a potential weakness of standards-based learning). In cases where direct apprenticeship and participation cannot occur, gaming might provide a virtual world for simulation of the environment.

McNeil (2000) discusses some of the problems associated with standardization:

> Standardization reduces the quality of what is taught and learned in schools. This immediate negative effect of standardization is the overwhelming finding of a study of schools where the imposition of standardized controls reduced the scope and quality of course content, diminished the role of teachers, and distanced students from active learning. (McNeil, 2000, p. 3)

In addition to overcoming pedagogical tradition, it is expected that there could be resistance to change in the classroom by the teachers themselves; especially those in the baby-boomer generation and older, known as *digital immigrants* (Foreman, Gee, Herz, Hinrichs, Prensky, & Sawyer, 2004). Foreman suggests that *digital natives*, or the generations growing up playing video games, will be the ones that will be ushering in this new culture into schools.

Foreman (2004) discusses some benefits of games: they can be community building; encourage discourse and negotiation; are collaborative, so groups can co-think through problems (gamers can trade a controller depending on who's better at the given task; thus dynamically allocating resources); and can involve distributed, social decision making processes. Squire (2005) discusses an additional benefit of games: most games involve problem-based learning, where

the learner has control of the flow and decision making involved in the learning. Problem based learning, as well as with most games, involves the learner being handed a set of tools or resources and then problem solving with those tools. Learners can find unique solutions to solve the problems presented to them, which promote creative thinking skills and dynamic resource allocation. "An interactive game can trigger profound insights for long-term thinking" (Stokes, 2005). These creative problem-solving skills may be a better preparation for tomorrow's jobs and economy, as well as a means of developing students' abilities to work through difficult problems.

The Federation of American Scientists (2006a) lists skills such as strategic thinking, planning, communication, application of numbers, negotiation skills, and group decision making as those which can be developed with games, and serve as practical skills that students will be able to utilize in tomorrow's jobs. While these skills can be learned in other instructional forms, gaming can provide a unique environment which can foster the development of these outcomes. Specific types of games such as MMOGs (Massively Multiplayer Online Games) can support specific types of learning objectives, such as doing group work, and are discussed in greater depth later in the literature review.

2.1.2.2 Things We Can Learn While Gaming

Prensky (2001) in his book *Digital Game-Based Learning* discusses some of the problems in defining learning. He compares research done by educational systems to other governmental programs, such as health care, defense, space, etc: and states that one tenth of a percent of education budgets are devoted to educational research (such as investigating learning). The author discusses the struggle in defining learning, partially due to a lack of research funding. Following in Table 2, Prensky breaks down learning into types of content that can be learned while playing games, as well as some of the ways in which to learn the respective content areas:

"Content"	Examples	Learning Activities	Possible Game Styles
Facts	Laws, policies, product specifications	Questions Memorization Association Drill	Game show competitions Flashcard type games Mnemonics Action, sports games
Skills	Interviewing, teaching selling, running a machine, project management	Imitation. Feedback coaching, continuous practice, increasing challenge	Persistent state games Role-play games Adventure games Detective games
Judgment	Management decisions, timing, ethics, hiring	Reviewing cases Asking questions Making choices (practice) Feedback Coaching	Role-play games Detective games Multiplayer interaction Adventure games Strategy games
Behaviors	Supervising, exercising self-control setting examples	Imitation Feedback Coaching Practice	Role-playing games
Theories	Marketing rationales, how people learn	Logic Experimentation Questioning	Open ended simulation Building games Construction games Reality testing games

Reasoning	Strategic and tactical thinking, quality of analysis	Problems Examples	Puzzles
Process	Auditing, strategy creation	System analysis and deconstruction Analysis	Strategy games Adventure games Simulation games
Procedures	Assembly, bank teller legal procedures	Imitation Practice	Timed games Reflex games
Creativity	Invention Product design	Play Memorization	Puzzles Invention games
Language	Acronyms, foreign languages, business or professional jargon	Imitation Continuous practice Immersion	Role playing games Reflex games Flashcard games
Systems	Health care, markets, refineries	Understanding principles Graduated tasks Playing in microworlds	Simulation games
Observation	Moods, morale, inefficiencies, problems	Observing Feedback	Concentration games Adventure games
Communication	Appropriate language, timing, involvement	Imitation Practice	Role playing games Reflex games

Table 2: Things we can learn in games (adapted from Prensky, 2001, p. 156)

Prensky relates learning activities with supportive game styles, along with suggestions on types of games that might best support that activity. Both game and instructional designers might find use in the examples provided by Prensky in Table 2.

2.1.2.3 Learning and Teaching Styles

Educational game designers should consider their intended audience, which will most likely be comprised of people with many different learning styles and information delivery. If this is the case, pluralization of channels of information delivery will allow students to choose the channel that best suits their learning style.

Felder & Silverman (1988), discuss 32 learning styles (a preference of each of the five categories, therefore 2^5 possible styles) and corresponding teaching styles, following in Table 3:

Preferred Learning Style		*Corresponding Teaching Style*	
sensory intuitive	perception	concrete abstract	content
visual auditory	input	visual verbal	presentation
inductive deductive	organization	inductive deductive	organization
active reflective	processing	active passive	student participation
sequential global	understanding	sequential global	perspective

Table 3: Dimensions of learning and corresponding teaching styles (from Felder & Silverman, 1988, p. 675)

Felder and Silverman discuss five questions aimed at gauging the learning style (Felder & Silverman, 1988, p. 675):

> A student's learning style may be defined in large part by the answers to five questions:
>
> 1. What type of information does the student preferentially perceive: sensory (external)—sights, sounds, physical sensations, or intuitive (internal)—possibilities, insights, hunches?
>
> 2. Through which sensory channel is external information most effectively perceived: visual—pictures, diagrams, graphs, demonstrations, or auditory—words, sounds? (Other sensory channels—touch, taste, and smell—are relatively unimportant in most educational environments and will not be considered here.)

3. With which organization of information is the student most comfortable: inductive—facts and observations are given, underlying principles are inferred, or deductive—principles are given, consequences and applications are deduced?

4. How does the student prefer to process information: actively— through engagement in physical activity or discussion, or reflectively— through introspection?

5. How does the student progress toward understanding: sequentially—in continual steps, or globally—in large jumps, holistically?

Some students will prefer traditional instruction. Squire (2005) implemented the game *Civilization III* in his classroom, and noticed in his research that many students were not used to learning by playing a game. Many students were overwhelmed by the complexity of decisions in a game: For instance, in *Civilization III*, students could choose to rule an empire of the past, and their decisions affected multiple variables such as politics, economy, social life and their military. Referencing Table 3, student learning styles may have been used to the deductive, reflective style of traditional learning, where the game presented an inductive, active learning style.

An outcome of playing *Civilization III* in Squire's (2005) study was that students learned higher-order thinking skills, such as strategic thinking, planning, and the management of complex variables; however many students

were overwhelmed by this complexity and preferred traditional instruction. Squire attributed this to a variety of potential factors: that his students had never done anything like this before in other classes, and were not prepared to learn in that matter; and that some students have different learning styles due to their personal history, genetic predispositions, and personal attitude towards the type of instruction (Hidi & Renninger, 2006). Most variables described need further research, but it is interesting to note that some variables might be manipulated (such as attitude), while others cannot (genetics, predisposition towards games, etc).

A teacher can help change attitudes towards gaming, and a game designer can design something suiting multiple learner styles by supporting multiple channels of information delivery in a game. Some learners prefer traditional instruction such as reading, recitation, and testing, while other learners prefer the affordances of problem-based learning, similar to what is encountered in many video games. While many off-the-shelf video games will have the latter, it may be possible for instructional designers to add something like a 'virtual book' and quizzes to a game to suit a broader range of learning styles for games being used in an educational environment.

Game-based learning can draw from other literature, such as theory on problem-based learning (see Barrows, 1986; Evensen & Hmelo, 2000), and goal-based scenarios (Shank, 1993) as discussed later in the literature review. Hagel (2007) discusses 'accidental learning', where learning occurs as a byproduct of playing the game (by accident). This kind of learning can benefit from trial and error, a valuable form of learning used in everyday life. Hagel discusses this with regard to traditional instruction, "...the most valuable learning is certainly not at the level of compartmentalized skills; it is much more about developing and evolving appropriate dispositions and the ability to integrate in new ways" (Hagel, 2007). He, along with many other authors, suggests that game-based learning may be most useful in teaching generalizable knowledge and creative thinkers that can generalize knowledge across domains (resourceful thinkers or creative problem-solvers). Regardless of the learning style and student disposition, when examining learning (traditional vs. game-based), learning must be considered as a process, not just an outcome, and the things learned as a result of the teaching method: such as facts, procedures, behaviors, and reasoning (Merrill, 1983). Prensky discusses some of these in Table 2.

Bloom's Taxonomies (Bloom, 1956; Krathwohl, Bloom & Bertram, 1973; Simpson, 1972) describe learning as occurring on three levels: cognitive

(mentally), affective (attitudinally) and psychomotor (physically). A huge amount of work went into each of these three domains of educational activity. Compilations from each domain (Bloom, 1956; Krathwohl, Bloom & Bertram, 1973; Simpson, 1972) are as follows (adapted from Clark, 1999):

Cognitive: *knowledge (recall information); comprehension (understanding); application (use); analysis (understanding structure); synthesis (building a structured whole); evaluation (judgment of value)*

Affective: *receiving phenomena (awareness, selected attention); responding phenomena (active participation); valuing (assigning worth); organization (prioritizing values); internalizing values (characterization that controls behavior)*

Psychomotor: *perception (using sensory cues); set (readiness to act); guided response (practicing motor skills); mechanism (habituated skills); complex overt response (skillful motor skills); adaptation (skills modify movement patterns); origination (creating new movement patterns)*

The idea of 'situated learning' (Lave & Wenger, 1991; Brown, Collins & Duguid, 1989; Brown & Duguid, 1992), by which participants learn through direct experience in contextualized social environments, can be used to improve traditional standards-based learning. Brown and Duguid (1992) argue that a

well designed technological interface can break the bounds of the classroom and allow participants to see through the learning and enter the real world that practitioners use. They argue this happens by many transformations through the technology (compared to traditional classrooms): instruction becomes learning; the explicit becomes implicit; the individual becomes social; and the systems move from narrowly construed to broadly construed. This research provided foundation for CSCL (Computer Supported Collaborative Learning) and learning technologies that utilized modern computer and Internet technologies.

Thomas and Brown (2006) describe some of the paradigms in looking at learning with video games. They describe one school of thought as learning from the standpoint of knowledge transfer, and another from the standpoint of situated learning. They propose a third way of examining learning, specifically in MMOGs (see below). First, they discuss how knowledge transfer works in a game, as a way of imparting skills such as hand-eye coordination or puzzle solving abilities. Situated learning is briefly described as another way of examining a learning system; for instance, they give the example of how "the pressures of time constraints might help improve time management skills or broaden a players understanding of how various interconnections work within those time constraints", thus providing players with an empathy of how the

game system works through the adaptation of a particular disposition required to excel at the game.

2.1.2.4 Social Learning Supported by Gaming

Thomas and Brown (2006) introduce a third learning paradigm that addresses the benefits of online games, specifically MMOGs (Massively Multiplayer Online Games), addressing the kind of social learning occurring in MMOGs. This idea is founded on the idea of imagination, and explained through example in the game *World of Warcraft*, currently with over ten million subscribers (Blizzard Entertainment, 2008):

> Our central thesis is that the power of MMOGs rests in their ability to create a play of imagination, whereby the player is immersed in a world of dense and vivid representations that provoke them to think beyond what they see on the screen. In that sense, we are interested in understanding the gaps between player and avatar, between virtual and physical, and between players themselves, that are continually filled in and traversed by acts of imagination. Further, we contend that MMOGs are extremely vivid spaces that not only allow for imaginative thinking, but integrate imaginative thinking into the fabric of the social and game experience of play.
>
> Understanding how these spaces function in terms of learning requires us first to understand what is unique about the ways MMOG players

> approach questions of knowledge, information, imagination, and play. (Thomas & Brown, 2006, p. 7)

The authors introduce the idea of 'conceptual bleeding', highlighted above, in which players fill in the gaps between distinct things: the virtual world and the real world; work and play; person and avatar. The authors propose that a type of imaginative learning is done on the players' parts, which is characterized by spontaneous thought and imagination. They argue that this type of learning is spontaneous, social, and very creative in nature (the author calls it "emergent collective action"), and what helps account for the success of *World of Warcraft*, currently the most played MMOG. The authors describe such a situation in *World of Warcraft* when a group is vulnerable after a battle:

> At such moments, groups can generally expect to have their entire party killed. In a position of vulnerability, caught unprepared, and without a plan or strategy, the result is usually a "wipe," forcing the players to exit the dungeon and start again from the beginning. There are times, however, when, against all odds, the players are able to do just the right things in just the right ways to survive and defeat the patrol. These are moments of emergent collective action, where players accomplish something they thought was impossible, often with little or no knowledge of how they accomplished it. They are also moments of simultaneous joy

and reflection, where players are elated at the accomplishment, but also likely to wonder how it is that they accomplished it.

These moments of emergent collective action are some of the most powerful learning experiences in the game, because they invite reflection on a wide range of issues, including unintended consequences, synergy and, from our perspective most importantly, imagination. When a player succeeds in the face of overwhelming obstacles she usually does so because she was able to imagine a new approach or new use of an item to dynamically alter the situation. Rather than confronting an unexpected situation as a problem, successful players are more likely to redefine the problem space itself, resulting in a re-imagined context for new innovative solutions.

This combination of disposition, imagination and agency create a new and particularly vivid situational awareness that provides the opportunity for the player to live in a space of possibilities, which we see as powerful training for innovative thinking. Moreover, this sense of vividness that MMOGs provide allow players to immerse themselves deeply in a world of simultaneous similarly and difference, which results in the development of key practices of situational awareness. In particular, we see these practices as an extension of ... conceptual blending. (Thomas & Brown, 2006, p. 11-12)

A special kind of social learning occurring in MMOGs (Thomas & Brown, 2006; Donath, 1988) is discussed later in the literature review. It is important to

note how the authors saw an inadequacy in learning theory when applying traditional knowledge transfer and situated learning theories to MMOGs.

2.1.3 *Use of Games for Learning*

While gaming offers advantages over traditional standards-based learning, most of the literature suggests that gaming and problem based learning is not the perfect solution to every problem. For instance, Squire (2005) does a study involving a 'commercial off-the-shelf' (COTS) game called *Civilization III* (to teach world history). While some students took to the game and excelled at it, other students resisted it. Squire attributed this to the fact that individuals have different learning styles: Some will prefer the complexity of a game and problem-based learning, while others prefer traditional forms of learning. Squire (2005) discusses his observations with *Civilization III*:

> Bringing *Civilization III* to school reminds us of something that constructivist educators have already learned: Contemporary pedagogical practice, which breaks problems down into bite-size pieces that are easy-to-learn often creates a sense of "learned helplessness" in students (particularly high achieving ones) who have only seen short, solvable problems where all of the information needed is laid out in front of them ... *Civilization*'s complexity was problematic within a school setting. If part of what makes games so interesting is their ability to present access to complex professional practices, then managing this complexity (and particularly students' reactions to it in school settings) will continue to be a challenge. (Squire, 2005, p. 3)

It may be expected that students will show hesitation if they have never encountered this kind of learning before. Upon a first implementation, students may prefer traditional instruction since their previous educational experience has not prepared them to deal with the complexity and dynamic resource allocation required in many of today's games. This may change over time as games become more commonplace in schools. However, one must remember that different learner characteristics exist, with each individual being unique. Many students will prefer the experience of traditional instruction to that of game-based learning.

2.1.3.1 Educational Game Development (A Serious Games Model)

Collaboration is necessary in a field that is interdisciplinary by nature (Stokes, 2005). Work needs to be done between game developers, software engineers, and psychology and communication experts. A former effort called *edutainment* was a means of attempting to create games to teach; however, the word today has a negative connotation following its limited success.

Many edutainment titles borrowed the gaming medium, thinking it was sufficient to create a fun, engaging learning experience. Game design focused on educational goals, with less focus on creating a fun, engaging game. Often, this resulted in games that students were less motivated to play: an analogy used to

describe these games is "chocolate covered broccoli", as the game medium was used to entice students into doing something they considered boring. Traditional schooling was often simply transplanted into a game, rather than making a fun, playable game where learning was a byproduct.

One example that Stokes (2005) points out as a shortcoming of collaboration is that of edutainment: "Many educators contend that edutainment has largely produced shallow products focused on short-term test scores." Stokes argues that educational game design can benefit from an interdisciplinary perspective, to bridge the gaps in expertise that may have existed in previous efforts.

Game design involves multiple disciplines and the management of complex issues and tradeoffs. Zyda (2005) presents below in Figure 1 some of the elements involved in Serious Game design which "unlike their entertainment-only counterparts, use pedagogy to infuse instruction into the gameplay." Pedagogy is subordinate to story: learning from the failures of edutainment, pedagogy is built into game design and story, rather than controlling the whole story. This is represented in Figure 1:

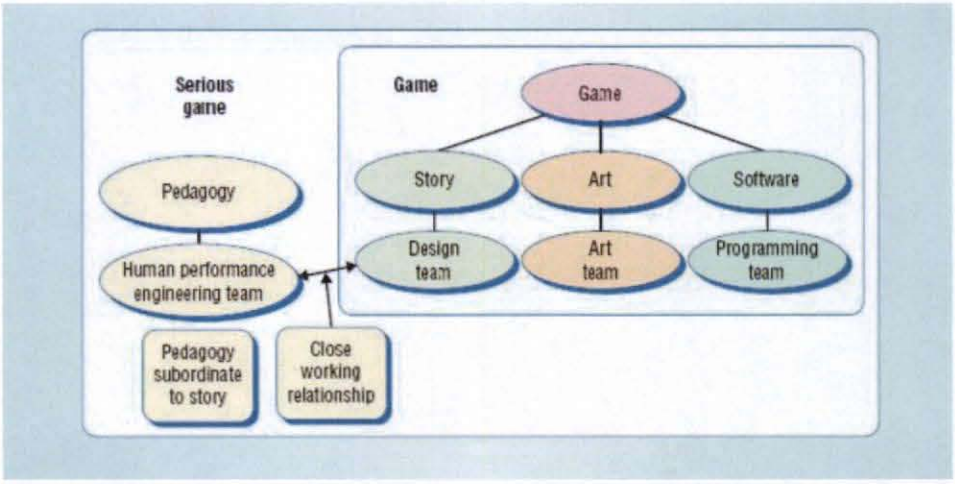

Figure 1: Traditional game design and Serious Game design (from Zyda, 2005, p. 26)

Zyda interviewed Bing Gordon, Chief Creative Officer at Electronic Arts, who once said that game design components consisted of "story, art and software". In Figure 1, this represents the inner box in the figure: elements of design in a traditional game. Zyda expanded this definition above, adding a Serious Games perspective that uses pedagogy, or "activities that educate or instruct, thereby imparting knowledge or skill. This addition makes games serious. Pedagogy must, however, be subordinate to story- the entertainment component comes first. Once it's worked out, the pedagogy follows" (Zyda, 2005, p. 26). Stokes (2005) defines Serious Games as follows:

> The term 'Serious Games' is increasingly used for digital games whose primary goal goes beyond entertainment to education, outreach or training. The term's use has grown largely through the Serious Games Initiative, which started in 2002 at the Woodrow Wilson Center for International Scholars in Washington, D.C. Today, hundreds attend conferences and collaborate online to find out what Serious Games might bring to their jobs as educators, political organizers, academics, game designers and more. (Stokes, 2005, p. 2)

Whether looking at Serious Games or traditional game design, it is obvious that it involves managing many complex issues and dealing with tradeoffs. As discussed earlier, an example of these tradeoffs could be managing fidelity and entertainment value: If designing an educational game, high accuracy and fidelity would be desired. However, this could possibly negatively affect the game's entertainment value: If game designers over-emphasize fidelity, they could sacrifice some of the 'fun' value of the game, as game players are not allowed to extend reality by doing things they otherwise cannot do in real life (an addicting entertainment element that can add fun and entertainment value).

While there is much promise for educational games, there are barriers to overcome in developing these kinds of games. Stokes (2005) mentions three key areas that need work: collaboration; cost of development; and distribution.

Creative solutions to these problems can help make huge strides for educational games.

2.1.3.2 Educational Game Development Barriers: Keeping up with the Jones' (Commercial Game designers)

The cost of developing a commercial game has become huge, rivaling the costs of making a Hollywood movie. Large gaming companies have enormous budgets, and Stokes (2005) points out that it can be difficult for small educational game companies to compete in this environment:

> As pop-culture video games align more closely with Hollywood and its special effects, fundraising expenses often include both professional video and technical engines. To help level the playing field, development educators should reward approaches to game production that are designed to leave behind tools and media assets for low-cost repurposing in the spirit of open source. Universities can help in this effort by building collaboration between emerging games studies programs and organizations dedicated to the public good. Finally, with games industry revenues outpacing Hollywood, commercial partnership remains a tempting, if elusive target. One backdoor exists in the free tools that some companies offer so their players can create 'mods' (modified versions of the original game). Building within commercial games will help industry envision broader partnership and thus deserves support. (Stokes, 2005, p. 7)

Stokes makes some suggestions on ways in which the playing field can be leveled between the huge game companies and educational game projects above. For instance, *mods*, or game engine modifications, or can provide a means of altering a sophisticated commercial game for educational purposes. Universities can help build links between the game companies and themselves for mutual-benefit: Universities might provide a means of gaining market-share, game designers and programmers, etc., while also taking advantage of some of the tools and products of the game manufacturers. In addition, Universities might advance the open-source movement, which could help the industry gain some standard tools that everyone could use, thus bringing down the cost of development and raising interoperability between games. Massively Multiplayer Online Games (MMOGs) are mentioned by Zyda (2005) in a discussion of how the interoperability of games could advance online gaming:

> MMOGs pose the fundamental research question of how to develop dynamically extensible and semantically interoperable software architectures. This functionality requires building game or simulation clients than can connect to a running MMOG, download the appropriate code for display and interaction, then operate with other online players. (Zyda, 2005, p. 28)

A common architecture for MMOG game development could bring down the cost of creating the game, as well as provide a way for online games and online worlds to be 'semantically interoperable', so that online game players of one particular MMOG could interact with those playing another MMOG. This could help raise critical mass for some MMOGs, as well as create opportunities that were previously unimaginable.

Distribution is another major hurdle for educational games, as game manufacturers often throw huge dollar amounts at marketing their games to their audience, "often costing 20% beyond game development" (Stokes, 2005). These are huge costs that cannot be matched by many educational game producers. Utilizing non-standard communication channels (Internet, etc.) could help lower costs as TV and radio advertisements are very expensive. Part of a game development budget needs to be set aside for marketing the game: people will not play a game if they do not know it exists.

New game design companies may have a difficult time competing with their large-budget commercial game designer neighbors, but a few key hits could kick the company off to a good start. While the playing field might not be level, it still is possible for a small company with a great idea to gain acceptance in the gaming marketplace, which could help to kick-start a company into being able to

compete with commercial game designers. While the huge budgets of commercial designers allow for better special effects and well-designed game play, new revolutionary features can also sell products.

Finally, from the standpoint of educators, the success of small educational game companies might not be as important. It is important to design games with solid pedagogy from the start if they are to be used in education. However, it may also be possible to utilize commercial games for educational purposes. A well designed commercial game may offer things like entertainment and well structured goals to a student. Either way, educators must analyze all games for their pedagogy and educational benefit, making sure they fit with the learning goals of their classrooms.

2.1.4 *Features of Games That Support Learning*

In this section of the review, educational and game theories in the literature relating pedagogy and learning are discussed, focusing on tying game features with learning objectives. First, the focus is on learning objectives and higher order thinking skills, followed by introducing game challenges and goal orientation in games, with a discussion of how motivation plays a role. Narratives are briefly discussed, which can be used to glue a games' challenges together.

2.1.4.1 Goal Orientation and Authentic Learning Environments

Traditionally, computer-based instruction has provided an advantage in information access (Schank, 1996). While this is an obvious benefit of computer-based instruction, Schank introduces what he calls a *goal-based scenario*, which "provides motivation, context, and specific challenges as well as access to information." Schank lists three requirements of multimedia learning environments:

> In addition to providing access to useful information, an effective learning environment must do the following three interrelated things: Generate goals that will motivate students to access information; provide an authentic context in which to situate the knowledge students access; and confront students with specific challenges that require them to analyze the information they access, and put it to use. (Schank, 1996, p. 28)

Schank's components of effective learning environments can also be generalized to effective educational games. They too need to generate goals that motivate learners, provide an authentic learning context, and give students specific challenges whereby they can put their knowledge to use. An earlier paper by Schank (1993) discusses the same points which he calls "learning, Goal-pursuit, and memory", both of which involve goals, some sort of internalization of information by the learner, and then allowing the learner to demonstrate that

knowledge in some sort of activity. In both papers, Schank addresses the affordances of a learning environment as being very important in achieving the desired outcomes.

Shank (1993) argues that "outside school, people typically learn during their experiences while addressing desired goals." He refers to goal-based scenarios as 'learning by doing'. This approach supports what Squire (2005) is saying about the advantages of his gaming model (see Table 1): Games can produce hands-on, creative thinkers, who are better prepared for tomorrow's jobs. Squire mentions the ability of games to "present players complex holistic problems" (Squire, 2005, p. 3), which has similarities to Shank's 'goal-based scenarios'. Both focus learning around the learner, as the locus of control resides in the learner rather than the teacher, and both involve immersive environments with artifacts and tools for the user to find creative solutions to the problems they encounter. Stapleton (2004) states "simplistically speaking, the locus of control is typically afforded to players in games and teachers in schools." Stapleton (2004) explains this further:

> Games are environments specifically designed for players to experience interactively through play. Without the activity of the player there is no game; games are to be played by players. Consequently, the locus of

> control resides with the player as a learner. Now compare this with the environment that typically dominates many of today's schools. Here, it is the teacher who decides what to do next, when to do it, what the primary goal is, and so on. In short "a learner is asked to learn what the instructor thinks [s]he should learn" (Gargarian 1996, p. 149). Control and activity is primarily afforded to the teacher. (Stapleton, 2004, p. 2)

This is a key benefit of games and simulations: They allow the learner to take control and choose the path of learning.

2.1.4.2 *Authenticity and Fidelity of Educational Games*

The Federation of American Scientists (2006a) suggest that educational games are more than commercial games, in that they are designed with specific learning objectives in mind, and that they "must be built on the foundation of learning science ... with the purpose of instruction, not entertainment" (FAS, 2006a, p. 29). Squire's study using *Civilization III* used an 'off-the-shelf' game (a commercial game), which may have blended entertainment with instructional goals. This raises the question of authenticity and fidelity as part of an educational game's educational value: Instructional designers must be conscious of the learning goals they are supporting and try to balance them with the fun-factor of gaming.

The Federation of American Scientists (FAS) describes authenticity as "the degree to which the simulation causes cognitive processes similar to those in the real world" (FAS, 2006b, p. 8). They discuss in two categories: cognitive fidelity and physical fidelity. Cognitive fidelity concerns itself with accurate conceptual representations (such as properties, behavior, etc.) from the real world, while physical fidelity relates to the degree of accuracy of the representation (such as an object resembling its true form). For instance, when playing a flight simulator on a computer, one may fly an airplane using a keyboard (low physical fidelity), however cognitive fidelity may be higher as one goes through many of the same motions that a pilot would in the real world (controlling throttle, flaps, landing gear, etc).

A discussion of authenticity and fidelity is important in determining how accurate a game or simulation needs to be in order that knowledge can be transferred back to the real world (FAS, 2006b). While this perspective of learning (focusing on direct knowledge transfer) takes a large assumption on the definition of learning, it raises questions as to how accurate a game or simulation needs to be in order for this process to occur efficiently. While focusing on knowledge transfer takes a limited view of learning, research highlighting the degree of authenticity and fidelity required for efficient and accurate knowledge

transfer is useful. Convergence on common terminology would be useful to define the gray border separating games and simulations: many use the terms *games* and *simulations* interchangeably. Others classify games as a type of simulation, while others classify simulations as games.

Game and simulation designers must be cognizant of their goals while making games, one of which might be the accuracy of the game or simulation (for instance: a simulation used for training practices). Games and simulations can be used for learning, and designers have to manage tradeoffs during game design. An example tradeoff might be between a game's accuracy and its entertainment value, which must be resolved so that appropriate knowledge can be transferred back to the real world by the learner. Accuracy and fidelity should be balanced with many other game design variables. Providing an authentic environment can have the effect of raising applicability and a feeling of usefulness to the user; however, simulating reality too closely might remove some of the fun involved in a game (such as extending reality), potentially making the game boring. These are tradeoffs to be managed by the game designer, and are discussed in more detail later in the literature review.

2.1.4.3 Higher-Order Thinking and Problem Solving

Literature suggests that games can also provide an environment in which higher-order thinking is encouraged. The Federation of American Scientists (2006b) state that:

> Modern video games may develop higher order thinking skills, such as problem solving, strategic thinking, analysis, planning and executing, resource management, multi-tasking, decision-making in a fast-paced environment, and adapting to changing work scenarios. (FAS, 2006b, p. 1-2)

In addition, video games and simulations can change the nature of what is being learned. Games and simulations are by nature visual. Snir, Smith and Grosslight (1995) discuss simulations as a means to "give students the opportunity to witness or 'perform' experiments that might otherwise be too expensive, time consuming or too dangerous for them to do in the laboratory." The authors continue and call for the advent of what they call 'conceptually enhanced simulations' that can serve to simulate things that could not otherwise be observed in laboratory experiments, based on "models that provide explicit representations for sets of interrelated concepts". While this seems a bit vague if taken out of context, they discuss learning visually in terms of learning an expert's mental model (and understanding) of scientific concepts, a benefit

associated with situated learning (Lave & Wenger, 1991). Briefly, Johnson-Laird (1981) and Gentner & Stevens (1983) describe mental models, an idea which stems from cognitive psychology, as a perceptual, simplified model of something, used to both help explain reality and predict future events, having a structure similar to what it represents.

While learning an experts' mental model may make a good learning game or simulation, it may not be the most effective way of teaching. For instance, there may be intermediate mental models that require less understanding but are more effective at introducing a novice or intermediate to a concept, compared to 'leaping' to an expert mental model (White & Fredericksen, 1998). The idea of educational scaffolding supports this claim, as discussed by the Federation of American Scientists (2006b):

> Educational scaffolding, like building scaffolding, is a temporary supportive structure that gradually is moved until the structure is able to stand on its own. The support that is given in educational scaffolding comes in the form of modeling, and giving students cues, prompts, hints, and partial solutions. With scaffolding, learners are able to direct their own attention, plan, and control their activities. De Jong and van Joolingen (1998) outline three of the most promising strategies for building such scaffolding: ready access to domain-specific information, game-like assignments driven by questions and exercises, and a learning

> environment with model progression. Ready access to domain-specific information could be supplementary information that a student accesses upon request during the simulation, such as definitions of key terms. Game-like assignments would be filled with questions and exercises that actively engage and motivate the learner with interactive tasks. (FAS, 2006b, pp. 9-10)

As discussed above, scaffolding gives learners cues, hints, prompts, and partial solutions in order to advance their knowledge of a concept. This relates to what Snir, Smith and Grosslight (1995) discuss when advocating 'conceptually enhanced' simulations. Game and instructional designers must be aware of the audience they are designing their game or simulation for: In some cases, an expert mental model may be the best 'goal' to move students forward; while in other cases, there may be 'intermediate' mental models that will advance the student's knowledge faster or more easily. This is a pedagogical question for instructional designers to consider based on the intended audience and the subject being learned.

2.1.4.4 Motivation: Proper Game Challenges

Game challenges can both add or remove motivation for game players to keep playing. Ducheneaut et al. (2006a) studied game data from the game *World of Warcraft*, a very successful MMORPG (Massively Multiplayer Online Role-

Playing Game). The authors found a direct correspondence between the level number and the average time required for players to 'level-up' (go on to the next level), as shown in Figure 2:

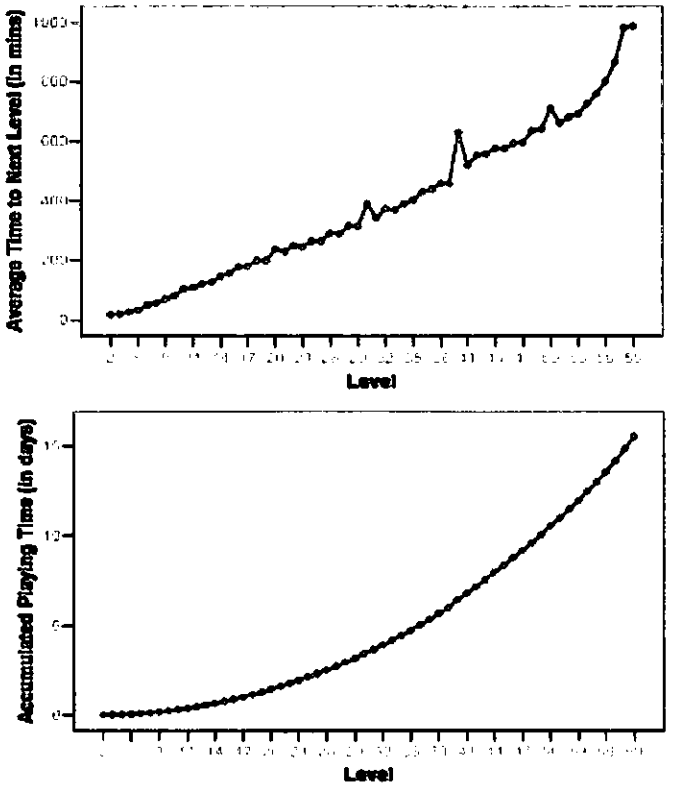

Figure 2: *World of Warcraft* 'Average time required to reach next level' vs. 'Average accumulated play time per level' (from Ducheneaut et al., 2006a, p. 409)

Graphing this created an almost perfectly exponential graph: the harder the level, the more play time required to reach it. This sheds light on the very addicting nature of *World of Warcraft*, as it shows that the game's difficulty structure is designed almost perfectly. The authors hypothesize that either a too-

difficult or too-easy level structure in a game leads to player boredom or frustration, while varying levels of difficulty are particularly annoying. *World of Warcraft*'s level structure is good at getting novices drawn into the game, and good at keeping skilled players motivated to continue playing. In addition, the slowly increasing level of difficulty keeps intermediate players from getting stuck too long on an unusually challenging level. An appropriate difficulty structure is one of many factors relating to a player's motivation to play a game.

Score keeping is another feature of games that can relate to player motivation. Score keeping is said to affect different types of players differently (FAS, 2006b). They state that there are two types of learners with respect to score keeping and game play: performance-oriented learners (often play at 'twitch' speed and go for high scores), and mastery-oriented learners (often play the game slower to take-in and master the game). The authors state that score keeping has its tradeoffs: while it can serve to direct attention on level of performance, it can also distract the process of generalizing the knowledge being learned. FAS describes performance-oriented learners as those that like to focus on their level of performance in a game (typically find a strategy or two that works, and stick with it), while mastery-oriented learners like to focus on mastering the subject they are learning (typically these learners go slow and

make sure they have a deeper understanding of the knowledge they are learning). Mastery oriented learners often have lower performance, but can generalize knowledge across domains better as they have focused on a deeper understanding of the subject. In a game, the FAS hypothesizes that score keeping favors performance-oriented learners, and can be distracting or annoying to mastery-oriented learners. Game designers should realize that score keeping suits performance-oriented learners, and may have a detrimental effect on the generalizability of knowledge learned in the game.

While classifying learners into groups may be useful for examining the ways in which different people learn, it seems that there could be an almost infinite supply of labels and groups to put people in. What is important to remember is that different people have different learning styles, and in creating an educational game, design decisions create game affordances that will be received and appropriated differently by different kinds of learners. Game designers can create games that present information in a variety of channels so that the learning styles encountered in the target audience are met.

Regarding motivation, a well-designed game should do a better job of motivating game players to return to the game. Hidi & Renninger (2006) describe individual interest as "a relatively enduring predisposition to reengage

with particular contents over time." The authors suggest a 'Four-Phase model of Interest Development' which can help in educational gaming environments. These four phases are: triggered situational interest (a short term spark); maintained situational interest (a prolonged situational interest); emerging [less-developed] individual interest (a longer term, personal mind-state, with a supporting environment); and well-developed individual interest (a long term mind-state, characterized by enjoying something very much). These four phases vary based on personal experience, genetics, and predisposition to the subject. Hidi & Renninger imply that the earlier stages are characterized by affect; while the latter stages are more cognitive in nature (the person has an innate curiosity and wants to return to the subject). The progression through the phases of interest development is typically not done in isolation: The teacher and the gaming environment can raise learners' curiosity and feeling of self-efficacy in order to move them through the phases outlined above. The teacher and gaming environment can help to scaffold interaction for the learner, structuring performance on the level of the learner. This is similar to Vygotsky's zone of proximal development, or "the distance between the actual developmental level as determined by independent problem solving and the level of potential

development as determined through problem solving under adult guidance, or in collaboration with more capable peers" (Vygotsky, 1978).

Motivation to play a game can come from various sources: Whether we have a curiosity about the subject, are drawn into the game through good gameplay and design, or by the game's goals and challenges which motivate us to 'win' or be successful in a game. An additional factor that provides motivation to game players that has not yet been discussed is narrative design, which is discussed subsequently.

2.1.4.5 Raising Motivation: Narrative Design & Goal Orientation

Narratives can 'glue' together the various challenges in a game, and add to the challenge presented in a game. The Federation of American Scientists (2006b) discuss game narratives as the 'glue' which helps gamers progress from mission to mission, and list three properties of game narratives: They stimulate curiosity (presenting an adventure, thus adding to player motivation); they set the proper pace for the game (to make the learning engaging); and that game designers must strive to seek a balance between plot and goal achievement (too much of one or the other can have a negative effect on gameplay). These points highlight game design issues that must be considered: a proper pace must be set for the game in order for the highest potential engagement; and a balance in the

amount of narrative in the game should be reached. Too much narrative can cause a lack of action on the learner's part, while too little can have a negative effect on motivating the learner and holding together the games' components. Once again, these are tradeoffs to be balanced by the game and instructional designers. The FAS mentions that most games' narrative structure is 'lightly branching', or slightly dynamic; game players have some control of their path in the game, but cannot get too far off course. A more complex branching structure could mean more freedom and options for the game player, but could also be a source for reaching 'unrecoverable errors' due to the added complexity of the game narrative.

Zyda (2005) mentions the complexity of narrative design in online games: "Creating a compelling computer-generated story has long been a game development challenge. To overcome this challenge, developers must computationally model story by deploying engines and tool suites that dramatically simplify the construction of networked game storylines." Narratives are more than simple plots to a game; they hold the components of a game together and can become very complex, especially for online games. MMOGs (Massively Multiplayer Online Games) are discussed later in the

review: while they are a variety of game; their properties (including narrative design and narrative complexity) differ somewhat from a traditional game.

2.1.5 *A Brief discussion of MMOGs and MMORPGs*

Massively Multiplayer Online Games (MMOGs) and Massively Multiplayer Online Role Playing Games (MMORPGs) have unique properties in comparison to other types of games, and are discussed briefly in this section of the literature review. MMOGs can be approached from a social perspective, studying how collaborative learning occurs in these games and how this learning might be generalized to (and used in) the real world.

2.1.5.1 Categories of Research: The PlayOn Project at Xerox PARC

The PlayOn project at Xerox PARC (Palo Alto Research Center) examines the "the social dimensions of massively multiplayer online games (MMOGs) and virtual worlds - extensive, persistent 3D environments that are populated by thousands of players at any given moment" (PlayOn Project, 2007). In their research they aim to focus on three issues relating to MMOGs: community (game communities and guidelines for the 'social architecture' of MMOGs); interaction (communication between avatars in MMOGs and guidelines for improving the social interaction); and culture (how player cultures and

socialization emerge and become shared across MMOGs). Their research groups highlight the trends in MMOG research and can help classify its findings. Many topics, such as avatars (online identities), can be examined from multiple perspectives.

2.1.5.2 A Brief History of MMOGs

Thomas & Brown (2006) outline some of the history leading up to today's online games, starting with MUDs (Multi-User Dungeons):

> In 1979, Roy Trubshaw and Richard Bartle created an online world called MUD, the first multi-user adventure game accessible online. The game was enormously popular and was eventually licensed to CompuServe where it ran until 1999. The idea behind the first MUD, which has spawned hundreds of other similar games, was to provide a virtual environment where players used text to create and describe the world they inhabited. The virtual worlds were games, but they were also literary worlds. Not surprisingly many MUD-like worlds which have spawned in the last decades have, themselves, been literary themed worlds where players create characters in contexts such as J.K. Rowling's Harry Potter novels, Frank Herbert's Dune universe, the Dragonlance series of books, or John Norman's world of Gor, to name only a few. In these worlds, players provide textual descriptions of who they are, what they look like and how they act and react to others in the world. They are worlds in which role-playing is valued and players are judged by how well they

> pose within the world. In that sense, MUDs were text based games, which afforded users a high degree of control over how they created and played the characters they invented. Because these worlds that were the products of a large number of people playing together, MUDs were also the first persistent games, meaning when a player logged off, the world continued functioning without them. (Thomas & Brown, 2006, p. 2)

The author describes console video games during the same time period, moving from what Prensky labels *twitch games*, or those that originated in arcades and required quick responses (*Pac Man*, *Pong*, many modern fighting games such as *Mortal Kombat*) to those with complex plots and storylines (*Zelda*, many modern quest games such as *Oblivion*), which lead up to MMOGs being played today (such as *World of Warcraft*) as shown below in Figure 3:

Figure 3: Screenshot from Blizzard Entertainment's *World of Warcraft* (from Thomas & Brown, 2006)

Massively Multiplayer Online Games (MMOGs) are a unique area of gaming research that is interesting to study in that it provides a way of studying group interaction in a gaming environment. Yee (2006) describes three types of games: stand-alone (such as Sim City); LAN / WAN (such as Age of Empires); and MMORPG (such as *World of Warcraft*). Foreman, Gee, Herz, Hinrichs, Prensky, & Sawyer (2004) discuss some of the affordances of games; they: promote community building; encourage discourse and negotiation; are collaborative so groups can co-think through problems (trade controller

depending on who's better at the task, thus dynamically allocating resources) and involve distributed social decision making processes. While it is possible to study these processes watching groups play an individual game; many of these features of games could easily be studied watching group interaction and group dynamics in an online game.

2.1.5.3 Player Gratifications

Yee (2006) hypothesizes that MMOGs have a multi-faceted appeal in that they gratify five game player motivations: achievement; relationship; immersion; escapism; and manipulation. Yee found many social science questions that could be researched: he found typically females favor the relationship factor, while males favor achievement. Some of the demographic information he found was that MMOG players average 22 hours per week playing time, and that the average age of players is around 30 years old, with players of both sexes from many different cultures.

Yee saw interesting and complex social phenomenon in MMOGs such as virtual characters (avatars) getting virtually married, choosing avatars of the opposite sex, or choosing avatars of qualities they wished to project (such as choosing to appear as a knight in shining armor). Yee found that MMOGs favor positive social interactions: people have greater anonymity; physical appearance

is less important; the Internet transcends physical space problems; and users have more control over the time and pace of their interactions (Yee, 2006, p. 12-13). Yee concluded that MMOGs are "more than just games" because of the interesting, unique phenomena and culture they exhibit. Game players exhibited qualities showing a high degree of immersion, taking their virtual lives quite seriously.

Thomas and Brown describe three main features of MMOGs that make them interesting to study and a new environment for learning:

> MMOGs are game spaces which combine three things: player created avatars, game mechanics (usually in the form of quests or missions involving combat, resource acquisition, or exploration), and a complex social, economic, and cultural network which has a direct and deep impact on how meaning and actions are valued and interpreted by players within the world itself.
>
> It is the combination of these elements, which we believe makes MMOGs a unique space for a new form of learning, one which produces new dispositional stances, exercises the play of imagination, and provides for a complex sense of agency. (Thomas & Brown, 2006, p. 7)

The authors continue to discuss how MMOGs blend the idea of learning and play, where players develop an understanding of the social world they are

playing the game in, as well as shape it. While MMOGs have a persistent game state (the game is always running online, and players come and go), it also has a constantly evolving social system and culture that evolves over time.

2.1.5.4 Identity Management in MMORPGs

Much research is devoted to the exploration of virtual identities, also called avatars, in online games. For instance, in *World of Warcraft*, players can choose characters from different characters, sexes, and classes as see in Figure 4:

Figure 4: Screenshot showing character selection in *World of Warcraft*

Players can customize their appearance and choose a character that suits their needs in playing the game. Each character set and class have different attributes, so the choice in a player's character determines much of their experience in the game, such as what missions they choose, what social groups they join, and their status within a social group. Forming groups of various identities can be useful in particular situations in the game where players can benefit from working on a task as a group, thus taking advantage of the variety of character attributes in order to succeed, as mentioned by Thomas & Brown (2006):

> One of the things that differentiate MMOGs from other types of games is the dynamics of coordinated action. Every character class in an MMOG has a skill set that helps the character with personal achievement (advancement and leveling), but it will also have skills that are most useful only in conjunction with other players. A sense of agency emerges, primarily, as the result of coordinated, joint action with the diversity of roles within the group. Instances or dungeons are prime examples. Instances are quests which require a group of players (from 5 to 40, in *World of Warcraft* for example) to complete. Moreover, these groups must be composed of different, complementary character classes to succeed. Character classes are often understood in terms of their abilities, such as tanking (the ability to distract enemies and draw their attacks toward yourself, called "holding aggro," in order to keep other party members

> safe, usually done by warriors), DPS (characters which inflict large amounts of damage, the name referring to "damage per second," usually done by mages and rogues), and healers (characters who can regenerate health in other party members, usually done by priests, shamans, and paladins). In a successful group, the three must function as a unit: the tank "holds aggro" while the healer keeps the tank alive and the DPS party members kill the target. (Thomas & Brown, 2006, p. 10)

Characters develop a sense of their role and an identity within a group or 'guild' when they work together in a team as described above. They can also teach empathy for other gamers as well as situational awareness (Ducheneaut & Moore, 2004a). These social groups serve multiple purposes in the game: referring to the PlayOn Project (Xerox PARC, mentioned above), guilds serve multiple purposes: they are community building, they add to the sociability and communication done in the game, and form a 'virtual culture' within the game.

Donath (1988) describes identity as being "essential for understanding and evaluating an interaction" in *Identity and Deception in the Virtual Community*. In virtual worlds, many of the communication mechanisms and non-verbal communication behaviors are not present. Donath argues that "In the disembodied world of the virtual community, identity is also ambiguous. Many of the basic cues about personality and social role we are accustomed to in the

physical world are absent" (Donath, 1988, p. 1). While less information and communication channels are available, they are not totally unavailable, and people can utilize the channels available to attempt to communicate as effectively as possible and avoid deception. Traditionally, identity was associated with one body (a one-to-one relationship). These identities could not be discarded, as they were tied to an individual. With virtual identity, the one-to-one relationship disappears: people can have no identity (remaining anonymous), have a single virtual identity, or have multiple virtual identities. They can also easily deceive (such as a male posing as a female in their virtual identity). In addition, virtual identities can be discarded, allowing those with poor user profiles to drop the profile and start over with a new one, if desired. These problems highlight some of the aspects of evaluating virtual identity, which is often very difficult.

Ducheneaut & Moore (2004b) discuss 'alts', or alternate virtual identities in a game, as "gamers rarely have a single identity: instead they manage an array of 'alts' that they use depending on their gaming context" (Ducheneaut & Moore, 2004b, p. 1). These 'alts' vary across a single game: players can use multiple identities in a single game; and vary across different games (different avatars are created across different games). Research has been proposed that asks whether an online identity could be used across multiple MMOGs, and

whether some sort of reputation system could be built that accounts for reputation across games, as gamers appear as a novice when first entering a new game, even though they may have much experience playing within that particular game genre.

2.1.5.5 Group Communication Mechanisms and Social Learning

Ducheneaut & Moore (2004a) describe four ways in which social learning occurs in MMOGs: through "self-organization among players" in activities such as group creation; through "instrumental coordination" where players work together in a game to accomplish the games' objectives; through "in-game sociability" in which players socialize in a game through things like small-talk and humor; and through "helping behavior" in which players share knowledge among one another in order to help other group members along in the game, as well as to coordinate action among group members.

Research by Steinkuehler (2004) suggests that players in MMOGs learn not only from the immediate feedback from the game itself (successes and failures), but from other players as well. Other more advanced players in the game often lend help within MMOGs, which add to the social aspect of learning in MMOGs. Ducheneaut & Moore (2004c) discuss a MMORPG called *Star Wars Galaxies* in which players often help other players in the game. Portions of the

game require the apprenticeship of a lower-level player in order to succeed at specific game goals. This feature of the game encourages social interactions, as well as provides newer players in learning the communication interface.

Many of the communication mechanisms in MMOGs are based on synchronous communication. Some games are adopting the use of VoIP (Voice-over IP) where players can actually talk to each other using microphones as input to the game. It is proposed that this will change the nature of communication (Donath, 1988; Ducheneaut, Yee, Nickell, & Moore, 2006c) as social processes may be changed by the change in medium, through the addition of social and verbal cues. Anonymity in virtual avatars could be sacrificed as well, as communication could convey things such as gender, age, culture, etc.

2.1.5.6 Community Building

Resnick (2002) describes social capital as a way of accumulating social ties among one another, through concepts such as trust and identity, where "social structures and dynamics" emerge as a byproduct, and are generally "beneficial to individuals, the network as a whole, or society at large". Resnick proposes that new ways of civic participation be found that accumulate what he terms 'socio-technical capital' in virtual environments. Ducheneaut, Yee, Nickell, & Moore (2006c) look at MMOGs as a way of building social capital through group

formation. Their research examines guild formation and structure, looking for patterns in membership, churn rate, and leadership in the guilds. As the title "From tree house to barracks" suggests, the authors analyze structural differences in guilds (tree houses being informal, come and go as one pleases; while barracks are structured formally, similar to military structures), and the effects these structures have on the group membership.

Besides guilds (within game social groups), other off screen communities exist that support many popular MMOGs. For instance, there are many web sites devoted to providing strategies and information about a MMOG (similar to a community of practice), creating a social network of game players that is loosely structured, yet still adds to the social capital of the game. The value of guilds and its benefit to society could be explored through further study.

2.1.5.7 Gender

Literature suggests differences in video game attitudes and performance according to gender (Brown, et. al, 1997). This might be related to differences among gender in reinforcement history (Bandura, 1977), as well as differences in aggressive tendencies between gender, and gaming experience between gender (Brown, et. al, 1997). However, literature suggests that gaming demographics are rapidly changing: Yee (2006) discusses how more of the gaming population

is represented by women and the average age of gamers is climbing. While gender, age and cultural differences are interesting to study, each individual should not be stereotyped into following a particular behavior pattern. Additionally, as games grow in popularity and appeal to a wider audience, demographics will become less of an issue for game players (the playing field is leveling among those of different gender, age, culture, etc.).

2.1.5.8 Group Flow

Mihaly Csikszentmihalyi (1990) describes the idea of individual *flow* as a "mental state of operation in which the person is fully immersed in what he or she is doing, characterized by a feeling of energized focus, full involvement, and success in the process of the activity." Csikszentmihalyi (1990) suggests several ways in which groups can work together so that each individual member of the group can achieve *flow*, or an optimal experience, through things such as the spatial arrangements of the physical workspace or the nature of the in-group collaboration. (Flow is further defined in a later section.) While many of these suggestions were thought of with a traditional group in mind, they still could shed insight for achieving flow in a group situation in an online game. Imagining gamers playing an online game, one might see individuals interacting with computers; however, objectively there exists a group of avatars interacting

in a virtual environment. Csikszentmihalyi's theory of group flow may precede the virtual era, but may be generalized to discuss what happens in a virtual environment. MMOGs may not have some of the spatial features listed above, but do have virtual spaces that can be designed to promote group flow. Later in the literature review, collaborative learning and group design are discussed in greater depth.

2.1.5.9 Distributed Cognition: A Potential Tool for MMOG Analysis

Briefly, distributed cognition and group cognition are theories about group dynamics and learning that discuss how groups go about achieving tasks. These two theories take different angles, but address similar things, and are expanded on in Section 2.2 of the literature review. Distributed cognition is described as a way to understand how collective action manifests at the systems level rather than the individual level (Hutchins, 1995; Carroll, 2003); whereas group cognition is defined as something where "meaning is constructed in group collaboration, which is then subject to individual interpretation" involving 'shared knowledge' or something "interactively achieved in discourse and may not be attributable as originating from any particular individual" (Stahl, 2005). Group cognition and distributed cognition (Hutchins, 1995) are discussed in

greater depth in the second section of the literature review, which focuses on cognition and collaborative learning.

Distributed and group cognition could be useful theoretical perspectives to research in MMOGs, as they provide a virtual environment where groups can work together to achieve tasks. It might be possible that a different 'kind' of learning is done in these environments, compared to traditional virtual environments of individually played video games. If so, research could be done that examines how learning may be different in an educational, multiplayer virtual environment or game compared to individually played games.

A reflection process could be studied in correlation with MMOGs. Stahl refers to 'shared knowledge' as something "interactively achieved in discourse and may not be attributable as originating from any particular individual" (p.81), and which involves four components: it is produced; negotiated; distributed; and internalized. This process might be emulated in an educational online environment and in MMOGs in order to utilize the benefits of gaming as well as the benefits of group tasks and collaboration. This provides an opportunity for researchers to see the ways in which multiplayer games can enable social interaction and individual reflection processes.

2.1.6 *Additional Benefits of Games for Educational Environments*

2.1.6.1 Immersion and Engagement

Games are "the most engaging intellectual pastime that we have invented" (Foreman et al., 2004). Prensky (2001) lists reasons why games are engaging, because "give us enjoyment and pleasure; give us intense and passionate involvement; give us structure; give us motivation; give us doing; give us flow; give us learning; give us ego gratification; give us adrenaline; they spark our creativity; give us social groups; and give us emotion" (Prensky, 2001, p. 144).

Flow (Csikszentmihalyi, 1990) can be used to describe a feeling of captivation and immersion in a game. Game designers can focus on this idea of flow in which game players feel pulled into a game, losing track of the outside world. Some of the properties of flow include the development of clear goals, feeling engaged in a rewarding activity, high concentration, a loss of the feeling of self-consciousness, a distorted view of time, and a feeling of direct control over the activity. This can be accomplished in a game through a well designed interface with appropriate feedback, with an appropriate difficulty structure.

Not all of the components of flow are needed for the experience of flow. However, negative flow can be experienced by a disturbance in the environment,

or a disturbance to one's concentration caused by a poorly designed interface (errors, lack of feedback, etc), in line with Norman's (1988) idea of technological affordances and good interface design (Norman, 1988).

The components of flow could easily be ported to game design. A common feature between this and human-computer interaction (HCI) theory is the description of the non-disturbing environment. In a game, errors can be a big cause of disruption, which can interrupt flow. Norman (1988) discusses how critical errors can cause the human-computer system to go astray, getting into a non-recoverable state. This can happen in a game, which is a good reason for user-testing so that game players do not get stuck, frustrated, or give up (interrupting their 'flow'). This relates to one of Jakob Nielsen's Ten Usability Heuristics: to help users recognize, diagnose, and recover from errors, and to provide plain and simple error messages with constructive suggestions for correction (Nielsen, 1994).

Immersion could be defined in multiple ways: Either a degree of feeling to which a game can pull one in (similar to Csikszentmihalyi's flow); or as a physical variable, such as 3-D virtual reality goggles having a high degree of physical or sensory engagement. Emphasis is on the first of these two definitions, examining ways in which higher immersion can be experienced by

the user as a result of gameplay. Focus is put on the emotional and intellectual experience, rather than looking at the physical hardware. The next part of the literature review discusses how immersion could be increased by raising the dimensions and channels of human communication utilized in a game.

Human communication theory could be discussed at length, and much discussion could be devoted to this topic with regard to games. For example, relevant theories include: uses and gratifications theory; politeness and face theory; pragmatics; a discussion of speech acts; self-disclosure and conversational implicature; and conversational and cultural maxims. However, the next topic discusses human communication specifically focusing on the bandwidth of communication (compared to face-to-face communication) being done in immersive, virtual environments.

2.1.6.2 *Simulated Actors: Supporting Human Communication and Behavior*

A complex relationship exists between motivation, immersion and the extent to which avatars can express human communication and emotion. An important aspect of immersion and engagement is the degree to which human communication is supported, including the degree to which a game can portray and evoke human emotion. Zyda (2005) discusses the complexity of modeling human emotion in a game:

> The modeling and simulation of human emotion lies at the frontier of networked games and simulations. For the entertainment world, the future of gaming includes developing an experience so immersive that it engages the players' emotions on a visceral level. The military, homeland security, defense, and hospital trauma sectors need a similar game-based simulation capability that spans the spectrum of entertainment and serious game developers. This capability must be thoroughly researched to determine in advance its potential human impact. (Zyda, 2005, p. 29)

Zyda predicts that much advancement can come out of research on adding human emotion to games. He explains the potential of games to evoke visceral, emotional responses from its players. The military and other training applications could make use of games with these features, and the game industry could benefit from introducing these features into some of their titles (Zyda, 2005):

> Affective computing measures a person's physical and emotional state. In the next two years, low-cost sensors will become available that measure a player's emotional state and provide this information as input when running a game. Software development kits that read those devices and transmit the player's emotional state to the game will need to be developed. In turn, the game must be able to use that state along with many other inputs and respond appropriately. Although this capability will have a major impact, at this point developers do not really know how

> this process will work, partly because they lack good models of human emotions and of how computer characters should react to them.
>
> Game designers must understand these things if they are to engineer and implement these capabilities so that these features behave predictably and reliably. This type of research effort could broaden the scope of both entertainment and serious games. Ultimately, a video game may not only make us cry, it may be aware that we are crying and respond appropriately. (Zyda, 2005, p. 30)

Zyda predicts the advent of sensors that will detect human emotion in the near future, but warns that computational models of human emotion need to be created first so that appropriate interaction can occur.

W. Lewis Johnson at the *Center for Advanced Research in Technology for Education* (CARTE) at the University of Southern California discusses socially-intelligent agents (Socially Intelligent Agents at CARTE, 2006). They describe their project as follows:

> The Social Intelligence Project is developing animated pedagogical agents with well-developed social skills, which they can employ to promote learning. The goal is to create agents that exhibit expressiveness (the ability to convey emotions and attitudes), empathy (sensitivity to learner motivational and emotional states), and politeness (an understanding of

when and how to interact in socially appropriate ways) (CARTE web site, 2007).

Their purpose is to develop agents or simulated actors that can exhibit the kind of behavior discussed above by Zyda. Within a game, this may be referred to the artificial intelligence being programmed into the game's computer-generated characters. Either way, the goal is to increase the level of learning and motivation to play the game by increasing the sophistication of the human communication being done by the simulated actors or agents. CARTE also aims to add pedagogical value as well by adding an educational purpose to the agents in addition to their advanced social and human communication skills (Johnson, Kole, Shaw & Pain, 2007).

Zyda discusses games in which human emotion can be modeled so that games can evoke emotional responses from game players. This relies on the game's ability to detect and model human emotion, and its ability to maximize human communication channels such as non-verbal behavior. The degree to which a game can simulate face-to-face communication will also be a factor in the quality of interaction between the game's simulated actors and the game players- or in the case of online games, between a game player and other game players.

Traum & Rickel (2002) express that "perhaps the greatest challenge in creating virtual humans for interactive experiences is supporting face-to-face communication among people and virtual humans" (Traum & Rickel, 2002, p. 766). The author continues to say that current computational models do not support face-to-face communication in a 3D environment, mainly due to three factors:

> On one hand, virtual worlds are an ideal application for current spoken language technology: they provide a microworld where conversation can legitimately be restricted to the events and objects within its confines. On the other hand, they raise issues that have received relatively little attention in computational linguistics. First, face-to-face communication in virtual worlds requires attention to all the nonverbal signals (e.g., gaze, gestures, and facial displays) that accompany human speech. Second, conversations that are situated in a 3D world raise a host of issues, including the attentional focus of the conversants, whether and to what degree they can see and hear one another, and the relative locations of conversants and the objects they are discussing. Finally, since there will typically be multiple real and virtual people, virtual worlds require support for multi-party conversations, including the ability to reason about the active participants in a conversation as well as who else might be listening or unaware of what happens in a conversation. While there has been some early work in the area of embodied conversational agents, and some of this work has addressed human-agent dialogues situated in

3D virtual worlds, there is currently no general model of such dialogues. (Traum & Rickel, 2002, p. 766)

The authors mention some of the shortcomings of embodied conversational agents (simulated actors) by describing some of the features found in face-to-face communication that are not supported in most 3D environments. There have been strides made since this article was published (2002): For example, the application *Second Life* supports gesturing and some basic conversational features, but still lacks much of the complexity found in face-to-face communication as it is very difficult to model and control through a simple user interface (game controller, keyboard / mouse, etc.).

2.1.7 Summary

Section 2.1 of the literature review discussed the many aspects of research being done in gaming, specifically those focusing on educational contexts. Much of the literature explains at length the benefits of introducing video games into an educational context, typically comparing some of the sets of features of games with educational outcomes.

It is important to realize the many components of the involved concepts: gaming, traditional classrooms, and learning. Each of these concepts has many components associated with it, which are important to understand when

analyzing research data. The use of games has many tradeoffs to be considered when being substituted for traditional forms of teaching. Traditional classrooms and teaching standards might pose problems for the implementation of games in the classroom, and a thorough investigation of learning is required in order to address the concerns of those hesitant to use games for educational purposes.

As mentioned previously, this study will focus on an in-depth analysis of the learning process when using games in a school setting, focusing on collaborative learning between students, other groups of students, and teachers; as well as an investigation of the relationship between the student and the game interface and its associated affordances. Section 2.2 of the literature review will introduce the theoretical background necessary to investigate these concepts and introduce how the learning process in the context of video games in education might be analyzed in light of these theories.

2.2 *Collaborative Learning and Cognition in the Context of Video Game Play: An Introduction to Influential Methods and Concepts*

This section of the literature review introduces many topics coming from Computer Supported Collaborative Learning (CSCL), Human-Computer Interaction (HCI), Psychology and Sociology. Specifically, topics such as affordances, collaboration, social and individual cognitive theories with respect to learning, and qualitative research methods drawing from ethnomethodology and grounded theory are introduced. These ideas are vital for understanding the methodology and discussion, and answering the research questions outlined in the introduction which aim to produce a descriptive inquiry into the use of games for learning.

Section 2.2 of the literature review has three parts:

(a) Discussion of existing theories relevant to collaborative game play. Some of these theories are later referenced in the discussion chapter, where this study's findings are compared with existing theory. Candidate theories include theories of collaborative learning, and activity theory

(b) Discussion of affordances, highlighting the inclusion of social and cognitive affordances and their use in studying learning

(c) Discussion of the theoretical foundation for the methods chapter, outlining ethnomethodology and grounded theory as a means of conducting descriptive, qualitative research studying the collaborative use of video games

2.2.1 *Collaborative Learning, Activity Theory, and Distributed Cognition*

Webb & Palincsar (1996) discuss the history of collaborative learning in the 20th century in their chapter *Group Processes in the Classroom*. Social psychology and sociology have both studied the impacts of the individual and social worlds on group tasks. Much of the initial work asked how groups function as a whole, and whether a group is more than the sum of its parts (or whether work can be done more efficiently individually). Of course, that depends on the nature of the task: for example, individuals might excel when the task requires long concentration, while the group could be 'more than the sum of its parts' in other circumstances that required more coordination than concentration.

Group task structure was questioned in the 1950s and 60s (Webb & Palincsar, 1996). Webb & Palincsar (1996) note the debate over cooperative vs.

competitive task structures during this time period, with studies focusing on which was better for a given task. Competitive task structures raise the competition between group members, which showed an increase in conflict between members, while cooperative tasks seemed to work best when the reward structures were created properly. This is discussed in more detail later in the literature review.

2.2.1.1 Cognition and Group Tasks

In the last few decades, various theoretical perspectives on cognition have addressed how learning occurs in group contexts. There exists a continuum of theory that focuses on learning at the individual level to learning at the group level: socio-cognitive / socio-constructivist (Piaget), focusing on learning through a process of cognitive disequilibrium; socio-cultural and socio-historical (Vygotsky, activity theory) where learning takes place as a transformation between the social and individual planes; and distributed cognition and group cognition (Hutchins, Stahl) where learning takes place at the group level of analysis (Webb & Palincsar, 1996; Dillenbourg, Baker, Blaye, & O'Malley, 1996).

2.2.1.2 Socio-Constructivism and Socio-Cognitive Conflict Theory

Webb & Palincsar (1996) discuss constructivism: "constructivism holds that cognition is an outcome of social processes" where "knowledge or meaning results from individuals' interpretations of their experiences in particular contexts" (Webb & Palincsar, 1996, p. 844). Piaget (1985, as cited in Webb & Palincsar, 1996) describes a process of socio-cognitive conflict, where "[disequilibrium] forces the subject to go beyond his current state and strike out in new directions" (Webb & Palincsar, 1996, p. 10) where conflict in the social realm causes reevaluation in the cognitive realm. Disequilibrium, as described by Piaget, challenges or upsets one's way of thinking. The disequilibrium serves as a catalyst for individuals to find a different way of thinking about things so that the conflict (in the social realm) can be resolved.

Webb & Palincsar (1996) cite Piaget (1976) and Damon (1984) in their argument of why peer collaboration can be most efficient. Piaget (1976) discusses how children interacting with adults may be less likely to lead to cognitive development, since the adult and child are at such different levels of thinking: the child is less likely to create cognitive conflict, and cannot as easily share in the adult's point of view. Damon (1984) describes peers as good sources of cognitive conflict because peers are more likely to: speak at a level the child

can understand; challenge one another than to challenge an adult; take feedback from each other seriously; reconcile contradictions; and communicate to correct contradictions because the communication is less threatening. Many of these ideas are borrowed from a discussion of communication theory and culture (such as Brown & Levinson's discussion of politeness and face theory, as well as Hofstede's discussion of power distance).

With regard to video games in education: it is interesting to monitor peer collaboration from this viewpoint. This discussion by Piaget and Damen highlights why it can be very useful to pair students into groups, as can be seen in Figure 10. Depending on the viewpoint taken, socio-cognitive conflict can be an interesting way to make sense out of the social interactions between students, and observe the ways in which conflict is resolved. This is discussed further later in the analysis and discussion chapters. Webb and Palincsar (1996) summarize socio-cognitive conflict theory well in stating "although social interaction is regarded as essential for learning, the social interaction is considered from the perspective of how effective it is in creating conflict within the individual. From this perspective we begin by considering the individual [first] and then move to the social interaction" (Webb & Palincsar, 1996, p. 845).

2.2.1.3 Socio-cultural and Cultural-Historical Activity Theory (CHAT)

According to Vygotsky, "the social dimension of consciousness is primary in time and in fact. The individual dimension of consciousness is derivative and secondary" (Vygotsky, 1979, as cited in Webb & Palincsar, 1996). Vygotsky views collaborative learning as a process that puts the social plane first, which then moves to the internal plane through a process of internalization:

> Any function in the child's cultural development appears twice, or in two planes. First it appears on the social plane, and then on the psychological plane. First is appears between people as an interpsychological category, and then within the child as an intrapsychological category. This is equally true with regard to voluntary attention, logical memory, the formation of concepts, and the development of volition. ... It goes without saying that internalization transforms the process itself and changes its structure and functions. Social relations or relations among people genetically underlie all high functions and their relationships. (Vygotsky, 1981, p. 163)

Vygotsky (1978) takes a cultural-historical approach to cognition. Vygotsky discussed the *zone of proximal development* as an evaluation of "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through

problem solving under adult guidance or in collaboration with more capable peers."

In contrast to Piaget and Damen (who suggest that optimal learning occurs with peers of a similar level), Vygotsky suggests that an optimal learning environment exists in which learning occurs most efficiently with the guidance of a more capable individual. With regard to learning through video games, guidance could come from the teacher, a lab monitor, a more capable peer, or from the game interface itself (through the suggestion of social and cognitive affordances).

Kaptelinin & Nardi (2006) introduce activity theory, citing Leontiev's (1978) concept of an activity as being concerned with the relationship between *subject* and *object*. Activity theory stems from cultural-historical psychology (Vygotsky, 1978; Leontiev, 1978; Cole & Engestrom, 1993; Kaptelinin & Nardi, 2006) and Russian psychology (Leontiev was a disciple of Vygotsky and his first studies were supervised by Vygotsky, who drew the concept of activity from Basov). In activity theory, activity is the most basic unit of analysis. Leontiev claims that properties of the subject and object only appear during the activity itself, and that the activity is the key source of development for both subject and object. Human activity serves to gratify needs, both biological and

psychological. Leontiev describes the *true motive* of an activity as "the most important attribute differentiating one activity from another" and that when "a need becomes coupled with an object, an activity emerges... from that moment on, the object becomes a motive and the need not only stimulates but also directs the subject" (Kaptelinin & Nardi, 2006).

Blending Vygotskian cultural-historical psychology with Leontiev's activity theory, *Cultural-Historical Activity Theory* (CHAT) is introduced. Similarly, CHAT concerns itself with the relationship of the individual mind with that of society by examining the relationship between subject, object and mediating artifact, as seen in Figure 5:

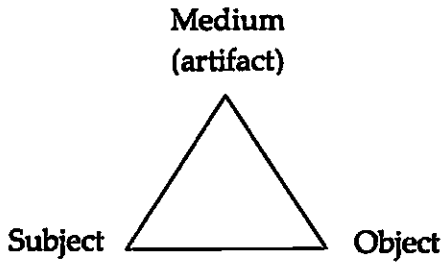

Figure 5: The basic mediational triangle, adapted from Cole & Engestrom (1993, p. 5)

Cole & Engestrom (1993) extend this basic mediational triangle, adding the social aspects of community, rules and division of labor, as seen in Figure 6:

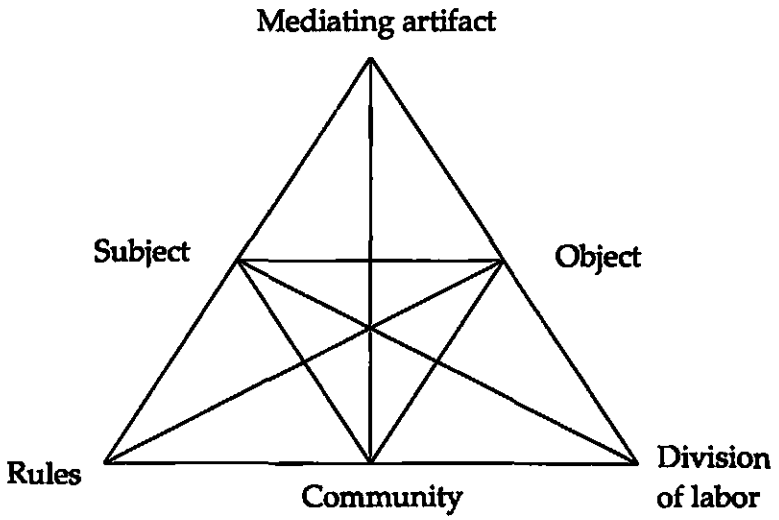

Figure 6: The basic mediational triangle expanded to show community, social rules, and the division of labor, adapted from Cole & Engestrom (1993, p. 8)

Cole & Engestrom (1993) provide the diagrams in Figures 5 and 6 (their work extended Figure 5 to the additions made in Figure 6), and provide a means for studying their main unit of analysis: a motivated activity. This is particularly useful for studying computer-mediated activity, and can be applied as a descriptive tool when analyzing students playing video games. Pairs of links in Figure 6 and 7 can be analyzed to examine mediational roles (of the item at the vertex of the links; i.e. how rules mediate between subject and community, etc.), providing a good conceptual diagram with which to frame students' activities. Figure 6 is examined with respect to this study, as shown in Figure 7:

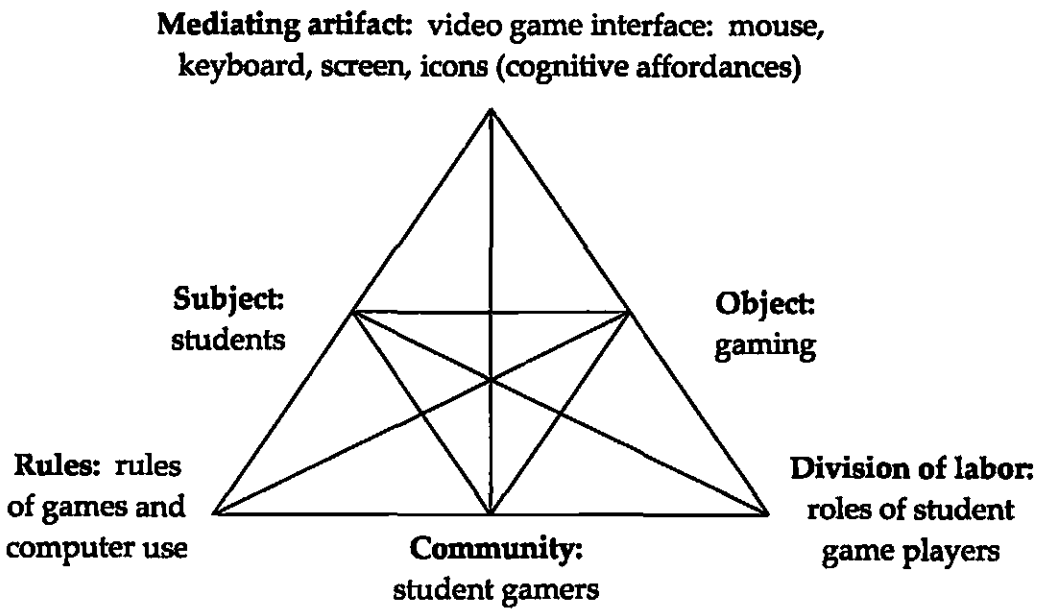

Figure 7: Example of educational gaming using Cole & Engestrom's mediational triangle (1993, p. 8)

The roles of subjects, objects and community can be studied by examining the mediating artifacts, rules, and division of labor: focusing on educational gaming, it is possible to analyze students, gaming to learn, and the student-gamer community by examining the video game interface and its cognitive affordances, the rules of computer game play and school computer use, as well as the roles of student game players in playing the game. Cole & Engestrom (1993) further their diagram in Figure 6 by adding an object – outcome link, which focuses on the outcomes expected by the object through the activity. In this case (in Figure 7), outcomes could be some sort of educational outcome:

such as students learning by playing the game (in comparison to traditional instruction).

2.2.1.4 Distributed Cognition, Group Cognition and Interpretation

As in CHAT, distributed cognition takes a socio-cultural and socio-historical perspective on learning, and focuses on the entire system of artifacts and actors as a cognitive entity carrying out tasks. Hollan, Hutchins, and Kirsh (2002) outline three fundamental properties of human activity "in the wild": "cognitive processes may be distributed across the members of a social group; cognitive processes may involve coordination between internal and external (material or environmental) structure; and processes may be distributed through time in such a way that the products of earlier events can transform the nature of later events" (Hollan, Hutchins, & Kirsh, 2002, p. 3). Hollan, Hutchins, & Kirsh (2002) further discuss distributed cognition and its cultural-historical perspective:

> Permitting the boundary of the unit of analysis to move out beyond the skin situates the individual as an element in a complex cultural environment. In doing this, we find that cognition is no longer isolated from culture or separate from it. Where cognitive science traditionally views culture as a body of content on which the cognitive processes of individual persons operate, in the distributed cognition perspective,

> culture, in the form of a history of material artifacts and social practices, shapes the cognitive processes of systems that transcend the boundaries of individual persons. (Hollan, Hutchins, & Kirsh, 2002, p. 4-5)

Hollan, Hutchins, & Kirsh (2002) further explain the interdependency that actors have in their environment. Their description of *external scaffolding* describes ways in which reminders or cues are placed in the environment as reminders of things in order to reduce cognitive load. For instance, a chef might leave a red rag on a pan handle to remind himself later that the handle is hot. With computer technology, one might leave sticky-notes on their monitor as a reminder of keystrokes or passwords that might be needed later. "The environment is one's partner or cognitive ally in the struggle to control activity. Although most of us are unaware of it, we constantly create external scaffolding to simplify our cognitive tasks. Helpful workflow analysis must focus on how, when, and why this external scaffolding is created" (Hollan, Hutchins, & Kirsh, 2002, p. 20). The authors extend this to the digital environment, and say that their suggestions are "absolutely crucial to such analyses ... to make these cognitive alliances as powerful as possible" (Hollan, Hutchins, & Kirsh, 2002, p. 20). The authors suggest a *cognitive ethnography*, which "contains methods to

document and analyze information flow, cognitive properties of systems, social organization, and cultural processes" (Hollan, Hutchins, & Kirsh, 2002, p. 8).

Clark's theory of language use outlines the way in which individuals reach a 'common ground' in conversation, or a means of determining that they have understood each other sufficiently. Monk (2003) outlines some of the features of constructing a common ground: through a process of verbal and non-verbal communication involving *describing-as, indicating,* and *demonstrating* in typical face-to-face communication (Monk, 2003, adapted from Clark, 1996). "Common ground... minimizes the effort to communicate" by utilizing non-verbal communication and the situated environment (Monk, 2003, adapted from Clark, 1996). Grounding can occur through *conversational repair,* by which common ground is reached after following sets of conversational maxims that allow both parties understanding that a message is jointly understood sufficiently. It is important to note how actors strive for efficiency by utilizing their environment as well as cultural and historical knowledge in order to communicate information as easily as possible; which can then be verified as jointly understood knowledge through verbal and non-verbal cues (engaging in conversational repair if necessary). This idea is incorporated in both distributed

and group cognition in the sense that tasks, actors, and the environment are intertwined as the unit of analysis.

Gerry Stahl (2005, 2006) outlines the idea of *group cognition,* which similarly to distributed cognition, focuses its analysis at the group level. Stahl (2005) explains group cognition with respect to Computer-Supported Collaborative Learning (CSCL) literature:

> ... in the CSCL perspective, it is not so much the individual student who learns and thinks, as it is the collaborative group... this approach does not deny that individuals often think and learn on their own, but rather that in situations of collaborative activity it is informative to study how processes of learning and cognition take place at the group level. (Stahl, 2005, p. 79)

Stahl continues his discussion of group cognition by advocating two main principles: *group meaning,* and *individual interpretation.* Stahl (2005) describes group (or socially shared) meaning as being observable in "the visibly displayed discourse that takes place in group interactions, including non-verbal communication, and associated artifacts" (Stahl, 2005, p. 80). Stahl admits that "only individuals can interpret meaning" and that "group meaning is constructed by the interactions of the group's individual members, not by the individuals on their own... it is an emergent property of the discourse and interaction" and that it is "not reducible to opinions or understandings of

individuals" (Stahl, 2005, p. 80). While both distributed cognition and group cognition focus on activity at the group level, they have different focuses of analysis: distributed cognition puts more emphasis on information flow in group tasks, and group cognition emphasizing interpretive action of individuals and the qualification of tasks for pursuit by the group.

Thinking of video games in an educational setting, group and distributed cognition and their related methodologies may provide insight into the ways in which game affordances are used in the production of understanding. Figure 10, in a following section, shows the relationship between the video game interface, students, and teachers. It may be difficult to record via videotape some cognitive affordances if no external action or collaboration is exhibited (such as the 'false affordances' in Figure 9). Therefore, using theory to analyze the situation at the group level may be of more utility in the environment, where collaboration and conversations are visible to an observer.

Some of the theoretical background of collaborative learning was discussed above, and is expanded upon in the subsequent portion of the literature review. Next is a brief discussion of collaborative and cooperative learning; followed by a presentation of some of the observable components of collaborative learning in educational settings.

2.2.1.5 Cooperative vs. Collaborative Learning

Dillenbourg, Baker, Blaye, & O'Malley (1996) contrast cooperation and collaboration by describing cooperative learning as "accomplished by the division of labor among participants" into hierarchical tasks that are later reassembled, whereas collaborative learning involves "the mutual engagement of participants in a coordinated effort to solve the problem" (Roschelle & Teasley, 1995, as cited in Dillenbourg, Baker, Blaye, & O'Malley,1996, p. 2). Webb & Palincsar (1996) describe collaboration whereas "the thinking is distributed among the members of the group" where "the essence of collaboration is convergence—the construction of shared meanings for conversations, concepts and experiences" (Brown & Palincsar, 1989; Roschelle, 1992; Roth, 1992 as cited in Webb & Palincsar, 1996, p. 848). Much of the theory behind collaboration is shared with the theories of distributed and shared cognition aforementioned in this review of the literature. The design of the study of video games in an educational context will make use of collaborative work; and therefore will make use of the above definition of collaboration in order to see the group affordances that students use.

Webb and Palincsar (1996) present an *Input-Process-Outcome* model of group processes in the classroom, below in Figure 8:

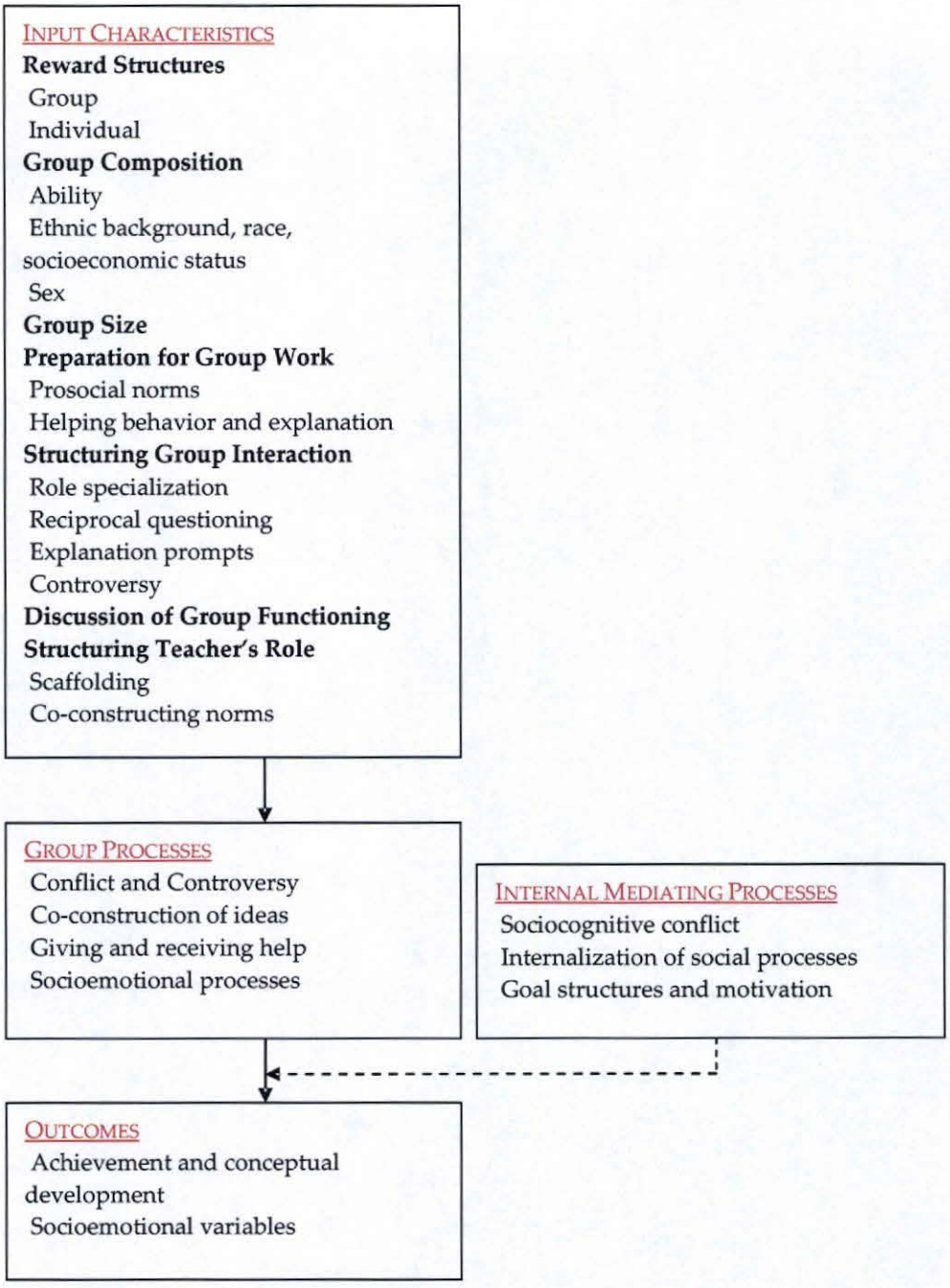

Figure 8: Input-Process-Outcome model of group processes in the classroom, adapted from Webb and Palincsar (1996)

The above model highlights some of the variables that can be examined when looking at collaborative work in the classroom. The authors suggest that the input characteristics "suggest the great variety of ways in which structuring groups and group work have influenced group processes", that the internal mediating processes suggest "how group processes influence outcomes" which is an "indirect relation to processes and outcomes ... because they are not directly observable" (Webb & Palincsar, 1996, p. 851), as seen in the dashed line in Figure 8.

Figure 8 highlights some of the challenges in group structure, which Webb & Palincsar (1996) discuss in relating group input characteristics to learning outcomes. For example, the way in which rewards are structured, the composition of the members of the group, the way the interaction is structured (and all the other input variables in Figure 8) will have an effect on the outcomes and therefore should be carefully thought through by the instructional designer. With regard to video games in the classroom, much of the success will relate to the instructional design; therefore the group input characteristics in Figure 8 should not be taken lightly.

2.2.2 *Affordances*

The idea of an affordance originates with James Gibson (1977, 1979). In his words, "... the affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill" (Gibson, 1977, p. 5). McGrenere & Ho (2000) describe three main properties of Gibson's affordances: "An affordance exists relative to the action capabilities of a particular actor; the existence of an affordance is independent of the actor's ability to perceive it; and an affordance does not change as the needs and goals of the actor change." However, Kaptelinin & Nardi (2006), in discussing affordances from an activity theory perspective, argue that affordances are directly tied to an actor's ability to perceive action on an object, called "action capabilities" (Kaptelinin & Nardi, 2006, p. 81). Further explanation of types of affordances and their relevance to this study are discussed later in the beginning of Chapter 5 (see Figure 40 and Table 5).

Donald Norman helped to popularize the idea of affordances in his seminal work *The Design of Everyday Things*, one of the foundations of human-computer interaction (HCI) research. Alternatively, Norman (1988) describes an affordance as:

> ...the term affordance refers to the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used. [...] Affordances provide strong clues to the operations of things. Plates are for pushing. Knobs are for turning. Slots are for inserting things into. Balls are for throwing or bouncing. When affordances are taken advantage of, the user knows what to do just by looking: no picture, label, or instruction needed. (p.9)

McGrenere & Ho (2000) describe the difference between Gibson and Norman's definitions of affordances. Gibson (1977, 1979) describes an affordance as something that is directly perceptible, and 'affords' action, focusing analysis on the physical level. On the other hand, Norman (1988) discusses affordances with technology in mind, also taking an actors' cultural and historical background into consideration, and that affordances are 'perceived properties' of an object. With regard to computer software, Norman suggests that well designed interfaces "provide strong clues to the operation of things" (Norman, 1988, p. 9) and "suggest the range of possibilities" (Norman, 1988, p. 82). Norman suggests that *perceived affordances* can exist, where a potential for action is perceived but may or may not actually exist, which can "make an action difficult or easy" (McGrenere & Ho, 2000, p. 3). McGrenere & Ho (2000) and Norman (1988) focus the use of affordances on an operational level, focusing on

the properties of the object that lend themselves to use. Gibson (1977, 1979) and activity theory (as presented by Kaptelinin & Nardi, 2006) would argue that if affordances are not perceptible, then they are not affordances: a point of conflict with Figure 9 below (Gaver, 1991) as well as McGrenere & Ho (2000) and Norman (1988).

Gaver (1991) discusses affordance use on the operational level, focusing on properties of objects:

> The concept of affordances points to a rather special configuration of properties. It implies that the physical attributes of the thing to be acted upon are compatible with those of the actor, that information about those attributes is available in a form compatible with a perceptual system, and (implicitly) that these attributes and the action they make possible are relevant to a culture and a perceiver. Artifacts may be analyzed to see how close they are to this configuration of properties, and thus what affordances they convey. (Gaver, 1991, p. 81)

Gaver illustrates this in Figure 9:

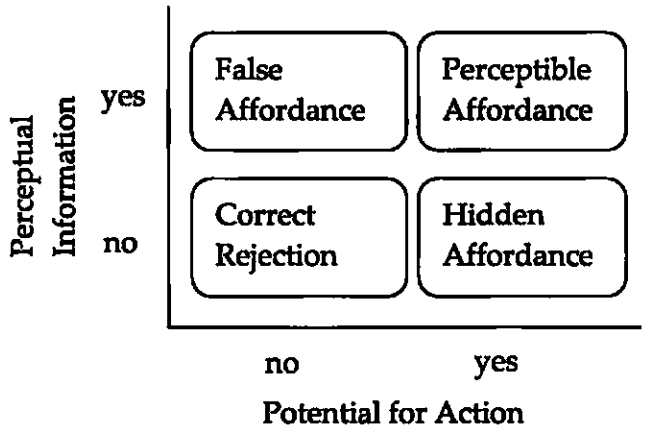

Figure 9: Separating affordances from information available, adapted from Gaver (1991, p. 80)

Gaver describes the process of distinguishing perceptual information from affordances, which predicts ease of use. Gaver describes a *perceptible affordance* when there is "perceptual information available for an existing affordance", while a *hidden affordance* is an affordance without perceptual information (where information is inferred from other evidence). A *false affordance* is one where actors mistakenly act, because perceptual information exists. A correct rejection is a failure to act in this particular way because no perceptual information leads actors to act.

For the purposes of this research, it is useful to examine both affordances and perceptual information. While it is difficult to record what Gaver calls a *correct rejection*, the other three categories in Figure 5 can be more easily

examined by recording actors' behaviors and actions, from an operational standpoint. Additionally, it is useful to examine actors' goals and activities, focusing the use of affordances in support of those goals and activities, as described by Gibson (1977, 1979) in his ecological perspective of affordances, as well as by Kaptelinin & Nardi (2006) in their description of activity theory.

2.2.2.1 *Social and Cognitive Affordances: Conceptual and Operational Definitions in the Context of Educational Games*

While there are differences in the definition of an affordance by Gibson, Norman and Gaver, for the purposes of this paper the activity theory viewpoint discussed and reconciled with Norman and Gibson's viewpoints by Kaptelinin & Nardi (2006, p. 80-83) is used. With regard to playing video games in education, as a technical interface, it seems important to take into consideration the cultural and historical information when observing an actor in their environment. Affordances of this study, both cognitive and social potentials for action, are illustrated by the relationships in Figure 10:

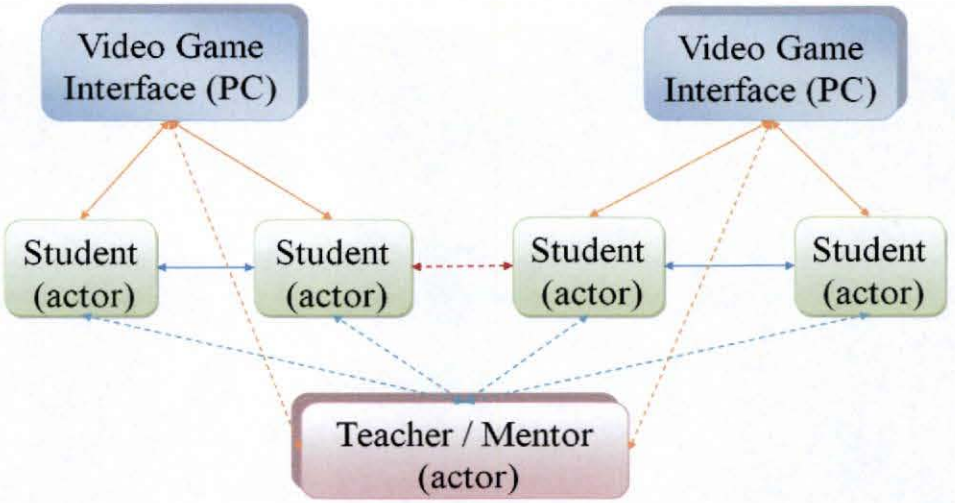

Figure 10: Social and cognitive affordances between actors and the video game interface in a collaborative educational setting

In the context of video games in educational settings, students may be engaged in playing a game together in front of a computer, potentially with the help of a teacher or mentor (lab monitor, peer teams, etc.). To expand the analytic scope of this paper to include the social environment, two types of affordances are defined: *cognitive affordances*, specifically those affordances offering the potential for cognitive acts; and *social affordances*, or affordances that offer potential for social acts.

For the purposes of studying games in education, the solid links in Figure 10 are examined primarily (between students and the video game interface, as well as the collaboration between students), with secondary focus on the dashed links between the teacher and the game as well as the teacher and students.

However, it is important to note the impact of the teacher as part of the environment being studied, as teachers can be considered part of the collaborative learning process of learning in video games.

This study followed a qualitative, inductive approach to inquiry, with influences from ethnomethodology and grounded theory (next section). This approach involved videotaping actors in their environment (students in a classroom). It is important to discuss how the aforementioned acted-upon affordances could be recorded and measured. The social affordances and the collaborative processes between actors were more easily recorded, since they primarily consisted of external conversations and other non-verbal communication (gestures, body language, etc.). On the other hand, some of the cognitive affordances were more difficult to observe, since many of the perceived potentials for action were subjective by nature. Since cognitive actions cannot all be recorded, the hope was that many manifested in either communication or behavior. Additionally, at each occurrence of an action, there may have been other affordances that students did not explicitly acknowledge or use. The analysis chapters (Chapter 4 and 5) include screenshots of the game interface while discussing which affordances were appropriated by students, in order that both action possibilities as well as choices can be analyzed.

2.2.3 *Representational Guidance*

Suthers and Hundhausen (2003) discuss the role of visual notations, and how they can influence the ways in which we interact with software interfaces. Their work compared differences in collaborative discourse among those using software tools supporting the same task but through different notations (text, graph, and matrix-based). Their results showed "that the type of representations that learners use in collaborative investigations will impact the focus of their discourse" (Suthers & Hundhausen, 2003, p. 202). For the purposes of this study, it also will be useful to analyze the game interface and how its visualizations may influence student activity.

Suthers (2001), in studying collaborative learning while working with a software-based tool, suggests that learner interaction (among each other and the software tool) is significantly affected by the tool's representations (both work and discourse of participants are affected).

> The major hypothesis of this work is that variation in features of representational tools used by learners working in small groups can have a significant effect on the learners' knowledge-building discourse and on learning outcomes. The claim is not merely that learners will talk about features of the software tool being used. Rather, with proper design of representational tools, this effect will be observable in terms of learners'

talk about and use of subject matter concepts and skills. (Suthers, 2001, p. 256)

Collaborative work is influenced by the software tool in two major ways, most apparent in software constraints and in the salience of certain representations (Suthers, 2001). First, the tool limits the type of work or expression that is possible, as the software allows particular kinds of activity through its limited set of objects and potential actions (the software *constrains* activity). Second, the software makes particular aspects of the activity prominent, possibly while hiding others, through the choice of the software's visualizations. In other words, the representations provided by the software make particular interpretations more *salient* than others (Suthers, 2001).

With respect to educational game play, the design of particular game representations can similarly guide the discourse of students playing the games. The analysis chapters (Chapter 4 and 5) examine this notion: how both the tool (video game) can mediate the collaborative interactions of students, and how particular kinds of interactions are promoted by the design of the game visualizations.

2.2.4 *Methodological Foundation: Ethnomethodology and Grounded Theory*

The analysis of the use of affordances in collaborative game play highlighted the learning process of students while gaming, providing a deep analysis and exploration of actual uses in the classroom. While much work has been done researching educational learning outcomes as a result of playing video games, less attention has been paid to researching the learning process of how video games are used both cognitively and socially to support learning.

This study draws upon various qualitative theoretical methodologies, which are discussed briefly below and expanded in the methodology chapter. A brief discussion of both theory and methods is provided because each method has its associated historical and theoretical stance. A blended approach drawing from ethnomethodology and grounded theory allowed the construction of an emergent, inductive approach to answer the research questions.

2.2.4.1 *Ethnomethodology*

Ethnomethodology can be examined from both a theoretical perspective as well as a source for descriptive methods. Clayman & Maynard (1995) describe the theoretical foundation for ethnomethodology:

> Ethnomethodology offers a distinctive perspective on the nature and origins of social order. It rejects "top-down" theories that attempt to

> explain social order in terms of cultural or social structural phenomena which are conceived as standing outside of the flow of events in everyday life. Adopting a thoroughly "bottom-up" approach, ethnomethodology seeks to recover social organization as an emergent achievement that results from the concerted efforts of societal members acting within local situations. (Clayman & Maynard, 1995, p. 2)

A subfield of ethnomethodology is conversation analysis. Of the subfields of ethnomethodology, this is probably the most active. Clayman & Maynard (1995) describe the theoretic perspective of conversational analysts as interested in "how various orderly characteristics of talk – regular patterns of turn taking, activity sequencing, institutional specializations, and the like – are accountably produced by interactants via procedures which are implemented on a turn by turn basis" (Clayman & Maynard, 1995, p. 4).

Heritage (1987) describes a method called *breaching experiments*, originally developed by Garfinkel (1967), the founder of ethnomethodology. Breaching experiments attempt to violate the norms and orderly characteristics described above, which help to expose the common work that members of a group take for granted. This is another "bottom-up" approach that helps expose some of the social order and "common sense" that ethnomethodology attempts to study through descriptive analysis (Heritage, 1987, p. 232-240).

Koschmann, Stahl & Zemel (2005) discuss several key principles of ethnomethodology, by providing an updated and clear description of Garfinkel's policies (1967). These policies are summarized below:

1. *Indifference.* Ethnomethodological indifference states that "any occasion whatsoever" (Garfinkel, 1967, p. 32) is useful in studying the construction of social order
2. *Contingently-achieved accomplishment.* Socially constructed order is specific to the situation in which it was accomplished. When making generalizations, those generalizations only apply to other situations with similar contingencies
3. *Relevance.* The researcher must 'bracket out' any preconceptions about the situation being studied. Relevant categories can only be produced as a direct result of observing participants' discourse and behavior. When studying a situation, the researcher may come in with prior knowledge and stereotypes of items being studied; however, those must not be allowed to shape the results or focus what we choose to see (a-priori definitions shall be avoided as well)
4. *Accountability.* Social actors' actions (social group members' behavior and communication) construct social order by giving

ongoing accounts of their activity. Participants actions are representative and real to their experience

5. *Indexicality.* Ongoing, contingently-achieved accomplishment is tied together as a sequence of actions, all of which build on each other. They are both context-shaped, and context-shaping, serving to construct social order

Ethnomethodology attempts to gauge "what the group themselves are constructing as doing", looking closely at the construction of social order, from the group members' perspective. This fits well with the emergent methodology described in the following chapter, as an inductive inquiry is conducted to expose the actual uses of video games for learning. Garfinkel (1967) summarizes ethnomethodology, the study of members' methods of constructing social order:

> In short, a common understanding, entailing as it does an "inner" temporal course of interpretive work, necessarily has an operational structure. For the analyst to disregard its operational structure, is to use common sense knowledge of the society in exactly the ways that members use it when they must decide what persons are really doing or really "talking about," i.e., to use common sense knowledge of social structures as *both* a topic and a resource of inquiry. An alternative would be to assign exclusive priority to the study of the methods of concerted actions and methods of common understanding. Not *a* method of understanding,

> but immensely various methods of understanding are the professional sociologist's proper and hitherto unstudied and critical phenomena. Their multitude is indicated in the endless list of ways that persons speak. Some indication of their character and their differences occurs in the socially available glosses of a multitude of sign functions as when we take note of marking, labeling, symbolizing, emblemizing, cryptograms, analogies, anagrams, indicating, miniaturizing, imitating, mocking-up, simulating—in short, in recognizing, using, and producing the orderly ways of cultural settings from "within" those settings. (Garfinkel, 1967, p. 31)

Of the above principles as summarized by Koschmann, Stahl & Zemel (2005), several are important to the research design and are discussed below (in order):

1. The principle of *indifference* is not as relevant, as occasion for the study has been chosen in the methodology.
2. *Contingently-achieved accomplishment* limits generalizability of findings, but is a means of extracting initial hypotheses about learning with games and the use of affordances. This property leads to using the hybrid approach involving grounded theory, in order to make results more generalizable. Influenced by

ethnomethodology, a transition to methods of grounded theory is made after generalizations begin to emerge from the data.

3. Much of the reason in drawing from ethnomethodology is for emergence with *relevance* to the situation studied. Accordingly we allow the data to speak to us directly (inductively), rather than running deductive tests on preconceived concepts.
4. The principle of *accountability* theoretically mitigates the choice of studying the social realm: while video tape does not provide access to participants' cognitive state, the principle of accountability states that participants' actions gives an account of their experience by analyzing what they are doing in their interactions
5. In the unpacking of learning, sequences of actions can be studied that are *contingently-achieved*, and serve as context building activities that can be broken down and analyzed (specifically, in Chapter 5 of the analysis: see methodology chapter for an overview).

Ethnomethodological principles guided the initial data analysis. This approach allows for an open look at what is being constructed and accomplished. As ideas began to emerge, the methodology integrated methods

of grounded theory to help abstract patterns in the data and generalize to other situations.

2.2.4.2 Grounded Theory

Grounded theory was originally developed by Barney Glaser and Anselm Strauss, as a response to the lack of integrated theory associated with Chicago school of interpretive sociology. The feeling at the time was that "qualitative research is valid, appropriate and necessary, but it does itself no favors by having no methodology to speak of, and by being unable to demonstrate how it develops theory" (Thomas & James, 2005, p. 771).

Grounded theory is a sociological method that concerns itself with the "discovery of theory from data" (Glaser & Strauss, 1967, p. 1), which is not "based on a preconceived theoretical framework" (Glaser & Strauss, 1967, p. 45). This idea is referred to as *emergence*, as theories emerge from the data, rather than going into the study with a predefined hypothesis to test. Glaser & Strauss describe grounded theory as a "general method of comparative analysis" (Glaser & Strauss, 1967, p. 1). The researcher makes constant comparisons of ideas while studying the data: looking for themes or "theoretical categories" (Glaser & Strauss, 1967, p. 23-24) and constantly reevaluating those categories (taking advantage of replication to test those ideas). This re-evaluation is accomplished

through *theoretical sampling*, or "the process of data collection for generating theory whereby the analyst jointly collects, codes and analyzes his data and decides what data to collect next and where to find them, in order to develop his theory as it emerges" (Glaser & Strauss, 1967, p. 45).

Grounded theory borrows the concept of abduction (Pierce, 1903): a combination of induction and deduction, where ideas are hypothesized and empirically tested. In line with the idea of emergence, patterns will emerge from the data (inductively), and these patterns will generate hypotheses that can then be verified (deductively) in the data (Charmaz, 2006). Most importantly, grounded theory (as opposed to grand theory) allows for the analysis of data without preconceived expectations. While the researcher may expect phenomenon and may be biased, specific theory will not be deductively applied to the research data.

The constant-comparative process of grounded theory uses the human brain as a "pattern-matching tool" to move through several processes in the abduction of theory (Charmaz, 2006). Specific methods of grounded theory that are used in the methodology include (from Charmaz, 2006):

1. *Initial coding*. An initial process of looking through the data and applying short 'memos' that describe / summarize segments of data

2. *Focused Coding*. The generation of specific, initial hypotheses, describing patterns among segments of video data, which are further refined conceptually until no new patterns emerge (called *saturation*; categories are saturated when no new anomalies appear), which are conceptually organized (called *sorting*, highlighting relationships among concepts)
3. *Theoretical Sampling*. A process of deductively testing generated hypotheses, to see if they hold up against new data

The process of abduction in grounded theory relates to (2) and (3) above: through inductive generation of hypotheses, which are then deductively tested on new data. This is discussed further in the methods chapter.

2.2.4.3 *Summary of Methods*

Qualitative research in video games within educational contexts is a rather new area of research, and does not have a set of established methods; therefore, the researcher may have more flexibility in method choice. However, method choice should not be taken lightly, for each method has its own history, theory and uses associated with it. These should be considered in method choice, which may consist of a blended approach that draws from multiple methodologies.

2.2.5 *Summary*

Research of video games used in educational contexts is a new area of research that can benefit from an in depth investigation into real-life practices in the classroom. Much research suggests the benefit of Serious Games as well as commercial off-the-shelf games in educational settings to support learning outcomes and teaching standards. The premise was that a qualitative study blending methods from ethnomethodology and grounded theory would provide insight into both social and cognitive relationships between the video game, students, and their teacher. Borrowing from related literature on collaborative learning, affordance making, and computer-supported collaborative learning, a descriptive case study was indicated that would investigate the learning process in detail in an actual classroom.

The literature review in Section 2.2 provided a theoretical framework and operational definitions with which to answer the research questions for this study. Following in the methodology chapter, a research plan is outlined for the study, which includes forms of data collection and selection of participants, as well as data analysis strategies.

CHAPTER 3:

METHODS OF ANALYSIS

The following study draws from theory outlined in Section 2.2 of the literature review; drawing from ethnomethodology, grounded theory, activity theory and theories of collaborative learning in order to frame and provide a descriptive analysis of the use of video games in education. A qualitative, inductive approach merging methods from ethnomethodology and grounded theory provides an in depth, emergent analysis of the cognitive and social affordances of video games in education. The video game interface, peer collaboration, and teacher mediation serve as foci for analysis in finding learning episodes. In the discussion chapter, emergent theories (empirically derived from the data) are compared to existing theory such as activity theory and theories of collaborative learning.

A case study of students playing games collaboratively with limited teacher mentoring included videotaping of student gameplay, researcher observations, and post-test interviews. The primary data collection consisted of videotaping high-school students while they played video games in dyads using a single computer. Two dyads, situated side by side, played each game. Videotape recorded usage of the video game interface as well as social interactions and discussions. Additionally, the researcher took handwritten notes while videotaping students to aid in the generation of questions for a post-

gaming interview, and for observations that might not have been collected by the video camera. These notes are provided in Appendix E. Near the end of gameplay, a demographics form was distributed to students, which was then followed by a videotaped group interview (outlined in Table 5). Information gathered represented student sampling information, such as gaming experience, gender, and personal interests (see Appendix C). A complete video record was made of the game play. Data from the right hand pair were analyzed for instances of learning and for the affordances used. Criterion for student selection, video game selection, and group characteristics are provided below.

The principle of emergence guided the researcher in generating inductive hypotheses among patterns in the gathered data. Data was collected and analyzed for episodes of learning, followed by the analysis of affordances in selected learning episodes. This generated observations about how learning manifests in collaborative gaming, and hypotheses about how the social and cognitive affordances of games are appropriated by students in learning events. The logic of the study is the inverse of an experiment: rather than holding all but one variable constant to see what co-varies with that variable, the study varies the games and participants to identify recurring patterns that can be postulated as inductive generalizations. Emergent hypotheses are discussed in the analysis

chapters (Chapters 4 and 5). Further testing and clarification using theoretical sampling (a method of grounded theory) is an opportunity for future work.

In the discussion chapter, results are compared to existing theory. Additionally, the discussion provides practical considerations for educators (how teachers can go about leveraging these affordances to support learning in their classrooms) as well as game designers.

Several qualitative methods were combined drawing from the methods outlined above for the study of video games in educational contexts. A qualitative approach was chosen as most appropriate to research this topic. There are tradeoffs in research design: while some external validity and reliability is sacrificed, additional insights that might not be possible through a positivistic, quantitative study are gained. While generalizability is limited, current research shows the need for an in-depth, descriptive research design to provide a detailed account of the collaborative use of games for learning. This affected some of the study design decisions, such as the game selection and collaborative game play. Further implications are discussed in the limitations and delimitations section of the discussion chapter (Chapter 6).

3.1 *Study Design*

3.1.1 School and Student Selection

High schools were chosen and investigated for the potential to conduct research by interviewing teachers and administrative staff of the schools. Teachers at Wheaton-Warrenville South High School (Wheaton, Illinois) and Naperville Central High School (Naperville, Illinois), agreed to participate in the research. Teachers whose classrooms relate to the subject matter of the games were requested to participate in the study.

Student selection at the high schools strived to achieve a representative sample of students. Teacher assistance was used to gather students of various gaming experience and gender who were willing to participate. When more than the minimum number of participants was available, selection was based on including variance of gender and game playing experience. Students were allowed to self-assign themselves into dyads for collaborative game play, as seen in Figure 11. Having participants who know each other can be a benefit, so that collaboration is not stifled or overridden by the need to get to know each other. Additionally, students were only allowed to participate in one of the games.

Figure 11: Data gathering of collaborative gameplay

Very rich data was gathered (the type of analysis does not require very large sets of data), and a smaller selection of students sufficed for the study. While the size and duration of the study was somewhat small, the length of the study was long enough to observe maturation of the participants as they played the video game. Game selection, group characteristics, and the timeline for the study are outlined below.

3.1.2 Game Selection

A brief list of criteria helped in selecting quality games for the study:

(a) Fun and engaging: Elicited many of the properties of games as discussed in the literature review

(b) Contained graphics, gameplay and control of contemporary games (a Serious Games perspective)

(c) Blended learning with entertainment value (balanced design between pedagogy and gameplay)

(d) Low computer hardware requirements (not requiring the latest processor and video card, etc., as schools are unlikely to have them)

(e) Low levels of violence, foul language, or sexually themed content (ESRB rating of 'E' for everyone, age 10+)

(f) Appropriate game play and content for the characteristics of the students selected for the study

(g) Involved moderate levels of strategy development, encouraging immersion and collaborative game play

(h) Contained a tutorial for ease of integration

(i) A well designed and understandable game interface

Based on the above criteria, the following games were chosen:

Game:	Brief Description:	Game web site:
RollerCoaster Tycoon 3 (Atari) ESRB rating: E (Everyone)	Game player can build a virtual theme park; building rides and managing attractions within the park	http://www.atari.com/rollercoastertycoon/
Making History: The Calm & The Storm (Muzzy Lane Software) ESRB rating: E (Everyone)	Game player takes the role of a country in World War II and can play scenarios from that country; managing resources, etc.	http://www.making-history.com/edu/
Sid Meier's *Civilization IV* (2K Games) ESRB rating: E 10+ (Everyone 10 and up)	Game player can play an ancient civilization (Greeks, Romans, etc) and make dynamic decisions affecting their success compared to other civilizations	http://www.2kgames.com/civ4/

Table 4: List of games chosen for study

The above list of games was strategically chosen so that theory may be discovered that applies across different kinds of games. For instance, both *RollerCoaster Tycoon 3* and *Civilization IV* are *COTS* (Commercial-off-the-shelf games, created by large game corporations) games, while *Making History: The Calm & The Storm* was developed as a Serious Game for educational purposes. Both *Making History* and *Civilization IV* are historically-based games (*Making History* focuses on World War II, while *Civilization IV* focuses on world history),

and can be applied in world history or 20th century history classes. In contrast, *RollerCoaster Tycoon 3* could be applicable to a business course such as Economics or Marketing since it enables the creation of products and services, and the managing of finances (such as balancing supply and demand). This allows generalizations to be made between COTS and Serious Games, and between subjects (history vs. business) during the analysis, allowing inductive generalizations to be tested across these categories.

3.1.3 Group Characteristics

Literature suggests that group phenomena require three or more participants (Wiley & Jensen, 2006). Additionally, learning may also result from between-pair as well as within-pair interaction (similarly to what occurs in traditional classrooms). Two dyads played each game simultaneously, for a total of four participants per game (two pairs). Since both dyads were recorded, redundancy was added to the data collection in case of unanticipated hardware or attendance problems that may have arisen in the study.

The configuration of the pairs facilitated collaboration between participants while playing the game (see Figure 12). Multiple participants per computer was slightly cumbersome, as there were only one set of input devices per computer (a single keyboard and mouse) and limited seating space (see

Figure 13). However, to encourage the discussion of in-game decisions, it was decided that a minimum of two participants per game needed to show up each day (so at least one pair of students engaging in collaborative gameplay could be recorded). Luckily, only minor problems in the data gathering existed, and there were at least three students (typically all four were present) at all times during data gathering.

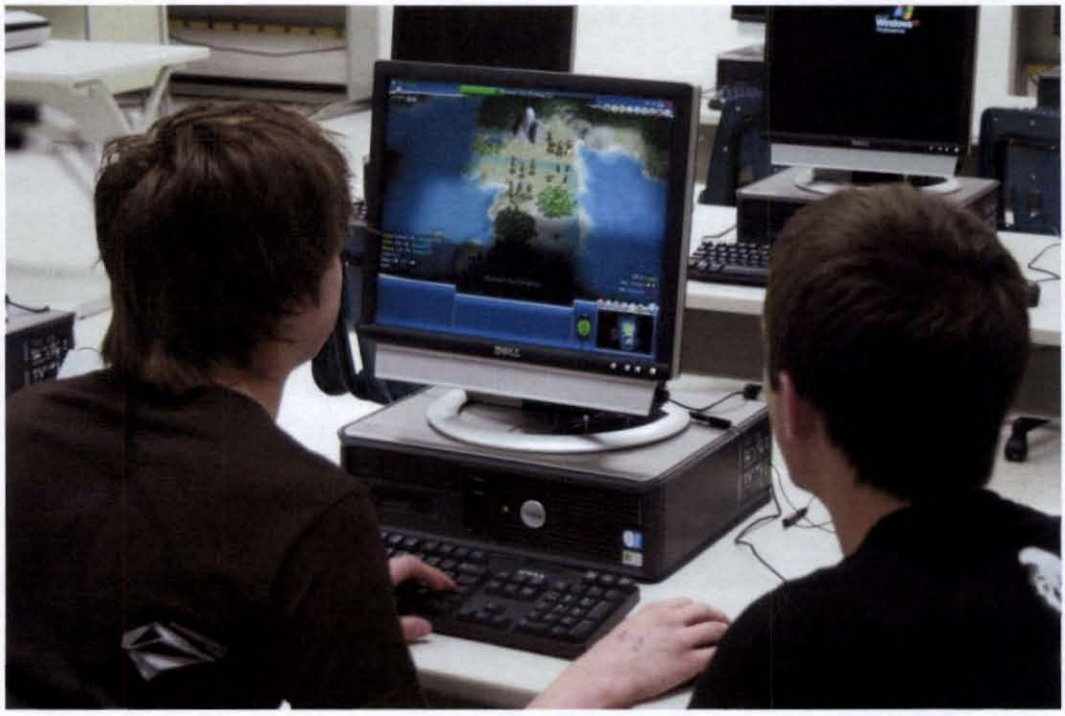

Figure 12: Collaborative gameplay in *Civilization IV*

Each of two video cameras recorded one pair at a time. Two cameras were used to record all four students playing at once while maintaining resolution satisfactory for viewing their computer screens. Video was recorded

in such a way that between-pair and pair-to-teacher interactions can be identified as well. Both pairs were recorded for redundancy and for cross-reference, but analysis focused on only one of the two recorded pairs of each game. Data for the other pairs are available for future work.

3.1.4 Study Size and Duration

In order to avoid classroom disruption and coordination problems, participating teachers were consulted as to when it was most convenient for their students to participate in the research. In some cases, students were asked to participate during a study-hall that corresponded to a time period that their teacher was not scheduled to teach. This helped avoid disruptions to the teacher's scheduling of topics and information presentation, as well as coordination problems with attempting to fit their class into a computer lab to play a game. This fit well with budget considerations of the researcher as well, as only two copies of each game were needed for purchase.

The study duration consisted of four class periods per game, consisting of two dyads (two pairs of students, as in Figure 12) playing the game for the duration of their study hall or class under supervision of the corresponding teacher. Consent of parents and assent of students was obtained. The consent and assent forms are provided in Appendix A1 andA2, and were approved by

the University of Hawai'i Committee on Human Studies (application #15225). Different students were chosen to play different games: *RollerCoaster Tycoon 3* involved students from a related business class at Naperville Central High School (Advanced Marketing), while *Making History* and *Civilization IV* involved teachers and students from Wheaton-Warrenville South High School that had taken appropriate history classes.

Toward the end of the fourth day, students were asked to stop game play and fill out a demographics form, provided in Appendix C1. Confidentiality was applied to the demographics forms, and the information gathered is used for research purposes only in order to aid in the discovery of patterns in the learning process among students.

3.1.5 Incentives

Incentives were distributed at the end of the last day of data gathering in each game. Students were entitled to incentives regardless of whether they choose to withdraw from the research (however, none withdrew), as specified in the consent and assent forms in Appendix A1 and A2. Incentives consisted of a $10 gift card to a local restaurant. Students chose between a gift card at Jamba Juice (drinks / smoothies) or Portillos Hot Dogs (a local favorite in the Chicago area, serving famous Chicago hot dogs and Italian beef sandwiches).

3.1.6 *Roles of the Teacher & Researcher*

Teachers are not expected to have experience with the games being used, so some time was offered introducing teachers to the game interface before running the study. Students' questions were deferred to the teacher (when available) but were handled by the researcher when the teacher could not adequately answer the students' requests. While teachers in the study often did not pay much attention to the students playing the game, there were a few instances of advice related to the game's subject matter. A few times the researcher helped to resolve interface and game-specific issues with which the teacher was not familiar.

While much of the success of games in the classroom depends on active teacher involvement (Hidi & Renninger, 2006; Stapleton, 2004), the researcher avoided taking the role of the teacher in the study to avoid bias in the experiment. During the course of gathering data, the researcher avoided giving students guidance except specifically when asked by students or when technical assistance was needed with the computer or game interface, i.e., they reach an impasse. At one point in data gathering, a computer rebooted itself automatically (to finish installing updates), so the researcher helped get the game up and running again.

Based on experience from the pilot study, there appears to be a large range of expertise in students' ability to learn a game interface (largely due to their prior experience with games). This was part of the motivation for collecting demographics (Appendix C). Students who are not familiar with games may exhibit different behavior in figuring out the game interface. Additional assistance was only provided at their request. Data from the pilot study suggested that this pattern would most likely manifest during the first day in the research timeline (which it did; however, students typically asked each other for advice or suggestions, to the delight of the researcher).

3.1.7 Timeline

Each of the three games mentioned were played over the course of four full school periods. Assuming a class period is approximately 45-50 minutes, this provided approximately two and a half to three hours of gameplay per pair (two pairs of students), per game (three games). The interviews mentioned below in Table 5 (at the end of Day 4) were also videotaped:

Day	Brief Description of Day
Day 1: (approx. 45 minutes)	Consent & Assent forms collected. Study introduced briefly to teachers and students; instructed the students to start a new game; save the game for next day before leaving
Day 2: (approx. 45 minutes)	Start or continue game from Day 1. Save game at end of session for following day (if game ended, instructed group to start a new game)
Day 3: (approx. 45 minutes)	Start or continue game from Day 2. Save game at end of session for following day (if game ended, instruct group to start a new game)
Day 4: (approx. 45 minutes)	Start or continue game from Day 3 (if game ended, instruct group to start a new game) After 40 minutes of gaming, instructed students pause the game Demographics forms distributed and collected (Appendix C) Started a post-gaming group interview to ask any unanswered questions Individual incentives distributed (gift card) Game play continued after interview / demographics / incentives until end of period

Table 5: Timeline and guidelines for data collection

3.2 *DATA COLLECTION*

As mentioned above, students were videotaped while playing video games, according to the timeline in Table 5. Data analysis focused on one of the two pairs of students. The second pair's data was gathered in case redundancy was needed if a video camera failed, and for cross-reference. The second pair of students also served as a means of creating between-pair collaboration. Additionally, the video from the non-analyzed second pair is available for future work. Approximately ten hours of video were analyzed (with another ten hours of video collected for the second pair of students).

Figure 13: Data gathering environment at Wheaton-Warrenville South High School

A post-game interview was conducted at the end of the last day of each game in order to answer unanswered questions collected from notes by the researcher. The interview was collected on the videotape (already set up and recording existing game play). Interviews were then transcribed, and are provided in Appendix J.

In addition to the video tape and handwritten notes, demographic forms were distributed to students at the end of the study. The demographics form can be found in Appendix C1. This form collected basic information among

participants, such as gender, game experience, gaming (in general) experience, as well as intended major and favorite subjects in school.

3.3 *DATA ANALYSIS*

The videos were imported into the Transana™ system for collaborative analysis by the author and his advisor. Analysis followed a hybrid qualitative research strategy that was initially data driven and inductive, but then brought in theory for specific purposes. Data analysis was conducted in two phases, following with a discussion of results in comparison to existing theory:

- Phase I (Chapter 4) followed an ethnomethodological approach to view what was occurring (what the pair was constructing and accomplishing), followed by the identification of learning episodes. Initially episodes that showed the production of understanding (Koschmann, et. al., 2005) were sought, followed by a more comprehensive search for episodes that showed a change in students' behavior as a result of experience. Grounded theory methods (Charmaz, 2006) were used to look for patterns among these episodes through the constant comparison (focused and axial coding) of episodes in order to describe patterns of learning
- Phase II (Chapter 5) analyzed the affordances in each learning episode, and examined the sequential use and patterns of affordances in learning

instances discovered in Phase I. Grounded theory methods were then re-applied to this level of description to seek regularities in the use of cognitive and social affordances during episodes of learning

Following, a discussion (Chapter 6) offers implications to educators and game designers based on the inductive study. Discussion also matches the generated hypotheses generated from the analysis with existing theory, drawing from theories of group collaboration and collective action such as activity theory (Cole & Engestrom, 1993; Kaptelinin & Nardi, 2006). Finally, implications for teachers, students and game designers were offered in the discussion, suggesting ways in which games could be designed, implemented with curriculum, and used by students and teachers in the classroom.

Initial analyses were developed in meetings with the dissertation chair to refine the approach, and were completed by the investigator. The Transana video analysis tool was chosen for this work, as Transana supports multiple types of analysis and collaborative analysis by distributed researchers.

3.3.1 Transana™: A Tool for the Qualitative Analysis of Video Data

Careful attention was given to the selection of the correct video analysis and transcription tool for the project. Transana MU was chosen as the software to analyze video data. Key features of the software include:

(a) Ability to create multiple transcripts for each video

(b) Ability to work with and organize large data sets

(c) Ability to timestamp video, linking transcriptions to the video segment in which they occurred

(d) Ability to break video into short segments or "clips" for further analysis

(e) Ability to add keywords to video segments

(f) Remote collaboration (MU version), allowing multiple remote researchers access to the same data

(g) Organization of large sets of clips into nested collections

(h) Ability to add analytic memos and notes to transcripts and clips

(i) Support for Jeffersonian transcript notation[1]

Not all software is perfect. Accordingly, some of the limitations of the software include:

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[1] Transana (2008). *Jefferson Transcript Notation*. Retrieved January 9, 2008 from http://www.transana.org/support/OnlineHelp/Team1/transcriptnotation1.html

Originally described in:

Jefferson, G. (1984). Transcript Notation. In J. Heritage (Eds.), *Structures of Social Interaction*. New York: Cambridge University Press.

For a full description of transcript notation, see Appendix G.

(a) Inability to propagate work to multiple levels: clips inherit transcripts from higher-level transcripts, but not vice-versa

(b) Inability to create a nested hierarchy of keywords

(c) Inability to cut and paste transcripts without losing timestamp information (between clips on common video data)

(d) Inability to tag portions of video with keywords at the clip level

Mitigation of these limitations was done by manually propagating clip information that did not inherit from parent level, and manually recreating timestamps and lost information upon moving transcripts. Some of these issues could have been avoided by coding video at the top level (series level in Transana that corresponds to the larger, video-tape unit of analysis). However, coding was done at the clip level, after pulling out episodes from the main videotape. Coding at the clip-level allowed the creation of hierarchical organizations of similar episodes, something difficult to do at the higher 'series' level in the software.

3.3.2 *Data Analysis, Phase I: Emergence of Patterns of Learning*

Emergent methods drawing from ethnomethodology combined with grounded theory guided the first phase of data analysis. A true ethnomethodological perspective would avoid predetermined categories or

theory (as described in the literature review, part 2.2.3). However, some focus was needed to find examples of learning (rather than focusing on the entire video), as the objective was to study the learning process.

3.3.2.1 Selection of Learning Episodes

The initial analysis sought episodes that evidenced "problematization" leading to "the production of understanding" (Koschmann, et. al, 2005). Then, to collect a wider variety of learning episodes, learning episodes evidencing a change in behavior were gathered to increase the variety of episodes for further analysis that illustrate learning. Students' identification of a problem might mark the beginning of an episode of learning, and could complete when the problem is resolved; however not all learning episodes were this well compartmentalized.

Missed opportunities were examined in addition to the learning episodes described above (unresolved problems and opportunities for learning). Additionally, sequences of learning episodes and trends of learning were examined, as early analysis showed learning occurring at multiple granularities.

Ethnomethodology and the principle of emergence guided the first portion of data analysis. Multiple passes were done examining each video, looking at what participants were "constructing as doing" (in line with the

emergent analysis). Following, grounded theory's process of initial coding further developed the emergent hypotheses. Initial coding consisted of attaching memos to video clips that exhibited learning, which qualified them for further analysis. Following the identification of learning episodes, methods of grounded theory (Charmaz, 2006) were used to create hypotheses based on patterns in the video.

In defining learning as "a change in behavior as a result of experience", almost any behavior could be considered learning. This fit well with the emergent approach, allowing the data to speak for itself. However, significant reduction was needed in order to process the very rich data, since approximately 24 hours of video tape were gathered, and were full of instances of learning. Following the process outlined below, the selection of learning episodes was done to highlight patterns encountered in the video data, and the most frequently occurring patterns of learning were selected and qualified for further analysis. This selection of the most frequently occurring learning patterns limits findings and provides an opportunity for future work, but was necessary in order to perform a deep, descriptive investigation of a few of the learning episodes (approximately 100 clips averaging a couple minutes each). All of these episodes were transcribed (see Appendix H) and the appropriation of

affordances was analyzed to gain insight into how learning makes use of the gaming situation.

3.3.2.2 Process

A blended approach combining ethnomethodology and grounded theory guided and focused this phase of the analysis by first taking an open look at what was being accomplished, followed by the identification of patterns among learning. Figure 14 is a visual representation of the grounded theory process:

Emerging 'grounded' theory via patterns in learning episodes:

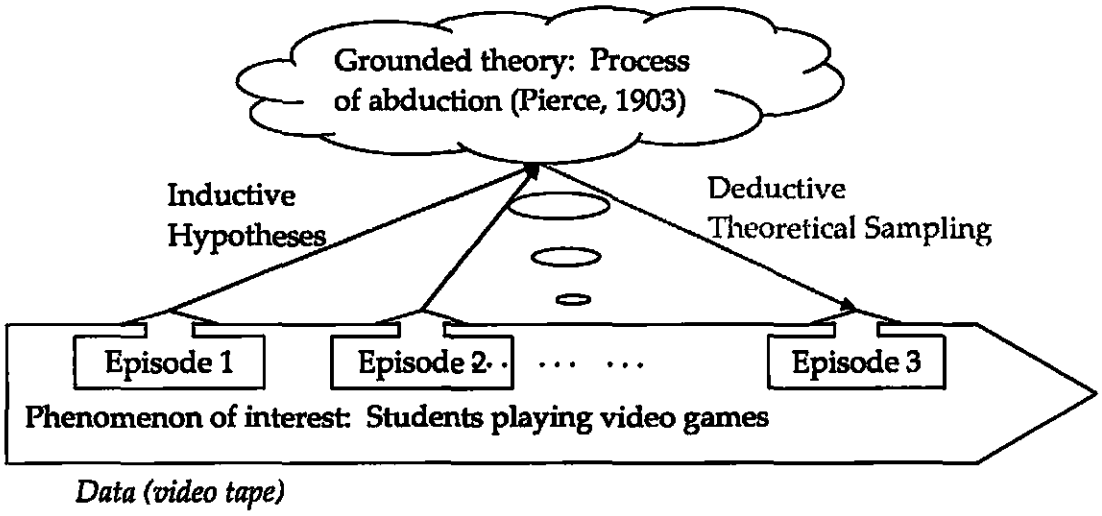

Figure 14: Phase I (Chapter 4) of data analysis: Finding learning episodes and patterns of learning

Hypotheses were inductively generated and deductively tested through constant comparison of learning episodes in the recorded video tape, as shown in

Figure 14. Hypotheses were then conceptually sorted, creating preliminary categories and domains. Next, categories were saturated, or continually compared and refined until no new properties emerged.

The first phase of analysis (Chapter 4) focuses on first finding episodes exhibiting learning, followed by a description of learning by examining the properties of interactions in selected episodes. Analysis included the transcription of all selected episodes in Jeffersonian notation (Jefferson, 1984), which are available in Appendix H. The analyses presented in Chapter 4 describe the patterns of learning though examples of transcribed episodes exhibiting learning, with an analysis of the learning behavior shown in the episode or sequence of episodes.

3.3.3 Data Analysis, Phase II: An Analysis of Affordances

Phase I resulted in the identification of learning episodes as well as inductive hypotheses about the properties of learning through collaborative game play. In Phase II, episodes illustrating learning were segmented into chunks to highlight the use of affordances. As in Phase I, ethnomethodology and the principle of emergence assisted in the generation of inductive generalizations on affordance use. These affordances were coded, and constant-comparative methods (grounded theory) were employed to theoretically define and organize

emergent concepts conceptually. Discussion in Chapter 5 focuses on patterns and relationships among affordances and their use for learning.

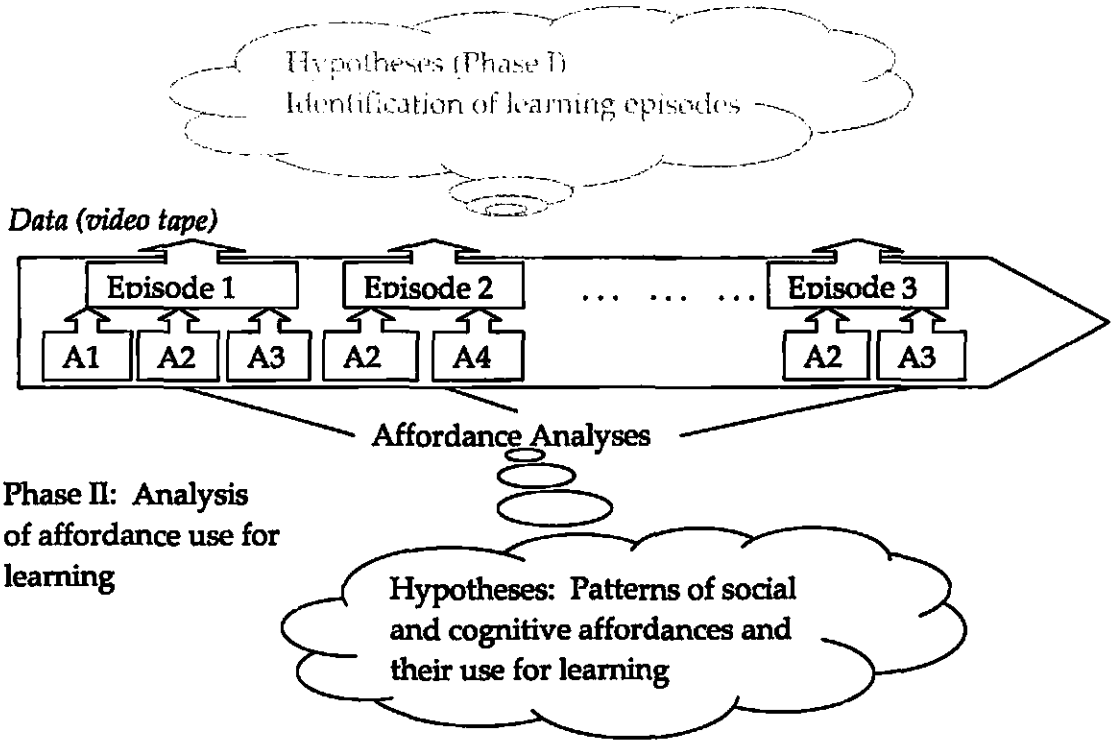

Figure 15: Phase II (Chapter 5) of data analysis: patterns of affordance use in selected learning episodes

An analysis of affordances was performed on each of the learning episodes by analyzing student interactions (Jordan & Henderson, 1995) in the learning episodes that were selected during Phase I. This attended closely to what was being accomplished through the student interactions, and described ways in which the game and peers were used in these accomplishments. After affordances were identified, methods of grounded theory were applied to the

affordance analyses to look for patterns among affordances used by students while learning. This allowed the researcher to make claims about key affordances in the learning process. In general, cognitive and social affordances (potentials for action) were examined, focusing on ways in which the environment (presence of games and peers) and the representations of the game (visualizations, behavior of game interface) afford action.

Learning episode, exploded view:

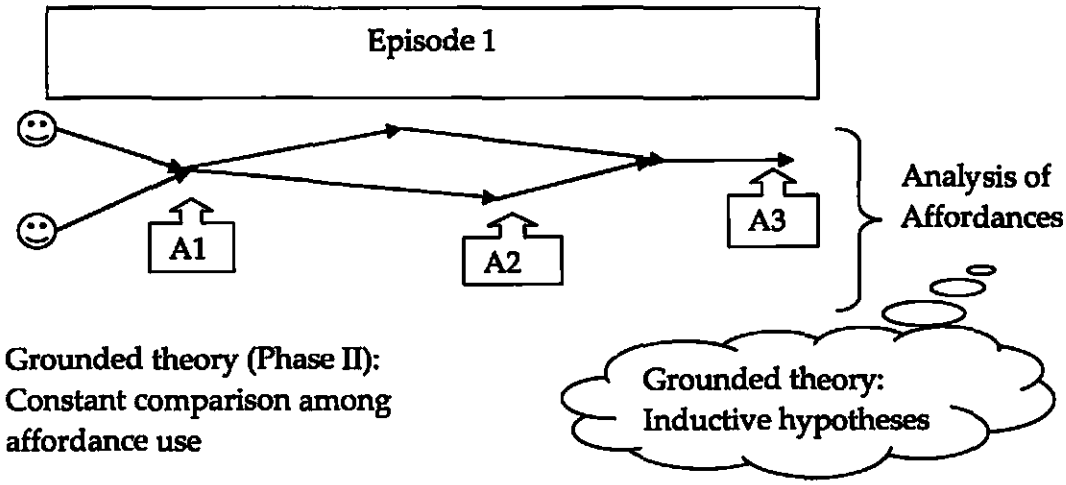

Figure 16: Phase II (Chapter 5) of data analysis: finding patterns among interactions, of selected learning episodes (exploded view)

Results from Phase II of the methodology are documented in Chapter 5. Focus was not on every possible action provided by the interface, as many action potentials were available at any given moment. Each screen or pop-up in the game (often a new visualization every few seconds) had many action potentials.

Many of these, especially once learned, were not used or discussed by students while completing tasks. Therefore, analysis focused on salient affordances used in accomplishing learning, looking at interactions while learning was being accomplished by students. Unused affordances were occasionally examined only for episodes highlighting missed opportunities for learning and during instances of inefficient learning.

The grounded theory method of theoretical sampling was not completed in this exploratory study. Each inductively generated hypothesis could be deductively tested and refined in subsequent studies. Opportunities for future work include the deductive testing of hypotheses (on our unused gathered data or with collection of new data); similar to what grounded theory's method of theoretical sampling specifies.

3.4 *Discussion Items*

Several items are reserved for discussion, after analysis had been completed. As mentioned in the introduction, the inductive hypotheses generated in Chapters 4 and 5 of the analysis served as a means for discussing the following topics:

(a) Implications for learning: guidelines for educators (both teachers and curriculum designers)

(b) Implications for learning: guidelines for game designers

(c) Comparison of results with existing theories of learning

3.4.1.1 Implications for Learning: Guidelines for Educators

Following the finding of patterns of learning and analyzing the use of affordances, guidelines were offered to educators for their use in curriculum design. Results may include strategies that aid the learning process, as well as suggestions regarding the implementation of games in schools.

3.4.1.2 Implications for Learning: Guidelines for Game Design

The analysis presented in Chapter 5, focusing on patterns of use of affordances, was used to frame the suggestion of guidelines to game designers to

promote features in games that lead to learning. The analysis focused on relationships between the use of game affordances and learning opportunities. Results of this portion of the analysis, particularly focusing on the use of affordances, inform the design of new video games.

3.4.1.3 Similarities among Results and Grand Theories of Learning

As shown by the following figure, the last discussion item identified similarities and differences between existing theory and the emergent hypotheses discovered in the analysis:

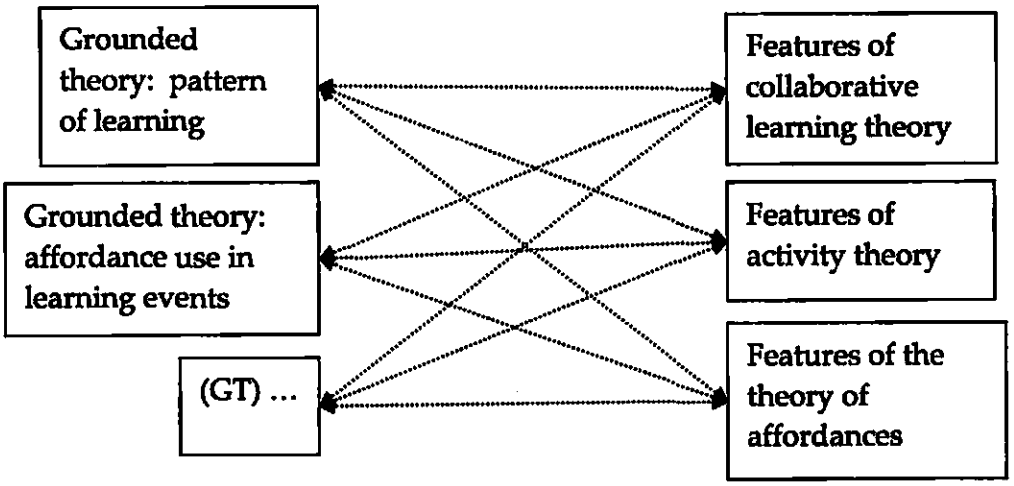

Figure 17: Discussion of findings: relationships between patterns of learning & affordance use with existing theory

Comparisons among the generated grounded theory and existing theory from activity theory, collaborative learning theory, and affordances are made in

the discussion. It is important to note that the generated theories are grounded in the data, rather than being imposed from the beginning. Similarities between discovered patterns of learning and existing theory guided and framed predictive generalizations to be made on the learning process through game play.

3.5 *CHAPTER SUMMARY*

The methods outlined above provide an in-depth, descriptive analysis of the learning process in educational games. Ethnomethodology and grounded theory have influenced the study design, placing value on emergent analyses that provide detailed descriptions and analyses of how students make use of games for learning.

By studying the cognitive and social affordances of games, insight was gained into *how* the learning process occurs in collaborative game play. Chapters 4 and 5 provide detailed analyses of the research questions (these chapters correspond to Phase I and II of the analysis outlined above). Results provide teachers, students and game designers with valuable information on how to better design and use games in educational contexts for learning purposes. Some limitations and delimitations mentioned briefly in this chapter (according to effects caused by a certain design decision of the study) are compiled and discussed further in Chapter 6, along with opportunities for future work.

CHAPTER 4:

ANALYSIS OF LEARNING EPISODES AND THE EMERGENCE OF PROPERTIES OF LEARNING

4.1 *INTRODUCTION*

As discussed in the methodology, a blended approach influenced by ethnomethodology (Garfinkel, 1967) and drawing from methods of grounded theory (Charmaz, 2006) was used. In line with ethnomethodology, preconceived categories were not imposed on gathered data; rather, emergent methods allowed the data to speak directly in the creation of conceptual categories. As categories began to emerge, grounded theory was used to extract, define, and test hypotheses from the gathered data.

Many passes were done across the video data. After a few initial passes, analytic memos were written to satisfy an initial coding phase as outlined in grounded theory. These analytic memos can be seen in Appendix F. Typical memos consisted of marking the video clips with time stamps, and adding a short analytic memo to the episode describing why it was chosen.

4.1.1 Selection of Learning Episodes

Initially, problematization guided the selection of learning episodes. Koschmann (2005) outlines problematization as the process by which a group comes to recognize an issue as a matter of concern for the group. The search for problematization episodes was undertaken as an initial strategy for selecting

interesting episodes of learning. In the many passes over the video tape, it was simple to mark points in the video tape where a problem was discovered and selected for pursuit (collaboratively by the dyad), and mark the later resolution of the problem. Cases where a task was selected for pursuit, but not later resolved were marked as well, as they represented opportunities where learning may have occurred, but did not. These *missed opportunities* are also represented in the analysis. Missed opportunities may serve as episodes worthy of further analysis, as they may highlight places where game design may be improved to better support learning. In the discussion chapter, these opportunities are discussed further with implications for instructional designers and game designers.

4.1.2 What Is Learning?

While conducting an emergent analysis and allowing the data to 'speak' directly, it became evident that not all learning was being well represented by problematization. Drawing from ethnomethodology, a predetermined definition (and expectation) of learning was not chosen. Garfinkel (1967) warns of a-priori definitions, warning that preconceived expectations can bias results, skewing the results based on the expectations of the researcher. Accordingly, the initial focus on problematization as an indicator of learning was not a fixed commitment, but

rather a guide for taking on a large data set. Problematization served as an entry or initial guide into working with the gathered video data, but after time it became evident that learning was occurring other ways.

Specifically, many episodes of learning appeared to be interrelated. Often, problems arose, and were followed by a sequence of events spread over time. Often problems were resolved after a series of interactions spread over a few days of the video tape. Additionally, other episodes appeared show learning occurring over several days, and were not well-defined by problematization. These 'trends' are discussed later in the analysis.

Our definition was thus expanded to include more types of learning, following the standard psychology definition of learning as "a change in behavior as a result of experience". While this definition of learning is rather broad, it avoids leaving out important aspects of learning that may be overlooked by less ambiguous definitions. The focus of this chapter is on providing an account of actual use of games for learning, in hope of adding clarity to the ways in which learning occurs in games, and to inform game design and pedagogy.

4.1.3 Selection of Learning Episodes

Grounded theory guided the selection of learning episodes for further analysis. With the approximately 24 hours of rich video data, initial coding and memo writing (aided by time-stamping video in Transana) was performed in order to help narrow what video was being examined and worthy of further analysis. "Anything interesting" was noted for subsequent passes on the video data, with focus on items that were selected for pursuit by the dyads during collaborative gameplay. Some examples include the learning of the functionality of an icon, the development of a military strategy in the history games, or the decision to acquire staff in the business game.

Selection of "interesting" episodes still left a huge amount of video data for further analysis. To identify a small enough sample of episodes that was still substantial for the project, episodes were selected that appeared in patterns (similar to focused coding in grounded theory). In this case, focused coding served as a means of reduction, rather than a means of gathering additional episodes supporting a hypothesis. Patterns in learning that appeared frequently enough to be recognized during focused coding became candidates for further analysis. This is a limitation of this project: not all kinds of learning have been accounted for in the analysis.

Although limited by this approach, the process favors the selection of learning episodes that show a recurring pattern of learning with games. Analysis of learning occurring repeatedly focuses on more common aspects of collaborative game play, which probably should be discussed first anyway. Further exploration of less common patterns of learning can be reserved for later work.

4.1.4 Student Demographics and Interviews

Student demographics and interviews are summarized here to help add some background and context to the transcripts discussed in this chapter. Additional information can be found in the Appendix: Appendix C1 has the demographics form that was distributed; Appendix C2 has the gathered results; and Appendix C3 has those results in tabulated form. Appendix J has transcripts of the recorded interviews.

As mentioned, there were two pairs of students playing each game. These groups were labeled "right" and "left" (their spatial organization in the classroom from the camera angle, situated behind the students and computers). Analysis in this document focuses on the right-side dyad in all three games; and additional information is provided for those dyads below. Information draws

from the demographics (a form filled out individually) and the interviews (done with the whole group, which shows higher convergence).

4.1.4.1 Civilization IV, Right Dyad

Both students were male, upperclassmen. The peer dyad consisted of two male upperclassmen as well. Neither had played *Civilization IV* before, but one commented that he had played similar games before, listing the game titles *Age of Empires*, *Age of Mythology*, and *SimCity*.

The students had different interests: one enjoyed classes in social science, music and astronomy best, while the other enjoyed sociology, psychology and math.

Both said they enjoyed their experience playing the game. One suggested it was hard to learn to play in the beginning. The other enjoyed the game enough to offer that he was considering purchasing a copy. Both said they learned while playing the game, thought it was fairly accurate, and enjoyed the collaborative play so they could discuss strategy with each other. However, both said they preferred being in control of the mouse (game controls). Both thought teacher assistance would be beneficial to the experience.

4.1.4.2 Making History: The Calm & The Storm, Right Dyad

Again, both students were male upperclassmen. The peer dyad consisted of one male and one female upperclassman. Neither student had played the game before. One student said they had played a similar game before, *Risk*.

The pair had different interests: one enjoyed photography, ceramics and cooking; and the other enjoyed social studies, gym and biology.

One student commented that the game was boring and difficult to play. The other said he enjoyed learning about certain periods of history (in World War II). He mentioned that the game was a bit confusing, but that he "got the hang of it" after playing a couple days. One mentioned that it made him think about the 'smaller' countries in World War II that often are not mentioned in textbooks. Both students and both pairs (in the group interview) mentioned that teacher assistance was helpful, based on the brief interactions with the teacher in this game (teachers did not interact with students in the other games).

4.1.4.3 RollerCoaster Tycoon 3, Right Dyad

The pair consisted of one male and one female student. Both said they have played the game previously. Both had played similar games, and mentioned *The Sims*. Again, they had different interests: one enjoyed history, geology and business; while the other enjoyed math, marketing and yearbook.

Both students commented that they enjoyed playing the game. Both mentioned that specific parts of the game were confusing, with one mentioning specific game aspects: such as creating level terrain and finding things. They both commented on their difficulty in placing attractions on unlevel ground in the game and working the 'controls' (most likely the control of the game interface, such as the camera view).

Both students thought they learned business principles from the game, such as management and "making money" by setting ride prices properly (based on customer feedback). They thought the business principles were accurate. They mentioned that playing the game collaboratively (in teams) helped ease difficulty in the game and encouraged negotiation. Both thought a teacher would be helpful, especially early in game play to help figure out the game interface.

4.1.5 Overview of Findings

Our emergent approach showed that learning occurs on multiple levels at multiple granularities, and that learning can be triggered by both social and game cues. These categories are discussed in depth in this chapter. Briefly, learning granularity describes the temporal location of learning in the video clips: represented either as a short episode, a sequence of episodes, or a trend.

Some of the multiple levels of learning with games show: mastery of the physical interface (keyboard, mouse, etc); mastery of the game interface and functionality; and the mastery of more advanced strategy, which can be used to accomplish game goals. Game triggers focus on cues that can cause learning, such as failure, other game events, and peers.

Following are examples and transcripts of learning episodes. These episodes have been coded in Jeffersonian transcript notation. For further reference on the symbols used in the transcripts, see Appendix G.

4.2 *Traits Common To All Learning Episodes*

Particular features of learning that were common to all learning episodes selected (in Appendix H) are discussed in this chapter. Some of these properties of learning are conceptual categories of learning, such as 'levels of learning' and 'granularity of learning', which are introduced here and discussed in greater detail later in the analysis.

4.2.1 *Levels of Learning*

In most cases, students began first by focusing on learning the games' interfaces, and the functionality of basic interface controls. This allowed students to achieve basic gameplay. With this foundation, students had the foundation to move a level higher and begin looking at the games' strategies required to win. Obviously, success hinged on their proper understanding and interpretation of the interface and game features, as well as a logically understood goal set made achievable by the game. As stated in the literature review, correct interpretation of the game's interface, functionality and goals hinges on the users' ability to match their mental models to what is happening and ultimately to the models and rules of the game.

Learning appeared to be done in overlapping, simultaneous levels in the games. These levels include:

(a) *Mastery of the basic physical interface*: usage of the computer such as mouse, keyboard, display, etc. (further discussion of this is outside the aims of this project)

(b) *Mastery of the software interface and functionality*: learning how to control the basic features of the game, such as learning the functionality of buttons, objects, and game features (discussed below in section *"A Foundational Level of Learning: Mastering the Game Interface and Interface Functionality"*)

(c) *Mastery of advanced strategy*: this varied per game, but had a common thread of goal achievement and strategizing ways in which to win at the game (discussed below in section *"A Higher Level of Learning: Advanced Strategy and Goal Achievement"*)

Typically, learning the functionality of the interface takes precedence early in game play in order to achieve basic control, which is followed by more advanced strategy. However, the learning of basic functionality of the interface occurs throughout all game play, as new features are often discovered later in the game.

Episodes illustrating the latter two levels of learning are described later in the analysis, with full transcripts of selected episodes in Appendix H.

4.2.2 *Granularity of Learning*

Initially, the analysis searched for learning in relatively short episodes initiated by Koschmann's concept of problematization, where learning episodes are marked at its endpoints by the discovery and resolution of a problem (Koschmann, et. al., 2005). Koschmann's definition worked well for the description of learning while examining video data, as it allowed for a "start" to be marked (the discovery of a problem) as well as an "end" to be marked (the problem's resolution). While Koschmann does not claim that all learning is episodic and can be problematized, it became clear during analysis that limiting ourselves to this would leave out additional interesting learning events that appeared in the data. However, the problematization lens served as an entry into the video data, as it gave something more specific to search for.

Two major problems arose from using problematization to frame learning: first, many anomalies emerged during data analysis, causing the problematization frame to be questioned; second, ethnomethodological principles suggested that predefining conceptual categories imposes predispositions on the data, causing bias and error. In line with emergence, the

concept of learning was broadened for the purposes of the study, and defined as any change in behavior that was observable. This definition was a better fit with the theoretical stance as well as the data.

However, the idea of learning as episodic was useful as an entry into working with the data. Problematization allowed for the discovery of many instances of learning. In looking for episodes, the majority of episodes showing learning were found using the problematization lens. Additionally, it caused the idea of episode granularity to be questioned. This led to the identification of a property of learning: that it can occur at different granularities.

Three categories of learning granularity were found and marked: those appearing as *single episodes* (short episodes, as originally expected: marked by a problem and its resolution); *sequences of episodes* (episodes that were sequentially linked, often across spans of time; where a problem was marked early on and solved in a later episode); and *trends* (changes in behavior that appeared across time; often not marked by a specific problem and its resolution). Learning episodes were found in Transana that illustrate all of these granularities and were tagged with keywords. Appendix H has a list of those episodes (coded in Jeffersonian notation) that were coded with a keyword to describe granularity (i.e., short episode, sequence of episodes, or trend).

The short episodes and sequences of episodes are discussed throughout the other categories of analysis, as they are similar in nature and fit well with the other conceptual categories. However, before describing the other conceptual categories, trends are discussed in their own section (in the section *"Trends"*, following this introduction). Many trends are game specific, but show learning occurring over larger spans of time. Trends are best illustrated by highlighting a game aspect that is moderately used over a long period of time (in this case, all four days of gaming).

4.2.3 Triggers for Collaborative Task Pursuit

During collaborative gameplay, the discovery of a problem and pursuit of tasks was often caused by either some social or game cue. Pursuit of a task can be recognized as uptake when a student takes "another's contribution and does something further with it" (Suthers, 2006, p. 331). Suthers describes types of contributions, which may include "attentional orientation, information, or expressions of attitude, reified as media affordances allow" (Suthers, 2006, p. 331). The concerted pursuit of tasks is representative of collaborative learning, as it shows the identification and pursuit of a problem.

Hidi & Renninger (2006) in their 'Four-Phase model of Interest Development' discuss gaining interest and adding motivation to tasks in their

first phase of interest development that they label "triggered situational interest". This might be set off by some sort of cue: either in the game, or socially. Analysis of the video data reveals several sources for information or cues that may lead to the pursuit of a task: they may come from specific game features (such as the game's representations and behaviors), or from social peers (while participating in collaborative gameplay together).

Social cues leading to pursuit of tasks are a feature of collaborative gameplay. In the episodes that follow, the pair tends to collaboratively negotiate their course of action, as well as share information with each other that they deem relevant. Many of the social affordances used by students are discussed later in Chapter 5 of the analysis, which will sequentially break down interactions in order to reveal affordances used.

Game cues leading to the pursuit of tasks are discussed in this chapter, in the section labeled *"Game Features That Trigger Task Pursuit"*, which illustrates how particular game features can lead to the collaborative pursuit of a task in the game by the students. Additionally, failure can often lead to the pursuit of tasks, which are discussed in this chapter in the section *"Failure as Motivation for Task Pursuit"*. Regardless, the cue grabs the attention of students and triggers their pursuit of a task. However, the pursuit of the task alone should not

automatically be classified as learning, as focus is on the pursuit of a task (similar to the identification of a problem), without determining whether the pursued task is successful (showing some behavioral change or the resolution of a problem). While the majority of the episodes exhibit a change in behavior and thus learning, it is possible that a game cue can trigger a missed opportunity (a task was chosen by the pair for pursuit, and learning was not exhibited).

Screenshots from the games are provided; however, it must be noted that these screenshots are not from the actual play (video recordings) by students, as the resolution in the video tape is not high enough to see what participants see. Therefore, screenshots taken from a game run by the researcher are used to aid the reader's understanding. Differences in representations (researcher's game versus student's game) are noted when appropriate.

4.3 *TRENDS*

Trends mark learning that occurs across a large spread of time: typically marked by a gradual change in behavior and evolving understandings of complexity of the game, its interface, and its functionality. As learning evolves, more complex strategies are employed by students in order to achieve success and meet goals in the game. Three examples follow: avatar interactions in *Civilization IV* (diplomacy), the use of production (economy) features in *Making History: The Calm & The Storm*, and the use of staffing in *RollerCoaster Tycoon 3*.

4.3.1 *Avatar Interaction in Civilization IV*

In *Civilization IV*, players take the role of an ancient civilization, and make strategic decisions on what technologies to research, what military units to build, what cities and economies to maintain, etc. Many complex decisions are made that result in the success or failure of their civilization. One of the very important aspects to manage is diplomatic relations with other civilizations.

The research design had two pairs of students playing a single-player video game for four days. These single player games had other computer-run civilizations that players were competing against in the game. As research

participants advanced over time, so did their competition (other computer civilizations).

Civilization IV starts out in a primitive state with just a few people, and is a turn-based game. This means that decisions are made by the game player each turn (they have as much time as they want for each turn), and that they have to choose to end their turn after they have decided on everything they want their civilization to do for that turn. After ending their turn, the computer civilizations do the same (make strategic decisions). Each 'turn' marks something changing / advancing, and also marks the advancement of time in the game (each turn represents a few years). As the years fly by in the game, typically civilizations become more advanced and greater in size. This is represented in Figures 18 and 19.

Figure 18: Early gameplay in *Civilization IV*

Figure 19: Later gameplay in *Civilization IV*

Diplomacy with other civilizations is a key aspect that needs to be mastered in *Civilization IV*. Often, the game's computer-run civilizations will address the game players. At first, this often surprises the game players, as they are intently focused on their own civilization and then they are interrupted from what they are doing. Diplomatic interactions take the form of a large pop-up that fills the screen with the avatar of another civilization (for instance, the Greek civilization's avatar is 'Alexander', who wears a bronze chest plate, has a somewhat cartooned 'Greek' appearance, and has a building in the background

resembling the Parthenon). The character is animated and his body language corresponds to his mood (for instance, if bad relations exist, he will appear angry), as can be seen in Figure 20:

Figure 20: Avatar interaction in *Civilization IV*

The following episode transcriptions show a progression over the four days of game play by a pair playing the game and illustrate a learning trend. Transcripts use Jeffersonian Notation (Jefferson, 1984): see Appendix G for a summary of the notation. Full transcriptions of episodes in this section are

available in Appendix H.6. There are eleven episodes; following are excerpts from them.

Following is the first interaction with avatars during the first day of game play:

R: Press Enter.
L: ((*Presses 'Enter' on keyboard*))
R: ↑What?↑ ((*Trader window pops up*))[2]
¤<832166> [3] (.)
L: 'I am (unclear speech)' ((*Reading from pop up window of a leader who has something to say*)) He's Greek.
R: He's gonna declare war against us.((*Laughs*))
L: ((*Laughs*)) Oh.
R: We should probably -
L: We should probably go start building an army. ((*Uses a shortcut on the keyboard*))

---

[2] "When another leader makes you an offer, you must choose to refuse or accept the offer. If you accept, the trade occurs immediately. If you decline, the other leader may ask you to make a counter-offer, may end diplomacy, or may declare war on you." (*Civilization IV* Manual, p. 101)

[3] Time Stamps will take the following form: ¤<1624413>

The number following the stamp ¤ inside the brackets < > represents a time, in milliseconds, in the original video data.

((*Highlights 'Farewell'*))[4]
¤<848677>

In the third line above, the right hand person is surprised by the avatar that has popped up in the game. Progress seems to slow down as the pair reads the new information that has seemingly come out of nowhere. As they realize it is another civilization that they are competing with, they strategize that they need to begin building up an army to deal with them.

The second avatar interaction is prompted by the gamers themselves. After realizing in the first interaction that they can talk to other civilizations, they initiate diplomacy as follows:

R: Like, click on them, and see if you can do anything. ((*Clicked on Isabella avatar*)) 'Let's discuss something else' ((*Reading screen option in avatar interaction*))[5]
L: ((*Clicks on 'Let's Discuss Something Else'*)) (unclear speech: reading dialog on screen)

---

[4] "The gamer has four options to choose from when the trader screen comes up. They can accept the trade, decline the trade, talk about the other leaders, or say farewell and leave the trader for now." (*Civilization IV* Manual, p. 101)

[5] This gives the option to discuss other leaders with the current leader that would like to trade. This game option can be beneficial when trying to figure out allies and enemies (for diplomacy, warfare, etc.).

R: 'What do you think of' ((*Reading avatar interaction dialog / option*))

L: ((*Clicks 'What do you think of...'*))

R: 'Let's discuss something else' ((*Reading screen option in avatar interaction*))

L: ((*Clicks on 'Let's Discuss Something Else'*))

¤<1358341> (.)

R: >↑Oh no↑<, go back. ((*Points to screen*)) Click (.) 'What do you think of'. ((*Reading screen option in avatar interaction*)) Can you type something in?

L: ((*Clicks on 'Let's Discuss Something Else'*))

¤<1362044> (.)

R: Or no?

L: No. ((*Clicks 'Farewell' to dismiss avatar*))

¤<1364984>

The first user-initiated avatar interaction (above) is different than the first, which was computer-initiated. Above, the pair seeks out diplomacy with the other civilizations at the top of the transcript. It appears that through the middle of the transcript, the pair attempts to explore diplomatic options by trying out some of the things on the diplomacy interface, which can be seen in Figure 21. While the first episode draws attention to the game feature of avatar interaction, the second shows the pair exploring diplomatic options that were afforded by the game interface, as if to gauge potentials for action (exploring affordances).

Figure 21: Trade and diplomacy interface in *Civilization IV*

Later on in the day, the pair was offered an item for trade, but decided to make their first major diplomatic act by declaring war on the other civilization. While this interaction was computer-initiated, the pair continues to explore the affordances provided by the interface and try out some of the functionality by declaring war:

L: ((*Leader pops up to make a trade*))
((*Leaders tradable items show on left side of screen, pair's tradable items show on right side of screen*))
R: ↓We we can trade a pig.↑ ((*Scrolls over to pair's tradable items*))

L: ((*Laughs*)) [°Barter.°]

R: ((*Scrolls over to leaders tradable items*)) [°What's expensive?°]

¤<2956804> (.)

R: ((*Clicks through different items to trade*)) I, I want to declare war on someone.

L: Oh, go back.

¤<2960774> (.)

R: ((*Clicks out of avatar screen back to main screen of game*))

L: And ah (.) hit you have to hit his name. ((*Points to the leaders name*)) ↑No not our name.↑

R: ((*Clicks on the avatar's name like L suggested*)) I did his name.

¤<2966472> (.)

L: There.

R: ((*Leader pops up again*)) ((*Clicks on 'Let's discuss something else'*))

L: No. >There there.< Do it.

R: ((*Clicks on 'Declare War'*)) Look, look at this. ((*Prompt pops up asking if they want to go to war*))

L: Yes.

R: ((*Clicks on 'Yes'*)) ((*Laughs*))

¤<2979834>

At the top of the transcript, focus was on trading: the pair seemed surprised that they could trade some pigs with the other civilization (remember, this is early in game play, and the civilizations are not yet very advanced).

However, after exploring the interface, the right hand (R) person states that he "would like to declare war on someone". Because his request is non-specific ("someone"), it appears that the request is to learn of their strategic capabilities and the functionality of diplomatic acts, rather than a strategic move against a particular civilization that is interfering with their progress.

The next avatar interaction shows several changes in the growing complexity of the group's understanding of avatar interactions. First, a second civilization has been discovered, raising the overall range of diplomatic possibilities (creating teams or alliances in the game). Second, the pair attempts more complex trade offers with other civilizations, attempting to trade resources in their proposals. Additionally, the pair explores advanced treaties involving the trading of cities, which they deemed impossible after trying:

```
R:  ((Leader pops up asking to go to war))
((Clicks on 'Let's Discuss Something Else'))1
L:  ↑War!  Do it.  Do it.
¤<2218975>  (.)
R:  ((Clicks on 'What do you think about Isabella?'))
No it's with Isabella.
L:  Let's team up with him and then just (.) kill
Isabella.
R:  °'Now tell me what you think and be totally
honest.'° ((Reading from the avatar screen))
¤<2229218>  (.5)
```

R: ((*Clicked on Isabella's name*)) Just keep clicking on it.

L: No dude.

R: Hold on. ((*L tried to take mouse away from R*))

((*Clicked on 'Let's discuss something else'*))

((*Clicked on 'What do you think of...'*))

L: Head off the war.

R: °No.° ((*Clicks 'Farewell'*))

¤<2244931> (.)

R: ((Clicked on *Alexander the Greek leader*)) No. I didn't want to do that. ((*Clicks 'Farewell' on avatar screen*))

((*Goes back to main screen*))

((*Clicks on Isabella*))

((*Isabella pops up*))

((*Clicks on 'What would you like to trade'*)) 'Trade Proposals' ((*Scrolls over what Isabella has to trade*)) 'Declare war on Alexander.' ((*Reading a choice on Isabella's trade list*))

((*Clicks on 'Declare War' does not confirm*))[6]

L: Trade. To declare war?

R: ((*Scrolls over what the pair has to trade*))

L: We have one gold. ((*Laughs*)) Whatever that means.

¤<2267681> (.)

R: ((*Clicking through what the pair has to trade*))

---

[6] "The polite way to open hostilities" (*Civilization IV* Manual, p. 100), referring to a diplomatic war declaration. It is also possible to initiate a war without warning the enemy by invading their territory.

Well how do we offer stuff? ((*Clicking on every option the pair has to trade with*)) Oh ok we can only trade gold?

L: Yeah. (.) ↑We can only offer tangible items.↑

R: ((*Clicks on all of Isabella's tradable items*)) Do you want (unclear speech) ((*Clicked on a city that Isabella had*))

L: No. You can't trade cities.

R: Why not?

¤<2287384> (.)

L: I guess you could but...

((*Clicks on 'Farewell' to exit avatar interaction*))[2]

¤<2290947>

A few discoveries were made in the above episode: the potential to team up with other civilizations was available (the team found an option under 'trade requests' to declare war on another civilization); and the pair discovered some regularity in tradable items (they must be tangible things such as gold, products or even cities).

After earlier exploration of what Isabella had to offer, the pair decided to allow 'open borders' with Isabella (this allowed the movement of their people, items, and military across the borders of the other civilization without causing conflict). Additionally food resources could be traded between civilizations:

R: 'Let's make a deal.' ((*Isabella, a leader, pops up to trade; reads choices from screen*))

L: 'Open Borders?' ((*Reading choices from pop up window*))

R: Yeah. Tell them that's a good deal.

L: To do it?

¤<1027672> (.)

L: We would -

R: °What are the current deals that we have together?° ((*Reading choice from screen*))

L: ((*Clicks on 'What are the current deals that we have together?'*)) [7] ↓Nothing.↑ ((*Laughs*)) ↑Oh wait.↑

¤<1038761> (.)

R: Open borders.

L: 'Isabella offers clam for wheat.' ((*Reads from screen*))

((*Moves mouse from 'Trade Offers' to 'Farewell' but does not click anything*))

R: Yeah. (.5) °Say 'Farewell.'° ((Reads choice from screen))

L: ((Clicks on 'Farewell'))

¤<1049837>

---

[7] "Some "annual" deals continue over time. This option lets you review any such deals you have in place with the leader." (*Civilization IV* Manual, p. 100)

Figure 22: World view in *Civilization IV*

A later episode demonstrates the discovery of more civilizations. As time unfolds in *Civilization IV*, the size of one's map grows (the map slowly uncovers itself as more territory is explored, as shown in Figure 22). In the following episode, a new civilization was discovered on a recently uncovered part of the map:

R: ((*A leader has popped up to trade*))

L: Whoa.

R: What?

L: 'Greetings honorable Craig.' ((*Reading from leader screen*))

R: 'There's only peace in our town.' ((*Reading from leader screen*))

¤<1808595> (.)

L: There's another guy?

R: Yeah. ((*Clicked on the pair's tradable items*)) ((*Scrolls through leader's tradable items*)) (1.0) °'Declare war has ended.'° ((*Reading pop up on screen*)) (1.0) Why can't they do that? (.5) How much gold we like from them? ((*Clicks on leader's gold*))

¤<1832004> (.)

L: ((*Points to gold supply*)) No dude they only have ten. ↑We have so much ↑gold let's give 'em gold for something.↑

R: ((*Clicks 'Ok'*)) Well we do. ((*Clicked on pair's gold supply*))

L: Give 'em ↑gold for uh (.5) ↓'Open Borders.'

R: ((*Clicks on gold amount and increase it for trade*))

¤<1844822> (.)

R: ((*Clicks 'Ok'*)) °Whatever.° ((*Clicks on several of the leader's tradable items nothing is appearing for options*))

L: °No passing?°

R: ((*Clicks on gold that was on the trade table*)) [8]

---

[8] "On the Trade Table, all of your tradable items are listed in the right-hand column, while the other leader's stuff is in the left hand column. To make an offer, click on one (or more) items in your column, and one (or more) items in the other leader's column, and then click on the "make

L: ↑'Open Borders for Open Borders?'↑ ((*Reading what in on the trade table for the leader and the pair*))
((*Laughs*))
R: Yep.
L: ↑>What. What.<↑
R: I guess we just have to end it somewhere. ((*Clicks on 'Farewell'*))
¤<1875610>

Often interactions with new civilizations consist of learning of new items that they might have for trade. In this case, the pair attempted to purchase open borders from the other civilization, which then came back with a counter offer: open borders for open borders (allows both civilizations to move across each other's land). It appears that game players were beginning to realize that new civilizations are resources in the game that can be used via diplomacy (to gain new items, to gain strategic positions, etc.)

The next set of episodes demonstrates a growing complexity in understanding of the role of diplomacy. The pair has been fighting a war with another civilization: Alexander (the leader of the Greek civilization). Alexander attempts to make a peace treaty with concessions early on in the war:

---

offer" button. If the leader agrees, the deal is done. If not, you can exit diplomacy or try another deal." (*Civilization IV* Manual, p. 101)

R: 'Peace Treaty.' ((*Reading choices from leader on screen who would like to trade*))

L: >NO.< We're gonna win dude. We're winning it.

R: He's furious.

L: >No, no, no.< It ain't happening. It ain't happening. ((*Points to 'It ain't happening'*))

R: Hold on here 'Willing to negotiate'. ((*Read option from leader's choices given*))

L: Wait try that first.

¤<2499149> (.)

R: 'Declare war on Isabella?' ((*Reading from screen the options that the leader is giving the pair*))

¤<2506074> (.5)

L: No dude.

R: ((*Clicks on pair's tradable items*))

L: ↑Forget that just we we're gonna take over his empire anyways.↑ (.5) 'Alexander offers to cease fire.' ((*Reading from screen*))

R: ((*Clicking on leader's tradable items*))

L: (1.0) ↓Make him give us gold.↑ ((*Laughs*))

¤<2525427> (.)

R: ↑What?↓ I am making him give us a city. ((*Clicks a city of Alexander's to trade; he starts flying his fists around and shaking his head no*))

L: >Do it.<

¤<2529462> (.)

L: ↑Forget that dude we'll just, we'll just destroy them.↓

R: ((*Clicks on 'Never Mind'*))

((*Clicks on 'Farewell.'*))

¤<2554873>

It appears that the pair is confident in their ability to destroy Alexander. The pair makes a counter-offer: a peace treaty with concessions, which is high-stakes for Alexander. This makes him angry, and he rejects the offer. The war between civilizations continues for a while.

In the next episode, a second diplomatic effort by Alexander is rejected by the pair:

((*A leader has popped up to make a trade proposal, offers peace treaty for current war with concessions*))
R: °What's this mean? Do 'Peace treaty.'[9]
¤<2015311> (.)
L: >No dude.< Then we have to trade our code of laws. ((*Points to the only thing the pair has to trade*)) Screw that it ain't happening.
¤<2020179> (.)
R: ((*Clicks on 'Can we Negotiate?'*)) °What?°
((*Clicks on 'Would you like to make another deal?'*))
((*The leader starts shaking his fist and head no*))
¤<2025653> (.)
R: °What?°
L: °He wants something = from us. °Nah screw that.

---

[9] "Available only if you're at war." (*Civilization IV* Manual, p. 100)

R: ((*Scrolls over what the pair has to trade*))
L: Just say 'Never mind.' 'Farewell.' ((*Reading from screen the choices*))
R: ((*Clicks on 'Never Mind'*))
((*Clicks on 'Farewell'*))
¤<2040500>

While the pair enjoyed some early success in the ongoing war with Alexander (Greek civilization), the war had been continuing for some time and had drained the pair of resources. The other civilization offered a peace treaty with concessions, a deal where the pair would have to give the enemy some of their technology items. However, the pair decided to reject the treaty in favor of continuing the war and keeping their goods. Still, a change could be seen because the war had been dragging on and draining resources.

A change in behavior could be witnessed in the next episode: after the war mentioned in the previous episode continued even longer, and the civilization became more drained by the war, a peace treaty with concessions was considered:

R: °Alright, lets this one° ((*Leader popped up for trade*))
L: ↑NO.
¤<2699317> (.)
R: Yeah. Dude they're going to kill ↑us. ((*Laughs*))
L: ↑Feudalism↑? ((*Points to what the pair has on the*

trade table, Feudalism))

R: Craig, they're gonna kill us.

L: ↑We're giving 'em↓ ↓our crap for ↓nothing dude!↑

R: ((*Clicked on 'Can we negotiate'*)) Give us the city.

¤<2710577> (2.0)

L: ↑Tell him to give us Delphi↑. ((*Laughs*))

R: ((*A note from the leader popped up*))

((*Clicked 'Ok'*)) °Whaaa ha what?° ((*Offer rejected*))

¤<2715688> (.)

L: ↓Whatever I don't care.↑

R: ((*Clicks to accept the original offer of a peace treaty with concessions*))

((*'We would like to make a proposal' pops up*))

°Where's the city?° ((*Clicks on the leaders city to trade*))

((*Trying to click on 'Declare War'*)) (.5) How do I declare war against someone? ((*Clicks 'Farewell'*))

¤<2731383>

Some negotiation occurred: one student did not want to give technology up for the peace offer, but ended up giving in after some convincing by his teammate. In the above transcript, diplomacy appears to take a more complex understanding, as game players realized it may be the only way out of the war they have been fighting for too long. This furthered their understanding of the purpose of diplomacy: the pair realized that giving away some technology is a better option than continuing to fight a war they might lose.

A final example from game play shows diplomacy becoming more complex, as other civilizations forced the pair to choose sides (as the level of competition was raised towards the end of the game). One computer civilization requested that the pair stop all trading (in effect, an embargo) with another civilization:

L: Ah, we would lose our Explorer. ((*Leader has popped up to start trading*))
((*Clicked on offer that is on the table*))
R: No.
L: And we can't construct harbors.
R: No. Say no.
¤<1152685> (4.0)
L: ((*Clicked on 'Farewell'*)) °Trader.° ((*Isabella popped up wanting to talk*)) °'It can no longer be tolerated we demand that you leave the Egyptians'° ((*Reading what the leader has to say*)) What's our deals with the Egyptians? (.5) ↑We should probably cancel it because she's right next to us.↑
R: Yeah. Let's do that.
¤<1176934> (1.0)
L: ((*Clicked on 'What do you think of...'*))
((*Clicked on 'Alexander'*))
L: 'Annoyed.' ((*Reading from screen*))
((*Laughs*))
R: ↑See if you can declare war with her.↓ Make a trade proposal. °No that's something else.°
L: ((*Clicked on 'Farewell'*)) Oops.

R: Click on ((*Pointed to Isabella's name*)) (.5) Isabella.

¤<1205440> (.)

L: [Trade Proposal?] ((*Reading from list of options from trade screen of Isabella*))

R: [Trade Proposal?] Yeah.

¤<1210254> (.)

L: ((*Clicks on 'Trade Proposal'*)) ((*Items to be traded for both sides pop up*))

R: °Like declare war on her. (.5) Scroll down. 'Alexander'.°

L: For what?

R: Click on that.

L: What?

R: Click on 'What do you want for this'. ((*Choice on screen*))

L: ((*Clicks on 'What do you want for this' option*))

R: No what? ((*Isabella is shaking her hand and her head no*))

¤<1230833> (1.5)

L: [Gold going up] ((*Clicked on their gold*)) ((*Closed gold option*))

R: [Gold going up]'Can you trade this for a good friend?' ((*Points to option on Isabella's trade screen*))

¤<1239030> (.)

L: ((*Clicks 'Can you trade this for a good friend?'*)) ((*Isabella shakes her head no and her hand no*)) I don't know what we're doing.

R: Ok never mind. Go back to. ↑Try to declare war.↑

```
L:  ((Clicked on 'Farewell'))
¤<1246428>
```

While the pair explored more diplomatic and trading options in the latter part of the episode (learning more advanced trading appears to continue), it is interesting to see their reasoning for choosing sides in their situation. After the experience of war with a nearby civilization, the pair appeared to want to avoid wars with civilizations close in proximity because their militaries can invade easily, and as with all wars, they can be costly. In the episode, the pair was willing to alienate another civilization in order to appease a nearby civilization (thus avoiding going to war with the nearby civilization).

The episodes above highlight a trend of learning that occurred in the game, namely learning diplomacy and trade in *Civilization IV*. As can be seen, it might be difficult to isolate learning to a specific episode or series of episodes, as learning appears to progress throughout the whole series of game play. Each interaction shows a slightly greater complexity of understanding by the pair. This is well supported by the game in keeping early interactions fairly simple, and steadily raising the difficulty of diplomatic exchanges.

4.3.2 *Production in Making History: The Calm & The Storm*

In *Making History: The Calm & The Storm*, game players selected a country during World War II. Multiple scenarios are possible: players chose times throughout the war to begin playing. For instance, one can play as Germany in the late 1930s, as Great Britain in 1941, as the U.S. in 1944, etc. Many countries are available to play, and each scenario can start at various times through the war, as seen in Figure 23:

Figure 23: Game scenarios and available nations in *Making History: The Calm & The Storm*

As in *Civilization IV*, there are many aspects of the game that need attention: game players need to focus on their military, diplomacy efforts, and their economy. One can play a scenario in the war and based on their decisions, change the outcome of the war. Often historians hypothesize about the 'what-ifs': For instance, what if Germany had never entered Russia? Game players could try various strategies and see what the potential outcomes might have looked like.

In *Making History: The Calm & The Storm*, players appeared to gravitate and orient themselves toward their country's military. Often early game play was marked by attempted military conquest. One of the first things game players discovered was how to declare war, and they often abused this power in the simulation. However, this caused problems: by declaring war on many countries and angering the world, diplomacy often failed as a result. This caused other countries in the game to form alliances and gang up on them, ultimately resulting in losing the game. After experiencing this, game players began to realize the importance of diplomacy in their efforts in the game. Also, as military forces began to run out of steam (often depleted after several battles), game players realized the importance of a strong economy to support their military objectives.

The following episodes mark a trend of learning through the four days of game play: focusing on how students learned to succeed in the game. There were eight episodes, with full transcripts available in Appendix H.6. The episode excerpts demonstrate game players learning to use their economy with growing complexity, typically to change production and support military objectives. Commonly, changes were made by the pair in building military units such as airplanes, tanks and troops to help support their military campaigns.

Early on, the pair became aware of oil production as an important resource in their economy:

L: Export. (1.0) ((*Looks over at peer dyad's screen*)) We need some oil I think.
R: What do we need to produce this though?
L: ((*Laughs*))
((*Clicked on oil icon*)) [10] Oooo oil.
¤<297653> (.5)
L: ((*Saw oil on map*)) Yeah. ((*Clicked on 'Mini Map' USA*)) [11]

---

[10] "Resources fuel your nation. To produce anything, your cities need oil, coal, and metals. Without these resources, production will slow and eventually cease." (Making History Manual, p. 34)

[11] "Use the mini map to quickly move around the world. Clicking anywhere on the mini-map will take you immediately to that destination. The default view is of your nation." (Making History Manual, p. 8)

((*Moved camera to India region*)) Oh there's a red dot right there.
((*Clicked on an explosion in the Indian Ocean*)) Oooo.
((*Scrolled around map back to USA*))
¤<307901>

While this is very early in game play and players were exploring the game interface, it appears that the pair identified resources in the game that they thought would be important. Later, they discover that they could produce things, which served to support their game objectives (For example: producing tanks to support a war). In the next episode, the pair became aware of the production of military units:

L: ((*Game manual in hand*))
¤<361956> (10.0)
R: Wait see we can make like ↓armies and ↓stuff.↓
((*Opened Production menu*)) [12] Choose where you want to build° ((*Scrolling through products to build*))
¤<377203> (5.0)
R: Should we build some planes?
L: We can build planes?
R: Yeah.
¤<391175> (.)

---

[12] "Production Reports list completed military units and resource outputs for that turn. Click on the Production Report button to view the report." (Making History Manual, p. 12)

L: ((*Looking through game manual at Military section*))
R: ((*Scrolls through Production menu*))
((*Chooses planes to produce*))
¤<402159>

In the above episode, the pair changed the production of one of their city's factories to produce airplanes. Early in the episode, they learned that factories can be modified to produce other goods (in this case, airplanes). However, the interface of *Making History: The Calm & The Storm* is a bit vague: it is not evident whether the pair thinks they have changed all factories to produce airplanes (each country or player typically has multiple factories), or just the factory they selected (an individual city or factory). In the episode above, the pair simply changed one factory's output. In the game, major cities on the map have factories, and to adjust their production, they must be changed individually.

The following episode excerpt shows one student explaining to the other student his understanding of how production works (with a few interruptions by the teacher giving advice):

L: How do you find that production of our...
R: Ah. Now what I just clicked you clicked on that. Just click on that thing. ((*Points to 'Manage & Build*

Forces')) [13] What do you want to build more armies? ((*Laughs*))

L: This?

Teacher: Hey, when you guys plan your attack, be sure you don't leave your resources too thin. ((*Gives advice about planning their attacks*))

¤<545056> (.)

R: No the swords. And just click German military.

L: ((*Clicked on the swords 'Military' icon*)) [14]

R: Then you can change like what you are producing.

¤<553433> (1.0)

L: What? ((*Scrolling through 'City Production' window*)) [15]

Teacher: When you plan your attack make sure you

---

[13] "To improve your military, you can invest in research. To expand your military, you should build new forces. When building, consider how you want to balance your forces—their defensive and offensive strengths, unique capabilities, costs, and production times. You can rearrange forces, splitting and combining as necessary. If you have economic difficulties, you can disband divisions." (Making History Manual, p. 22)

[14] "Army units are called "primary units" because they are the only military forces that can control land regions. Conquering and defending land regions is essential to game success. Army units fight in divisions, which can contain any combination of Infantry, Armored, Artillery, Missiles, or Mobile forces." (Making History Manual, p. 16)

[15] "Clicking on the (Nation) Industry button takes you to the City Production box. There you can review and revise what your cities are producing. As leader, you decide what is most important to produce, and change orders accordingly. The four tabbed sections—Cities, Output Distribution, Supplies, and Production Report—allow you to assess all aspects of your nation's industrial needs." (Making History Manual, p. 33)

don't deplete your resources so low that you can't defend yourself.

L: Right. ((*Clicking through 'Production' menu*))

¤<567060> (.)

L: ((*Laughs*))

R: ((*Laughs*))

L: ((*Closed 'Production' menu*))

Teacher: The thing with war you want to take the offensive but you don't want to leave [your (.5) uh] =

L: [Oh should I leave...]

Teacher: = defenses so thin that you can get attacked from the other side.

¤<578019> (.)

L: ((*Scrolled through map*))

((*Map now has each country in different colors*))

R: What happened to the map? ((*The group was on World Summary' map*)) [16]

L: ((*Clicked on 'Diplomatic' icon*)) [17]

((*Clicked on 'Diplomatic' icon on mini map*))

R: Oh. ((*laughs*))

---

[16] "The World Summary map gives a big picture view of the world's nations. You can see nation borders and capitals and track territorial changes. (A conquered region changes to its new ruler's color.) You can also click on all regions, nations and capital cities." (Making History Manual, p. 9)

[17] "In the Diplomatic panel, you can propose treaties and review alliances. As the game progresses, you can declare war, demand surrender, or beg for peace." (Making History Manual, p. 25)

¤<583198>

Shortly after the above episode, more peer direction and explanation of understanding was given:

R: Some city.
L: ((*Clicked on 'Military' icon*)) [18]
¤<686652> (.)
R: Yeah I think we're making (.5) yeah we do need more planes. ((*Scrolling through 'Production' menu*))
¤<690977> (4.0)
L: Basic fighters (.5) see assign. ((*Scrolling through 'City Production' screen*))$_2$ One per five turns. Alright, so we need to get more so I can use (unclear speech) 'Change Order' ((*Clicked on 'Change Order'*)) [19]
R: No go to yeah or [air force]
L: [Air force]
¤<720421> (1.0)
L: Takes five turns to make resources required. ((*Reading from 'City Production' screen for 'Air*))

---

[18] "Your army, navy, and air forces contain a variety of military units, each with a set of offensive and defensive capabilities. Offensive powers are measured in how well a unit can attack on land, in air or at sea. Defensive strength is assessed by how many hits a unit can absorb in battle. Some units have capabilities unique to their unit type." (Making History Manual, p. 14)

[19] "From the city panel, click on change order. In the Production Orders box, your current order will be highlighted. Review the tabbed options, choose a new production order and click on the order. Note: you can only build naval forces in port cities." (Making History Manual, p. 23)

force')) [20]

((Clicks on an Air Force in Europe))

((Clicks 'Change Orders'))

¤<729569> (.5)

L: Ah it will be finished in one turn. What's IPU? Required. *((Picks up game manual puts it down to return to game))*

R: I don't know.

¤<759827> (.)

L: *((Clicks on a Bomber plane))* [21]

R: Oh see the IPO IPU is like (.5) like that is why it takes five turns.

¤<781952>

Early in the episode, the pair selected different products for their factories to produce. Toward the end of the episode, they begin to realize that products take time to produce, depending on the factory and the item. Since *Making History: The Calm & The Storm* is a turn-based game (players take turns, and time

---

[20] "Fighting in squadrons, air units can attack land and air forces, cities, ships, and resource producers. They can also patrol and perform reconnaissance over land and water, both crucial to unfogging regions. Air units cannot control regions. In the game, look in Military Unit Types in the Book to see air unit capabilities. (In this guide, look in the Book section to learn about the Military Unit Types chart.) Some unique air unit capabilities are fighters and bombers." (Making History Manual, p. 17)

[21] "Bombers can travel farther than fighters. They can attack everything fighters can attack, plus naval groups, cities and resource producers." (Making History Manual, p. 17)

passes), the pair realized that products were not immediately made. Rather, each product takes some time to build, depending on the production level of the factory and the item being produced. An example can be seen in Figure 24, which shows a sample of production items and the amount of time required to build the items. It appears that a more complex understanding of production was gained by the pair: such that each resource could be made by assigning factories to make the resource, and that information is available telling how many turns (represents time in the game) it takes for a resource to become available (until it is built).

Figure 24: Example factory production orders in *Making History: The Calm & The Storm*

The next episode shows a quick modification of products (of several factories):

```
L:  ((Clicked on an Alliance factory))
(('Production' menu came up))
((Clicked on 'Air Force'))
((Closed window))
¤<1817322>  (.)
L:  ((Clicked on a different Alliance factory))
((Clicked 'Change Orders'))
((Production window came up))
((Clicked on 'Air Force'))
```

```
((Closed window))
¤<1848192>  (.)
L:  ((Clicked on a Alliance))
((Clicked on 'Change Orders'))
((Production menu popped up))
((Clicked on 'Air Force'))
((Scrolled over 'Fighter' planes))
((Clicked on 'Fighter'))
((Closed window))
((Clicked on another alliance factory))
((Clicked on a different alliance factory))
((Clicked on another alliance factory))
((Clicked 'Change Orders'))
((Clicked 'Air Force'))
((Clicked 'Bomber'))
((Closed window))
((Clicked on another alliance factory))
¤<1856294>
```

Not much was discussed in the above episode. The lack of discussion might imply shared meaning: that both students understand what is being accomplished. However, the lack of discussion could also indicate the right hand student was disengaged with the game: he did not verbalize his thoughts before or after the episode. At the end of the preceding episode, a brief mention of IPU (production units, which relate to how long it takes to built things in the game) showed an understanding that different items take different amounts of

time to build (and that the right hand student was still somewhat engaged). However, it was still unclear whether the pair realized whether they had to adjust production levels of each individual city (and factory, as there is one factory per city). While unclear earlier, the left hand student's actions show that he knew that each city's factory produces something, and that the production of each must be checked individually.

A final episode shows the linkage between production of goods and other game actions:

```
L:  Alright, let's see where are we, what we're
producing.  Oh that's not good.  ((Clicked on a
factory))
((Clicked on 'Change Orders'))  Should we do land
troops?
R:  Yeah.
¤<302763>  (.)
L:  ((Clicked on 'land troops'))
((Clicked on first option in Production menu))
((Closed window))
((Clicked 'Change Orders'))
((Clicked 'Land Troops'))
((Clicked 'Air Force'))
((Clicked Bomber))
((Closed window))
((Clicked on an alliance factory))
((Clicked 'Change Orders'))
```

```
¤<321070>  (.)
R:  Send those planes in there.  Just bomb the crap
out of them.
L:  ((Clicked 'Land Troops'))
((Closed window))
¤<330109>  (.)
L:  ((Clicked on a factory))
Alright, what?
¤<338782>
```

The above excerpt illustrated several related actions, e.g., the checking of production of factories, followed by a military move attacking an enemy. It appears that the pair understood that their nation's production was a source of replenishing their military forces.

4.3.3 *Staffing in RollerCoaster Tycoon 3*

In *RollerCoaster Tycoon 3*, business students were taken from a similarly focused business class to participate in playing the game. Most students had prior experience with the game or a similar game and were enthusiastic to play. It seemed that all knew that their role was to manage a theme park and make money (to operate a profitable park).

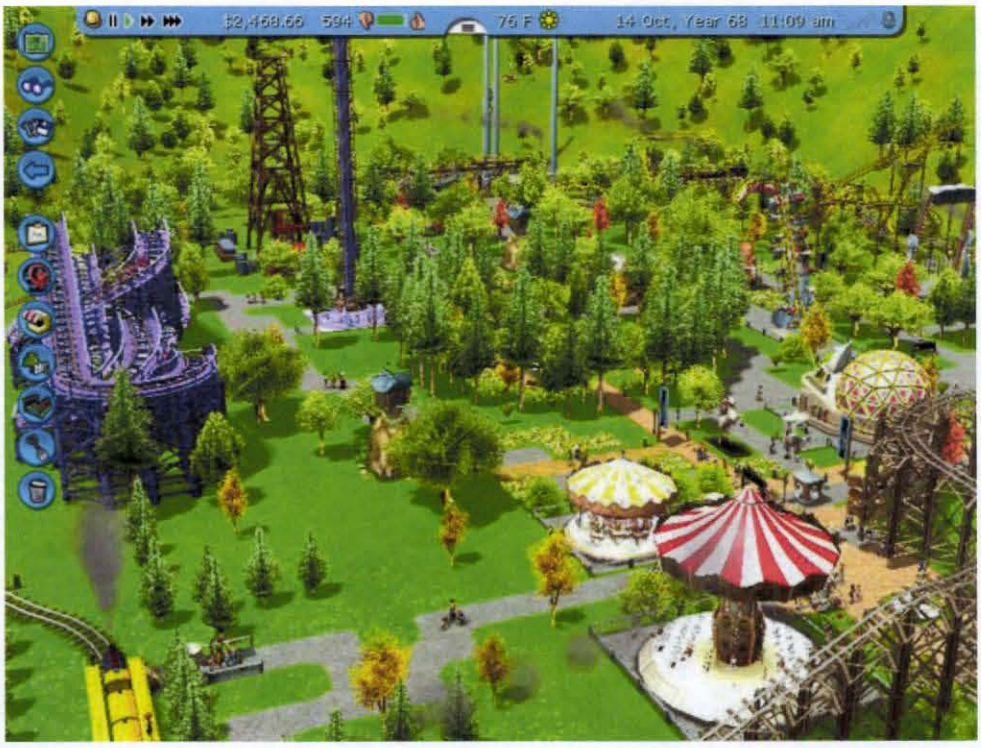

Figure 25: A sample theme park in *RollerCoaster Tycoon 3*

As can be seen in Figure 25, *RollerCoaster Tycoon 3* is a theme park simulation, where game players assume control of a theme park. They are given a top-down view of the park, and are responsible for things like creating attractions, rides, food stands, foot paths, scenery, etc. (things common at a theme park). Additionally, they assume a managerial role by controlling things like admission prices, staffing, food and ride prices, as well as park and ride maintenance.

One recurring trend in *RollerCoaster Tycoon 3* was staffing. As park manager, gamers were required to hire staff to maintain the park operations:

mechanics to maintain rides, janitors to keep the park clean, ride inspectors, animal trainers, and entertainers. Each employee has properties that can be changed (wage, uniform, training, etc.) and has a satisfaction rating with their job (satisfied, bored, ready to quit, etc.), as seen in Figure 26. It is the role of the gamer to manage these employees, keep them happy, and keep enough staff to maintain the park's cleanliness, ride reliability, etc. without having too many employees (resulting in boredom, laziness, and too much expenditure).

Figure 26: Staffing in *RollerCoaster Tycoon 3*

Learning appeared spread over time as a trend with regard to staffing in *RollerCoaster Tycoon* 3. Early on, students appeared to discover staffing as something that they could control and they tested out hiring employees. As time passed, complexity grew as students learned to customize their employees, keep them happy, and find a sweet spot between too many and too few employees of each employee type (janitor, mechanic, etc.). Following are excerpts from seven episodes; the full transcriptions are in Appendix H.6.

The first episode illustrates the first use of staffing by the students. In this example, the pair figures out how to hire employees of different types (different job functions, such as mechanics, entertainers, and janitors) and how to customize them:

L: We want staff. ((*Clicked on 'Staff' icon*)) ((*Opened up all of their current staff members*)) Ok. (.) We want Janitors.
R: Janitor 1. We can name 'em.
L: ((*Clicked on Janitor 1*)) Ok. Dooo ((*Double clicked on the name 'Janitor 1' and hit the backspace button to put in a name*))
¤<1195012> (.)
R: Name him Water Boy because he's watering.
L: (hhh) ((*Types in name of janitor*)) ((*humming*))
R: ↑Jackie?↓ ((*Laughs*))
¤<1204200> (1.5)

L: ((*Laughs*)) I'll be the mechanic and you can be the Janitor.

((*Clicks on mechanics name*))

((*Changes it to a different name*))

R: Ok. ((*Laughs*))

¤<1211364> (1.0)

L: ((*Laughs*)) 'Park Inspector' ((*Reading names of staff off of staff screen*)) His name is Park Inspector. Let's hire him. ((*Clicks at bottom of screen on the icon for hiring a janitor*)) ↓Let's hire a Janitor.↑

¤<1221766> (.)

R: You're hiring more. How many [Janitors do we need?]

L: [Let's hire (.) mechanics.] We need mechanics.

((*Clicked on hiring a mechanic*))

R: Make like five janitors.

¤<1228428> (.)

L: We need a bunch of mechanics. And a couple more janitors. ((*Clicked on hiring a janitor*)) Couple of security people. ((*Clicked on security people to hire*)) Couple entertainers. ((*Clicked on hiring entertainers*)) Animal Keeper. Ahh. We don't-

R: Animal Keeper.

L: 'You need at least one enclosure (unclear speech) ((*Reading from pop up when L scrolled over 'Animal Keeper'*)) Alright, we don't need him.

¤<1247701> (.)

R: What is this person doing?

L: It's an entertainer.

R: OH.

L: He's not really entertaining. ((*Laughs*))

R: ((*Laughs*))

¤<1256544> (.)

L: Like (hhh) ((*Clicked on costume option for entertainer*)) costume to wear.

R: Make it like an animal. Cute one or something.

L: ((*Clicked on costume options for entertainer*)) A shark.

¤<1262119> (.)

R: A whale. Oh [it's a shark.]

L: [It's a shark.]

R: Make it a Panda. Oh ok good.

L: He's not really happy. ((*Viewing face next to staff member*))

R: Click the costume colors.

L: ((*Clicks on costume colors as suggested by R*))

R: Oh pink.

¤<1271881> (.)

L: ((*Clicks on pink*))

((*Clicks on the entertainers 'Thoughts' icon*))

R: It's just (.) just his [thoughts.]

L: [Thoughts.] 'I hate working [here.']

R: What the - hate working [Here]. Make him like (.) happy.

L: Uh ok. 'Laziness.' ((*Laughs*)) 'Happiness'

((*Reading icons that are options for the entertainer*))

((*Clicked on wage*))

¤<1285147> (.)

R: Oh no. Don't make his wage higher.

L: Why? That's why he's <u>sad</u>.

R: Well. ((*Laughs*)) Make it higher and see if he gets happier.

L: ((*Clicked to increase wage*)) It only goes up to °there.° Maybe we should ↑like not have ↓him.

¤<1298829> (.)

R: He's a horrible employee.

L: We should fire him.

R: ((*Points to a different entertainer*)) There he is. Is that him? Oh no that's another entertainer.

¤<1309337> (.)

L: I think that's him. ((*Scrolls across the different staff members at the bottom of the 'Staff' window*)) ((*Clicks on a staff member*))

¤<1314271> (.)

R: Is he happy now? He's standing. ((*Scrolled to bottom right of screen the entertainer is now standing*))

L: Yep. ((*The entertainer's mood is now happy because his face turned green with a smile*))

R: ((*Laughs*))

¤<1321715> (1.5)

L: Yeah he's happy now. So let's check everybody else what they're doing.

R: Everyone else seems happy. (.) Like Jackie's happy.

L: Everybody else is happy. ((*Scrolling through all the staff members faces*)) °Happy, happy, happy, happy.° <u>Cool</u>.

¤<1339537> (1.5)

L: Awesome. ↑Now↑
¤<1341588>

This pair is rather verbal, resulting in a longer transcript. The above episode shows the hiring of multiple employees. After hiring a few, the pair hires even more employees rather quickly. Following, they move to customizing their employees, as the game has options for configuring appearance, name, and wages for employees. Afterwards, the pair learns that employees have a happiness rating, and they take measures to make one of their employees (that appears unhappy) happy. In the next episode, an employee that has become unhappy with his job and is not doing his work properly is discovered. The pair struggles to fire him:

L: What are these guys doing? ↑These guys aren't supposed to be around here.↑ (.5) These entertainers. ((*Zooms in on the courtyard where the entertainers are*))
((*Clicks on an entertainer*))
((*Clicks on the entertainers thoughts*)) ↑'Bored, Bored, Bored'↑ ((*Reading the thoughts of the one entertainer that L clicked on*)) because you're in the wrong ↑spot.
R: [Mechanic 2 is thinking about quitting.] ((*Reading*

from drop down menu at top of screen)) [22]

L: [Mechanic 2 is thinking about quitting.] ((*Reading same as above*)) No. Get mechanic 2. Where is mechanic 2? ((*Laughs*))

R: ((*Laughs*))

L: Let's get him.

R: Go to the (.5) You may want to go to the people.

¤<1287778> (.)

R: What's these little glasses for? ((*Points to the courtyard area of the park*))

L: Here it is.

¤<1295755> (.)

L: Staff.

R: 'You've won an award' (.5) best = ((*Reading the prompt that popped up telling them that they won an award*)) [23]

L: ((*Clicked on 'Staff' icon*)) = Reliability. (.5) This is so strange (.5) ugh. Wait, who was thinking about quitting?

¤<1305909> (.)

L: Mechanic 2 and 3 both are! ((*Clicks on the mechanics unhappy face*)) How do we move?

R: Look at their pay. What is their pay? Maybe we

---

[22] The game updates with information on 'behind the scenes' park operations such as customer thoughts, staffing problems, broken rides, etc.

[23] Once a certain level has been reached, a certain amount of money has been made, or a park inspection has been passed, awards are given. Some awards are required to move from Apprentice to Entrepreneur to Tycoon (levels in the game).

only need one mechanic. Maybe they're bored because they have nothing to do.

¤<1322461> (.3)

L: ((*Clicks on each mechanic*))

((*Scrolls over their pay*)) Maybe they have too much to do. ((*Clicks on a mechanic in the park to see what they have been working on*)) (.5) Let's change the uniform. ((*Clicks on 'Uniform' icon*))

R: ((*Colors pop up for uniform colors*)) Pink. (.5) Purple.

L: Red.

R: They're still not happy. ((*Looks at 'Staff' screen*))

((*Scrolls over mechanics emotions*)) (1.0) ((*Scrolled over how many rides the chosen mechanic has fixed*)) He hasn't fixed, any rides. =

L: Let's fire ↓him.

¤<1345910> (.)

R: = And he got employed in March. And it's ↑July.

L: Let's fire ↓him.

¤<1350061> (.)

R: How do you fire him?

L: ((*Moves cursor to 'Staff' window and starts scrolling over different icons*))

((*Asks peer dyad*)) Do you guys know how to fire people?

R: What's the 'i'?

L: Yeah, well, one of 'em is bored so, I'm like get out of here.

Peer Dyad: I know the feeling.

L: Yeah. Umm hmm. It happens. It happens when we're making the most money. What's up ↑Liz? ((*Talking to peer dyad*))

¤<1381496> (.)

L: ((*Closes the 'Staff' window*)) 'K, well, you know what? If they're unhappy, guess what? I don't ↑care. They're gonna do their ↑job.

R: And they'll quit.

L: ↑Yeah. (.5) They're still ↓working.

¤<1394752>

While the pair struggles to fire an employee, they realize that the employee will eventually quit if he dislikes his job. The only negative consequence to 'waiting' for him to quit, is having a potentially lazy and ineffective employee on staff (receiving pay each month). The realization that the staff member would eventually quit may have resulted from reading game messages: occasionally there are messages about employees highlighting their status. These messages notify the gamer if an employee is unhappy ("Mechanic 1 is bored") or if they quit their job ("Janitor 2 has quit"). The pair cannot find a way to fire an employee, and figure that the game AI will take care of removing him after his happiness rating drops a little further.

The next episode shows the hiring of staff early in the third day of gameplay. In this example, the pair had just begun playing a new scenario in the game, and pulled up their staffing early on:

L: ↓More mechanics?↑
R: Yeah.
L: Alright, where's that again? ((*Scrolls through side menu*))
R: The mechanics 'Park Management'.
¤<876228> (.)
L: ((*Clicked on 'Park Management'*)) [24]
((*Clicked on 'Staff'*)) ↓Oh we don't have anybody.↑
R: There's a mechanic. ((*Points to Mechanic icon on staff menu*))
L: °We need a janitor.° ((*Clicked on 'Mechanic'*))
((*Clicked on 'Janitor'*))
¤<883799> (.)
L: ° We need a couple of mechanics.° ((*Clicked on 'Mechanic'*))
((*Clicked to add another Mechanic*)) ↓We need a couple of everything.↑ ((*Scrolled over the staff that the pair can hire*))
((*'Animal Keeper' popped up*)) °No we don't need an 'Animal Keeper' though.°
R: mmm

---

[24] 'Park Management' contains 'Staffing', where different employees can be hired, fired, disciplined, or promoted.

¤<893340> (.)

L: °Two 'Entertainers'. ((*Clicked on 'Entertainers'*)) We need to change the 'Entertainers' costumes. Something scary.°

((*Clicked on 'Costume' for entertainer*))

((*Clicked on entertainer's thoughts*))

¤<903093> (.)

R: We got to drop them somewhere. ((*The staff member that they just hired is in mid air*)) (.5) I think you're holding him.

L: No.

R: Yeah. He's right there.

L: ((*Scrolls through new hires*))

((*Closes staff window*)) Uh yeah?

¤<917467> (.)

L: ↓Ok well then we'll↑ ((*Zoom out from map*)) (.5) put him (.5) let's go over here. ((*Scrolling around park with new employee in air ready to be placed*)) [25]

((*Places the new employee in an open area of map near a ride*)) (1.0) ↑Alright, let's do another ride.↑

¤<940940>

In this example, it appears that the pair has learned the importance of staff in the success of their park. Through the game, messages are displayed notifying

---

[25] When a new employee is hired, they will need to be placed somewhere in the park. Placing employees next to a ride (or section of the park) that they are intended to work is helpful so that it does not take them long to get to their objective.

the gamer of things in the park, such as park cleanliness (awards can be won for a clean park), satisfaction of guests (they say what they enjoy or dislike about a ride or the park as a whole), etc. These messages often can suggest improvements for the person(s) playing the game. The above episode occurs relatively quickly after the pair started a new scenario, highlighting that they deem staff as important to their success.

The previous example highlights a hiring spree of employees after the students discovered that they had no staff (after starting a new scenario). Following is another example, showing the pair expecting action from computer AI given to their staff:

L: °Nobody's on this ride.° ((*Zoomed out from park*)) ((*Scrolled over a ride the number of people on it-zero*))
R: ↑No one is on the ride?↓
¤<3071220> (.)
L: Well (.5) I don't know see. ((*Zooms out with camera to see if ride is moving*))
R: Is it broken?
L: Yeah.
¤<3075620> (.5)
R: How much does it cost for that one? (.5) 'Minutes from last'
L: ((*Clicked on ride broken down*))
R: ((*Reading from ride menu the last time the ride*

was checked by maintenance)) ↑Uh↑ it should be like every minute. (.5) Get pick the janitor for the thing. ((*Points to maintenance man icon*))

L: ((*Clicks on maintenance icon*)) Oh [yeah.]

R: [Like I] mean this thing so he can fix it.

¤<3095730> (.)

L: °Can I pick him up and have him go over° ↑here?↑ ((*Maintenance guy is not near the ride*))

R: I don't know.

¤<3104161> (3.0)

L: ((*Clicked on maintenance guy*)) °Well we need him because we're losing money.° (.5) There he is. He's coming.

R: Yep. ((*Teacher came in to ask the students a question*)) (1.0) How much is this ride?

L: ↑A lot↑

R: It is?

L: °We're making <cash> on it.°

¤<3157771> (0.5)

R: Fast forward it I hate it when it's dark. ((*The game has turned to night mode screen is getting darker*))

L: ((*Clicks the fast forward button at top left of screen*))₁ Ok hopefully uh the janitor went to go or the -

R: ((*Yawns*)) Mechanic.

L: Yep. ((*Clicks on fast forward again*))₁

¤<3207299>

A few things can be highlighted in this example: First, the pair was somewhat surprised that a broken ride had not been automatically fixed by their mechanic. After finding the mechanic and realizing he was not close to the ride, the pair attempted to move the mechanic (in the game, it is possible to pick up a person and drop them anywhere on the map, but the pair did not). After attempting to move the mechanic, day turned into night temporarily, and the pair could not follow the mechanic. After losing track of him, they assumed that he went to fix the broken ride. The example shows understanding of the relationship between making money, maintaining rides, and support staff.

In the next example, the pair monitors their staff to verify that all are happy and doing their job:

L: Where is it again? ((*Scrolled over left side menu*))
R: Underneath the eyes.
L: No that's save.
R: No go up again. The eyes. Those little things. This thing. ((*Points to 'Park Management'*))
L: °That's not it.°
¤<746262> (.)
R: It's not?
L: °No.°
R: Are you sure? [Oh no,] it's just the statistics with the graph.
L: [Yeah.] ((*Clicked on 'Park Management' icon*))

((*Staff screen popped up*))

¤<755774> (1.0)

R: ↑Hey. We only have one mechanic.↑ (.5) And one janitor.

L: ((*Scrolls over the mechanics and janitors*))

¤<771988> (2.0)

L: There now it's light out. See? ((*Screen changed from dark / nighttime to light / daytime*))

R: Fewww. (hhh)

¤<787002> (.)

R: We've got to place him.

L: ((*Reading from game prompt that customers are thirsty*)) 'Consider placing drink (.) drink stalls?' There's no drink places are there? Oh yeah we never had any. Oh yeah we got to put this security guard somewhere. (1.0) Where should I put him?

R: Just drop him right there.

L: ↑How about (.) a janitor?° ((*Scrolls through staff menu*))

¤<813241> (.5)

L: Ok. He's on his route. (.5) °Janitor do your job.° (.5) 'Going to broken ride. Going to inspect a ride. Rovering. Rovering. Rovering. Entertaining. ((*Reading off what each staff member is doing by clicking on each staff member*)) °You better start entertaining bud. You're not scary either.°

¤<843035> (.5)

R: ((*Laughs*))

L: °'I hate working.'° ((*Reading thoughts of the janitor*)) Let's go to (.) to there. ((*Increased the*

staff members pay)) Now he's happy.
¤<859592> (.)
L: Happier. So I'm ok with. What's this?
R: Janitor.
L: Alright, now what.
R: Drink spot and then delete that ride.
L: Alright.
¤<877354>

While nothing new is done in the above example, it appears that the pair has learned the importance of keeping happy employees to serve park functions. Additionally, the pair comments on the number of support staff, which appears to indicate they have a better feel for the number of support staff needed to maintain their park (one mechanic and one janitor is not enough). Also in the above transcript, the pair utilizes an employee list and takes time to read the status of each employee, as if to check that all are happy and working. In *RollerCoaster Tycoon 3*, there is a screen that lists all current employees along with their 'thoughts' (a way of gauging their satisfaction), as can be seen in Figure 26.

4.3.4 *Summary of Trends*

As mentioned, trends were typically most evident in game features that were occasionally used in the game, across larger spans of time. Typically, problematization did not mark the beginning and end of a learning trend; rather,

it was something that occurred naturally with a slowly growing complexity through the game play.

This marks the end of the discussion of trends in the video data. Following, the rest of the learning patterns are described in terms of episodes and sequences of episodes (collections of episodes that are conceptually linked to each other with an overall purpose).

4.4 *A Foundational Level of Learning: Mastering the Game Interface and Interface Functionality*

An important factor in learning while playing games is the ability to figure out the game interface. As mentioned earlier in the chapter, episodes here contain the learning of basic game controls, including the functionality of different icons, objects or things in the game. Success in the game hinges on the ability to make use of the interface. These episodes are candidates for examining the affordances of the game interface in Phase II of the analysis (Chapter 5). These episodes highlight potentials for action offered by the interface, and it can be seen which affordances were frequently appropriated by student gamers.

These episodes may be less interesting to examine; however, they offer potential use for the analysis of the game interface and how game players learn to use it. Following are specific examples from each of the three games in the study. Three sequences (of several episodes each) and nine individual episodes are provided with full transcripts in Appendix H.2. A few selected transcripts are mentioned below to show some examples; however it is kept brief as these episodes are more interesting in the next phase of analysis.

4.4.1 *Civilization IV: Peer Explanation of Basic Game Functions*

In this example, early on in Day 1 of *Civilization IV*, game players are talking out loud in order to resolve the functionality of things on the interface. Ideas are tossed around, which can be shown on the following episode. In this episode, the left person (L) is controlling the mouse, and the right person (R) is telling him what to do:

R: °Right click (.5) click (.5) borders expanded.° Like if you click on people and you tell them what to do, and you click Enter each time. Craig, what are you doing?
L: Zooming In. ((*Zooms in on map*))
((*Scrolling around map*))
¤<672751> (.)
R: Like, click on those people again. ((*Points to a group of workers*)) (.5) Now tell them where to go. And what to do. (.5) Why did we build a road?
L: ((*Clicked on the group of workers that R suggested*))
((*Clicked on 'Build Road' icon*)) [26] I don't know.
((*Scrolls to bottom of map*)) So we can get through?
((*Clicks on open land*))
((*Workers move to new area*))

---

[26] "Order the worker to build a road (and later, railroad) in the square it occupies. Roads can be built on any land space (except for impassable spaces)." (*Civilization IV* Manual, p.74)

((*The workers start building the road*))

((*Laughs*)) See, now we can get through.

¤<695504> (.)

R: Press Enter.

L: ((*Clicks on workers*))

R: Now click no, on the other guys, above them.

L: No, those are our explorers, >↑those are< our scouts.↓ ((*Points to the group of workers working on the road*))

R: No, click on the other guys. Then press Enter.

L: ((*Clicked on the group of workers*))

((*Clicked on open land*))

((*Workers moved to new area*))

((*Pressed Enter*)) [27]

((*Screen showed road being added after turn ended*))

↓Whoa.

¤<712088> (.)

R: See then they built their road.

L: Oh Ok I see. ((*Clicks on the workers building the road*))

¤<715747>

Above, one student is instructing the other student repeatedly. Communication seems aimed at gaining an agreed-upon meaning of the game's objects and purposes. While only one student can control the mouse and the

---

[27] Pressing Enter (on the keyboard) will end the turn.

game interface, both are involved in learning how to control and use the interface.

4.4.2 *Making History: The Calm & The Storm: Learning to Use Airplanes in Warfare*

In *Making History: The Calm & The Storm*, a country's military has several main components: land troops, tanks, and airplanes. Each of these military components has several types, but their controls are similar.

Making History: The Calm & The Storm presents a map of the world as the main interface. Maps are detailed with provinces or states, and gamers play as a particular country in the game, as can be seen below in Figure 27. Territories can be gained or lost to other countries in warfare. Each territory has economic resources, and each country has military forces that can be moved around the map to fight battles with other countries.

In this example, students playing are engaged in a war, and are struggling with moving and using airplanes. They see airplane icons on their map, but are not sure how to make use of them. At the time, gamers are playing as the United States, and are fighting Canada.

```
L:  Alright this guy (.5) ((Clicks on a plane in
Georgia)) needs to go (.5) over here.  ((Clicks on an
area in Michigan))  (1.0)
```

L: ((*The plane does not move*)) How do you move 'em again?

R: The planes won't move (1.0) like I can get the (1.0) armies to move but I can't get the planes to move.

¤<1384390> (.)

L: ((*Clicks on a plane in Georgia*)) ((*Clicks on Washington*)) Do you know how to move planes? ((*Clicks on the same plane in Georgia*)) ((*Clicks on Washington*)) ((*Moves cursor to 'Mini Map' of nations*)) ((*Clicks on 'Ideology' map*)) [28] ((*Clicks on 'In Supply' map*)) [29] ((*Clicks on 'Operational' map*)) [30] ((*Asks the peer dyad for help with moving planes*))

Peer Dyad: Do you?

L: Do you know how? ((*Scrolls through US continent*))

---

[28] "Every nation in MAKING HISTORY belongs to one of four ideologies: Authoritarian, Communist, Democratic, or Fascist. With the Ideology map you can see which nations share ideologies. You can also click on regions, nations and capital cities." (Making History Manual, p.9)

[29] "With the In Supply map you can see what trade routes are open to your nation. Occupied regions and enemy lands are "out of supply". Your military divisions need open supply lines to remain armed and at full strength. From this map you can also click on regions, nations and capital cities." (Making History Manual, p.10)

[30] "The Operational map is central to playing MAKING HISTORY. From here, you can move forces and view military divisions, battles, cities, regions, nations, and resources. You can click on any city, region, or nation in the game." (Making History Manual, p.9)

Peer Dyad: No. Do you know how?

L: No ((*Laughs*))

Peer Dyad: ((*Laughs*))

¤<1409599> (.)

Peer Dyad: That would be really helpful. How do you get your file like that? It would make it so much easier. Having this crazy...

L: ((*Changing the view of the map*))

((*Zooming in and out on map*))

((*Zooms in and out on Michigan*)) You just right click it.

Peer Dyad 1: Ohhhh ((*Laughs*))

Peer Dyad 2: Oh it's so much easier.

¤<1423655> (.)

L: Alright, somehow we just need to get... uh↓ what the heck?↓

L: What the heck? ((*Scrolling across Midwest region of US*))

((*Right clicked on an army in Canada*))

((*Clicked on an army in US that was engaged with Canadian forces*)) [31] °What the heck?°

R: We are going to kill them. ↓How do you move those planes?↓

---

[31] When a military unit is given orders to attack an enemy, a green arrow appears between them both (drawn from your military unit, pointing at the enemy unit to attack: showing a path to the enemy). This shows that the unit is on the move towards the enemy. With each turn passing, the military unit will follow the green path and advance towards the enemy until the enemy is reached, at which point the battle begins.

¤<1442484> (.5)

L: ((*Clicked on an airplane in Georgia*))

((*'Air Force' menu popped up*)) ((*Clicked on 'Rebase' in the 'Air Force' menu*)) [32] Oh here we go. (.5) Canada. What the heck? Why isn't Canada in here? ((*Scrolls through list of states / countries to find Canada*))

R: Maybe you gotta send (.5) try sending the one from New York to Canada.

¤<1465659> (.5)

L: ((*Continues to scroll through states / countries*)) ,Or to Michigan., ((*Continuing to scroll through list of states / countries*))

¤<1472521> (1.0)

L: ((*Continues to scroll through the list of states / countries to attack*))

R: Yeah go to Minnesota. Then we can attack them from there.

¤<1498749> (1.0)

L: ((*Clicks on Minnesota*)) Go ((*Scrolls over continent*))

((*Sighs, places hands up by mouth*))

((*Scrolls through map along green active path from Georgia to Minnesota*))

---

[32] When rebase is chosen from the Air Force Menu "a green arrow will outline the squadron's path to the new region. It will take one turn for the squadron to move to its new base." (Making History Manual, p.17)

¤<1506771>

At this point, game players appear frustrated in their inability to use their airplanes to fight Canada. It is interesting to note how ideas are verbalized, and are then grounded between participants, as demonstrated on the two lines preceding and the one line following time stamp ¤<1442484>. There is a repeating pattern of disclosing ideas to teammates as a form of negotiating understanding. One problem encountered is that of airplane range: an airplane in Georgia may not be able to conduct an air mission in Canada, without first relocating to a Northern state (as in real life, airplanes have a flying range). It is not clear whether the pair realizes this rule in the game; however their discourse of rebasing planes towards Canada towards the end of the episode indicates a strategy moving them towards this understanding.

The next episode in the sequence shows them figuring out the interface in order to use their airplanes to bomb enemy targets:

```
R:  ((Clicked on different airplanes around the map))
(('Air Force' menu popped up))
((Right clicked on an airplane))
((Options for the airplane popped up))
¤<1706739>  (.5)
((Clicked on American flag))
((Clicked on a plane in Massachusetts))
(('Army' menu popped up))
```

((*Clicked on an airplane in New Hampshire*))

((*'Air Force' menu popped up*))

Oh they took over so many of our ((*Scrolling map across Northeastern U.S.*))

¤<1716872> (.)

R: ((*Right-clicked on an enemy target in Maine*))

((*A menu appeared offering the option to bomb them*))

((*Mouse control traded from R to L*))

R: Oh crap =

L: Oh how did you =

R: = They're taking over all of our states.

L: = no we can actually bomb someone now.

¤<1724524> (.)

R: Oh (.5) how did you do that? [33]

L: I don't know you did it. ((*Laughs*))

R: ↑Did I?↑

L: Yeah ((*Laughs*))

R: Ah geez↓

¤<1729912> (.5)

L: Ah sweet (1.0) alright bomb them. ((*Clicked on one of their airplane units*))

((*Clicked on an enemy targeted army*))

R: It's like (.) hold it down or something.

L: ((*Double clicks on airplane*))

((*'Air Force' menu pops up*))

((*Right clicks on enemy army*))

((*Clicks on their army*))

---

[33] Figured out how to send an airplane to bomb an enemy target.

((*Clicks on an airplane*))
((*'Air Force' menu pops up*))
¤<1749253> (1.0)
L: There. (1.5) Wait. (8.0) ((*Clicked on airplane*))
((*Mouses over airplane*))
((*Options for the airplane moused over pop up*))
((*Chooses air mission*)) Air mission. Alright there we
↑go. ((*Scrolls across US towards Illinois*))
¤<1772281>

In this case, the game players discovered how to bomb enemy targets by selecting a nearby airplane and then mousing over enemy targets. Selecting a plane that was close to an enemy target resulted in a new icon over the target that resembled a target (upon mousing-over the target, after selecting the plane). Figure 27 shows an example of what this looks like in the game:

Figure 27: Airplane selection and use in *Making History: The Calm & The Storm*

Early on, the pair had struggled with using planes that were further away, as the 'bomb enemy' icon (looks like a target) does not appear if the plane is not within range of the target. This prompts the students to move airplanes closer to their enemies later in the game. In the above figure, the selected airplane has a green circle around it, and by 'right-clicking' an enemy target, the option is given to have the airplane bomb the enemy target.

4.4.3 *RollerCoaster Tycoon 3: Controlling the View (Camera Angle)*

In this sequence of episodes, game players are becoming frustrated with the camera controls. There is difficulty moving the game map over the area that they desired to work. The pair appears to be able to swivel the view around a fixed point, but that fixed point is not always the location they would like to focus their work. The problem manifests itself for a long time in game play, and eventually they figure out how to control the camera angle after asking the peer dyad. Figure 28 shows an example similar to what the pair is looking at when trying to control the camera angle on their park.

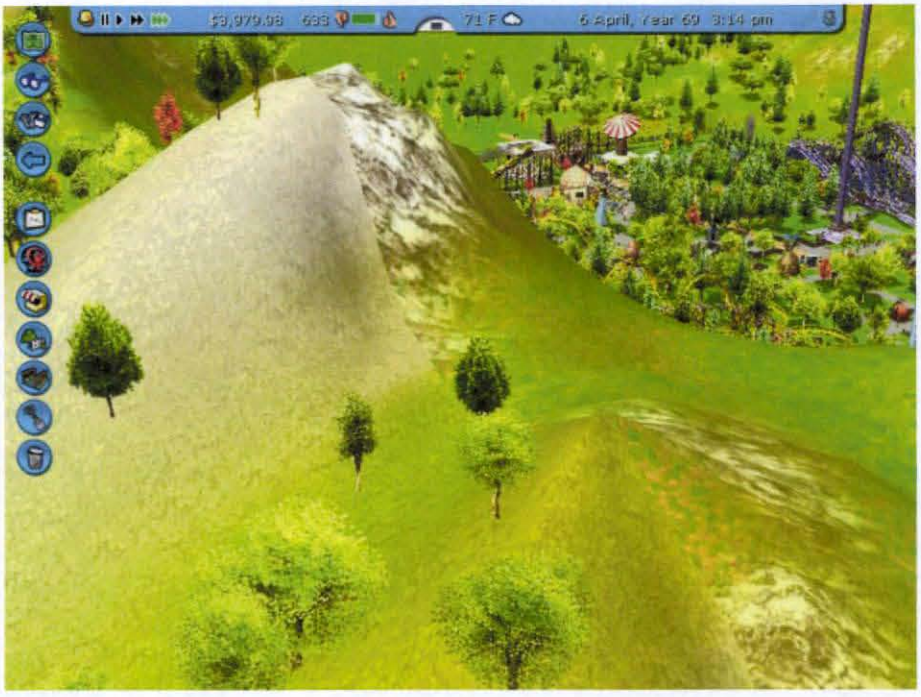

Figure 28: Trouble controlling the camera angle / view of the park in *RollerCoaster Tycoon 3*

The first episode highlights some of the trouble being experienced by the pair in attempting to control their camera angle (view of the park):

L: I wouldn't. ↑Oh, no↓ (.5) °Gosh.° Confusing.
((*Changes camera view*))
((*Camera is stuck in the mountain alongside the park*))
((*Changing angle of camera still stuck in the mountain*))
¤<454906> (.)
L: ((*Zooms out from park*)) Not working out for us that well. There we go.
R: Seriously
L: ((*Still attempting to get camera view to move to center of park*)) Gosh, alright I'm getting out of this one.
¤<476244> (1.0)
L: OK, °I'm getting kind of frustrated° ↓at this folks↓ ((*Clicks on 'Delete Object' icon*)) [34]
((*Camera view keeps changing and the pair cannot get the view that they want*))
R: Does it keep popping it back up?
L: ((*The camera view of the park keeps going from sky to ground*)) Yeah.
¤<484965> (.)
R: ((*Laughs*))
L: ((*Zooms in and out*))

---

[34] 'Delete Object' is signified by single and double trash can icons (delete single, delete multiple). After clicking one of these icons you can delete objects in the park by clicking on them.

((*Changes camera view from left to right*)) OK, well, uh,

R: ((*Laughs*))

L: I can't get it, here, ((*Laughs*)) you do it, just try it.

R: ((*Takes over control of the mouse*))

L: You have to use like use, the um, yeah, that, yeah and you have to like click it to move, and then move the mouse. No, hold, hold that,

¤<504090> (.)

R: ((*Trying to control the camera view with the advice of L*))

((*Zooms in and out of park*))

L: NO that the middle button and then move it. (.5) Then you scroll. [35]

L: Are we going to build a path?

¤<514693>

Above, frustration begins with the inability to move the camera. After some frustration, mouse control is traded between students (left hand to right hand student) and an explanation of understanding is offered. However, this is not enough to solve the problem. Later in the game, the problem manifests again:

---

[35] L offers explanation of his understanding of how to move the camera to R.

R: I am trying to figure out how to get over there.
((*Talking to researcher, who does not offer help*))
((*Zooms in an out of camera view*))
((*Swivels camera view by moving mouse*))
((*Zooms in on park*))
((*Swivels the view of the camera*))
((*Zooms out*))
((*Zooms in and out*))
((*Swivels camera view from right to left in a circle*))
((*Zooms in on park*))
((*Zoomed in and out on park*))
¤<118571>
((*A few minutes pass…*))
¤<160652>
R: I can't get over there. I spent literally five minutes just trying to get over to the ride. ((*Zoomed camera in on park*))
L: Oh no. Wait why are we back to here?
R: ((*Swivels view of camera from left to right*))
¤<176783>
R: ((*Laughs*)) I can't (.) Because when we left I guess the mouse moved. ((*Clicked on ride that was in the process of being built*))
L: There we go.
¤<184372>
R: ((*Laughs*)) Where did they even go? ((*Zooms in on ride*))
L: I don't know.
¤<189523>

Frustration has grown, as much time was spent focusing on moving the camera (unsuccessfully). Early in the episode, one student asked the researcher for help, who ignored the request. The episode occurred between passing periods where the students had to show signed permission slips to their study hall teachers. Upon coming back to the game, the pair hypothesized that the mouse had moved while they were gone, to explain why their view was centered on a remote area of the theme park.

Finally, the pair consults the peer team to learn how to control the camera angle in the game:

> L: Liz, do you know like how to move it so like you can like ((*Laughs*)) (.5) control it like perfectly so you know where exactly to go? Because we're like moving it and it's not even working. (.5) Like we're trying to get like down here and we're scrolling but it only goes to there. ((*Scrolls mouse to zoom in and out*))
> ((*Clicked near the point where the camera is swiveling the view, off to the side of the park*))
> Peer Dyad: Um you can scroll like by moving it to the edge of the screen. Move your mouse to like the edge of [the screen]
> ¤<217607> (.)
> R: [Like this way] [That's what I] ((*Points to right side of screen all the way to edge*))
> Peer Dyad: [Yeah just like that way]

L: ((*Points the cursor to the edge of the screen and the camera moves right, back over the middle of the park*)) OHHHHH.

R: ((*Laughs*))

L: ↑<u>What</u>.↑ No <u>way</u>.

¤<225618> (.)

Peer Dyad: It's easier that way.

L: Yeah it is. Geez. ((*Now able to view and look around park with camera successfully*))

Peer Dyad: Yeah there are some things you just have to...

L: It's like ((*Laughing*)) I don't know how I didn't get that. ((*Continues to scroll to edges of screen to move around camera view*))

¤<233193>

In this case, a lingering interface problem inhibited the pair's playing of the game, and was not resolved until the second period of playing. The pair offered an explanation of their problem to a peer dyad. Resolution came after the peer dyad responded with advice on how to solve their problem. In this case, a peer dyad was used as an informational resource in solving their interface control problem.

4.4.4 RollerCoaster Tycoon 3: Learning to Connect Rides to Footpaths

Later in the game, the pair above struggles with creating footpaths to their new rides. In *RollerCoaster Tycoon 3*, creating a ride is a several step process: one

must build the ride, create an entrance and exit to the ride on suitable ground, construct footpaths to those entrances and exits (often above or below the level of the path), and open the ride for business. Additionally, once open, many options on the ride can be configured such as the price, color, music, and maintenance schedule.

In this case, the pair is struggling creating footpaths to the rides, which can be difficult in *RollerCoaster Tycoon 3*:

L: Is that cool? ((*Places ride near a main path*))
R: Yeah. Is the pathway going to be hard to make?
L: °No.° ((*Places the entrance / exit for the ride*)) [36]
((*Clicks on 'Path' Icon*)) [37]
¤<2039905> (1.0)
R: NO.
L: It shouldn't have been. ((*Trying to place path by entrance of ride*)) [38]
R: It's on a hill ((*Laughs*))

---

[36] Every ride must have an entrance / exit in order to have the customers be able to get to and from the ride.

[37] The paths icon allows the gamer to create a paths from other paths in the park to their new ride. This will allow the customers to get to and from the new ride.

[38] If you have a ride that is on a hill (elevation above or below the footpath) you must make your path a ramp in order to connect the path to the ride entrance and exit. Path creation has options (icons) for vertical incline or decline of foot paths.

L: °Well it shouldn't have been.°
¤<2047916> (1.0)
R: We should have stuck with the other one.
L: ↑I know↑ ((*Laughs*)) OOPS ((*Clicked on the different path options*))
R: We should go back. ((*Laughs*))
¤<2061405> (.5)
L: How do you get? Do you guys know how to do like ↑inclines↑ for like ↓paths?↓ ((*Zoomed in on ride*))
Peer Dyad: Yeah. There's like a I don't know there's like a button for it or something.
L: ↓Oh is that what↓ ↑what↑ it is, ↑a button?↑ ↑Thanks for the help.↓ ((*Clicks on a different type of path*))
R: ((*Laughs*))
¤<2078659> (.5)
R: It's not gonna work. ((*Chuckles*))
L: Alright, <u>fine</u> we're gonna make it work. (.5) That was a bad spot to put it in. We should of put it in the middle. ((*Changes camera view to middle of park where the land is flat*)) <u>But</u> we can do more rides.
¤<2093225>

In the above transcript, the pair realizes that it would have been easier to put the ride on flat ground initially to avoid path leveling issues (an example of a successful path leading to a ride entrance and exit can be seen below in Figure 29). Again, they try to make use of the peer dyad to figure out how to use a

game feature, but this time the peer team's advice is not helpful enough to find a resolution.

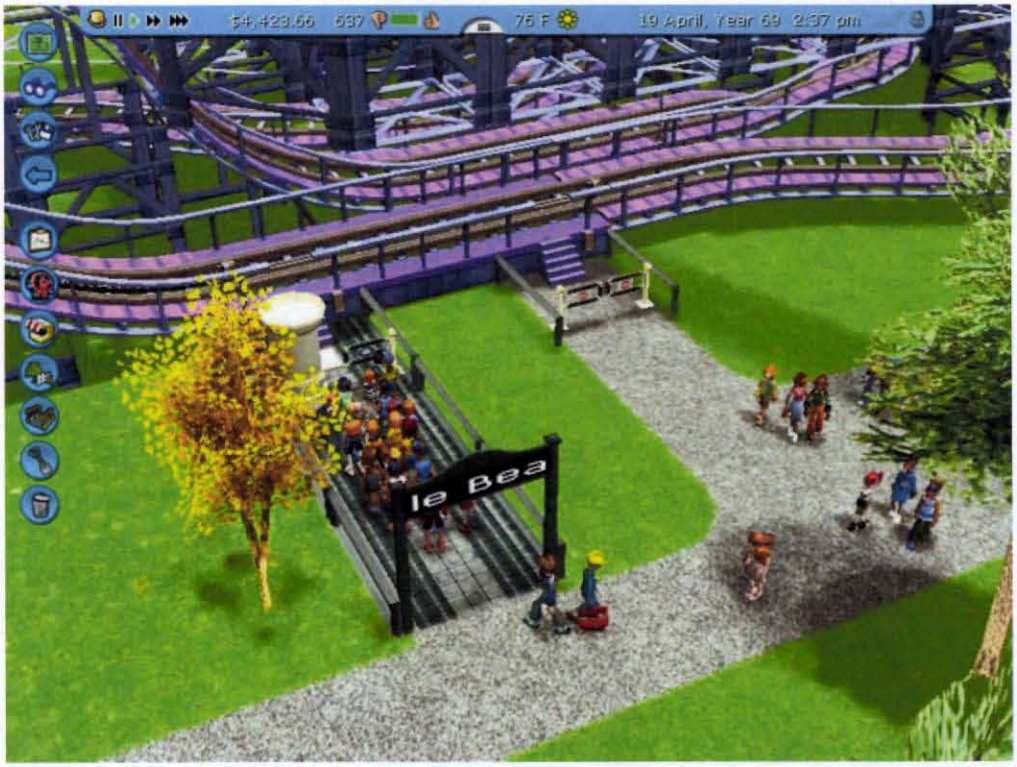

Figure 29: Successful creation of paths leading to entrance and exit of a ride in *RollerCoaster Tycoon 3*

Later in gameplay, the same problem occurs as the pair attempts to build a ride that is on the side of a hill:

L: It's up though. [39]

R: >Which is going to be a problem.<

L: Not really. ((*Places an entrance and an exit by*

[39] The land is on a hill so the group believes that a path will be a problem.

new ride))

R: Most likely. ((*Laughs*))

L: Um ((*Changes view of camera*)) I don't know yet. I will find out. (1.0) ((*Zooms in on the new ride*)) We'll find out right here. ((*Clicks on 'Paths' icon*)) ¤<1392361> (.5)

R: Yes or a bridge or whatever. (.5) We have to build a bridge.

L: ((*Starts placing an Asphalt path near entrance and exit of new ride*)) [40] Yeah I know. So (.5) how do we do that?

R: Right there ((*Points to 'Paths' editing buttons*))

L: °No I think this° ((*Scrolls over path choices*))

R: Oh this is it right here. ((*Points to 'Queue Path' button*)) (.5) No it's not it.

L: Hmmm

R: ((*Points to 'Scenery' icon*)) [41] I think it's this button because there's like fences and trees and there should be... (2.0) We can raise the ground right there.

L: ((*Scrolls through icons under 'Scenery' icon*)) No. We haven't had too much luck with that. (.5) Alright. (.5) How about (.5) we (3.0) ((*Moused over all icons*)) I don't know how to do that. (.5) Do you want to try the terrain thing? ¤<1472031> (.)

---

[40] The problem is that the ride entrance and exits are elevated.

[41] The scenery icon allows for the placing of garbage cans, trees, plants, and benches.

R: ↑Try it and see what happens.↓ ((*Clicked on 'Terrain Tools' icon*)) [42]

((*Clicked on 'Terrain textures' icon*))

L: Oh that's texture.

R: ↑Do you like this one?↑ ((*Clicked on 'Terrain shaping' icon*))

((*Pointed to 'Adjust terrain tiles' icon*)) What does that do?↓

L: I don't know.

¤<1490166> (.)

R: ((*Laughs*)) Do this one so it goes like up and flat. ((*Points to 'Adjust terrain tiles' again*)) I think. Or maybe not. (.5)

L: ((*Clicks on 'Adjust terrain tiles'*))

((*Clicks on 'Free-form terrain tile shaping' icon*))

R: OH YEAH. (.5) °That's what it was.°

L: ((*Clicked on ground and nothing happened*))

R: (1.0) Yeah, that doesn't work.

L: Where does it work? (.5) There's no money. WHAT. What is going on? (.5) No ramps.

R: Didn't we like have ramps like just

L: Yeah that's what I thought we did. (.5) I swear we had a ramp. Whatever we're gonna have to do something else then.

R: (hhh) Just go into a (unclear speech)

¤<1540888> (.)

---

[42] Terrain icon is for changing the terrain of the landscape either to flat, rocks, or grass. You can also have the option to level land by clicking on the icon that looks like a shovel.

L: Oh there might be something here. ((*Clicked on ride menu*)) (4.0) ((*Clicked on 'Exit' icon in ride menu*)) I'm gonna try the entrance exit thing. ((*Changing view of camera*))
((*Clicked on path leveling icon in ride exit menu*))
(2.0) ↑Ooo↑ What is this? ((*Ground under path automatically is leveling to height of ride exit*))
R: Oh my goodness.
L: Cool. ((*Placed exit by clicking*))
¤<1588641> (.5)
R: It's so much nicer. Now we have to go back and do the entrance. (2.0) Oh that one didn't work. ↑Do we have to draw a [path over...]↓
L: ↑[Oh yeah] I didn't do that um this thing↑
((*Clicked on 'Choose an entrance for the ride / attraction' icon*))
((*Clicked the path leveling button on the ride entrance menu, which successfully leveled the terrain to connect path with entrance*))
R: Ahh. (2.0) Now open it.
L: Cool. ((*Successful*))
¤<1623264>

In this example, the pair struggles again to connect their ride entrance and exit to the parks' footpaths. Much time was spent looking through the interface of the game, and many options were explored. The game offers a terrain editing tool to raise or lower ground levels, but it did not help the pair to create a level path. The discovery of the terrain shaping tool in the ride entrance and exit

submenus appeared after spending time looking through different menu options. This allowed game players to edit the terrain of the adjacent footpath to the ride entrance and exit (automatically raises or lowers height of adjacent terrain tiles to match the level of the entrance and exit to aid footpath creation). The pair employed the strategy of using the terrain shaping tool to create a level footpath between the ride entrance and exits and the footpaths in adjacent tiles. Much time was spent using trial and error of different items on the interface until a solution was found.

4.4.5 *Summary of Learning to Master the Interface*

While gaming, one of the early steps in game play is learning the game interface. It provides the basic control needed to play the game and invoke strategy. In examples witnessed, ideas about the functionality of the game interface were tossed around and communicated between teams and within teams. These communicative acts seemed to help ground the idea of an objects' functionality, as well to check that teammates were on the same page with each other. Often teammates would assist each other by telling them what to do (click this, and then click that) in order to test hypotheses of an objects' functionality (or to show peers known functionality). Phase II (Chapter 5) of the analysis will

break apart these interactions into sequences of events, and key affordances are analyzed.

4.5 *A Higher Level of Learning: Advanced Strategy and Goal Achievement*

In this section, episodes are presented that illustrate higher levels of strategizing in order to win at the respective games. In most episodes, gamers have a foundation of understanding of the basic game interface, and are looking to win at the game and meet goals that they and the game have established. In these instances, learning is represented as a change in the behavior of the participants that aims to accomplish goals set forth by the game as well as the gamers themselves.

Many of the examples following show multiple things occurring: at this stage of game play, the complexity has been raised and therefore episodes often have multiple things happening. Many of the episodes in this section are represented in other parts of the analysis, as they apply there as well. Again, a subset of transcripts is provided; for a full list of transcribed episodes from this section, see Appendix H.1.

4.5.1 *Civilization IV: Use of the Technology Advisor*

First, an episode from *Civilization IV* will illustrate how the students make use of a feature showing the game's technological advancements, so that one can look ahead and see technological advancements yet to be unlocked. Each city in a civilization can contribute to researching technology and can produce items. Over several turns (number of turns varies per item researched) teams will unlock technology items, which can be used to produce things for the civilization (workers, soldiers, etc.).

Figure 30: Unlocking a technology item in *Civilization IV*

Upon unlocking a technology item, the game offers a description of what was achieved, what it can be used for (as seen in Figure 30), and then a list of choices of what to research next, as seen in Figure 31:

Figure 31: Prompting to research a new technology in *Civilization IV*

Above in Figure 31, choosing the first item labeled 'Let's see the Big Picture' will pull up the 'Technology Advisor', which shows a graphical tree of technologies that have already been researched, and those that have not yet been researched, which can aid the choice of what to research next (as seen below in Figure 32). The Technology Advisor in *Civilization IV* supports goal formation as

well as motivation to unlock future technologies and use them in one's growing civilization:

((*Window pops up in game, explaining the new technology item the pair unlocked*))
((*A description of the new technology item is listed; as well as new items that can be built*))
R: ((*Clicks on one of the items that can be built, then exits back to pop-up*))
((*Clicks 'Continue' to proceed in game*))
((*List of future / researchable items appears, prompting pair what they would like to research next*))
R: ((*Clicks first button called 'Let's see the big picture' which pulls up the 'Technology Advisor'*)) [43]
R: ((*Mouses over the different items to be researched next*))
L: ↑Iron working. Can remove jungle↑ ((*Laughs*))
R: ((*Scrolls through the 'Technology Advisor' from left to right according to advancement*))
R: "Build a Winery"? ((*Surprised*)) [44]
¤<2626940> (1.0)
L: °So much stuff.° 'Electricity'? ((*Scrolls through*

---

[43] The 'Technology Advisor' allows implications of decisions to be viewed by displaying a tree of technology items along with their contingencies. The 'Technology Advisor' displays all 80 technologies available to the gamer (including those available later in the game) from left to right. The technologies on the left are less advanced then the ones further to the right.

[44] "'Build a Winery' provides access to the wine resource. It can be built only in a space with that resource." (*Civilization IV* Manual, p. 75)

the 'Technology Advisor' at all the different technologies listed))

R: ((*Clicks on 'Electricity'*))

¤<2632656> (.5)

R: °Slow down° ((*Moused over a few of the different technologies in the 'Technology Advisor'*))

R: ((*Clicked on the keyboard*))

¤<2633941> (.)

R: ((*Scrolled to the end of the technology list*))

R: Let's go with uh = ((*Game gives them a list of technology items to work on next*)) [45]

L: Robotics? ((*'Robotics' was listed last on the technology list*))

¤<2637558> (.5)

R: = °Pottery.° ((*'Pottery' chosen as next technological advancement*)) [46]

R: ((*Game moves the view to a character needing a task for the turn*))

L: You can get like into the (.) you can get advanced in this game.

¤<2644970>

---

[45] A technology will appear on your list only when you have learned the necessary prerequisite technologies.

[46] "Pottery allows your workers to construct cottages, which increase the commerce in their space. Pottery also allows you to build granaries in your cities." (*Civilization IV* Manual, p. 71)

Above, the pair unlocks a technology item, and pauses to see the implications of the new technology (what new products can now be built, what future technologies can be researched as a result). After growing curiosity of the hierarchy of technology items, the pair decides to look at the 'Technology Advisor', *Civilization IV*'s way of showing technological advancements both locked and unlocked. It presents as a roadmap-style diagram, with a mapping of contingencies (see below in Figure 32). This visual representation manifests itself in goal formation, as the pair mentions how 'advanced' the game can become, appearing motivated to unlock and use future technologies.

Figure 32: Technology Advisor in *Civilization IV*

Later in the game, the pair revisits the 'Technology Advisor' roadmap. Icons that have been unlocked are colored green, while those yet to be achieved are blue.

L: What should we (.) 'Code of Law'? ((*Scrolling through the list of technologies that can be researched next*)) [47]

L: ((*Some technology items have the word*

[47] "'Code of Law' enables caste system." (*Civilization IV*: Tech Tree & Specifications Charts)

'Recommended' after them)) [48]

((*The game pops up a suggestion menu with categories for what the pair should probably work on next*))

R: Hold on. Look for other kind (.5) click on 'Let's see the big picture' ((*'Let's see the big picture' pulls up the 'Technology Advisor'*))

¤<1159936> (1.0)

R: What do we need? ((*Looking at the 'Technology Advisor' screen*))

¤<1164032> (.5)

R: Hold on.

L: ((*Laughs*))

R: Like, what stuff do we have that we (.5) Mining leads to Masonry?

L: ((*Mouses-over different technologies listed in the 'Technology Advisor'*))

¤<1171711> (1.0)

R: ((*Looks over to peer team's screen*))

L: I think the green ones are the ones we have. ((*Scrolls through 'Technology Advisor' screen from left to right*)) [49]

¤<1182120> (.)

L: We should probably get this. Says it leads to Monarchy. ((*Mouses over 'Monotheism'*)) [50]

---

[48] The game suggests what technology items the gamers should research next.

[49] Green boxes are unlocked items; blue boxes have not yet been researched yet.

[50] "'Monotheism' allows Judaism" and "enables organized religion". (*Civilization IV*: Tech Tree & Specifications Charts)

L: ((*Monotheism is not colored green*))
¤<1185752> (.)
R: 'Monotheism'?
L: Yeah.
R: Really? ((*Laughs*))
L: Oops. ((*Didn't click on 'Monotheism' from 'Technology Advisor' screen wrong menu popped up*))
¤<1190680> (.)
L: Alright ((*Clicks 'Monotheism'*)), now I think we can get other guys. ((*Scrolls across map*))
¤<1196318>

Technology is vital to one's strategy while playing *Civilization IV*. For instance, to develop more advanced military technology to win at warfare, one must unlock advancements in iron working, horses, etc. As these technologies are unlocked, they support the use of new materials and technologies in one's military. In this example, the game feature of 'Technology Advisor' visually displays goals in the game, and aids players in choosing and achieving those goals. This is discussed at greater detail in the section relating game features to learning.

In the above episode, the pair seems to make use of the Technology Advisor in choosing their strategy. After discovering the Technology Advisor in a previous episode, the pair actively makes use of it in their selection of

technology to research. This supports their evolving strategy in the game, which is partially developed with the aid of the Technology Advisor.

4.5.2 *Making History: The Calm & The Storm: Peer Team Awareness*

Another example shows how strategy can be borrowed from peer teams. In this case, very early in the first day of *Making History: The Calm & The Storm,* students choose to follow the peer team's direction while learning the basic gameplay:

Peer 1: Declare war <on>
Peer 2: Do it (0.5) ha ha declare war.
L: ((*Scrolling through map*))
¤<322092> (.)
Peer 1: OK, we're declaring war on uh (0.5) on Britain here. >READY AND, GO!< We just declared war.
¤<327828> (.)
L: How did you [declare war?]
R: [↑How did you declare↑ war?]
Peer 2: No idea.
Peer 1: I don't know, we just clicked [International] =
L: Here you can try. ((*Mouse control traded from L to R*))
Peer 2: [Click the] middle button with like the piece of paper
L: ((*Followed the direction of the peer team; clicked on the Diplomacy (middle) button*))

Peer 1: = and it gave us the ability to go to war at the very bottom.

¤<338392> (.)

L: We don't have any °current wars°. ((*Reading from Diplomacy Screen*)) [51] Oh, let's make some negotiations.

¤<344269> (.5)

R: Select uh. (.5) Who should we select? ((*Clicked on 'Select Nation'*)) [52]

L: Let's get ↓uhh↓

R: Bhutan? ((*Laughs*))

L: ((*List of countries came up for the pair to choose from*)) Let's get (.) Germany.

¤<354186> (1.0)

R: ((*The pair selects Germany, which brings up a new menu of diplomatic options with Germany*)) ((*Mouses over 'Diplomatic Relations' buttons*)) [53]

L: <Propose> (0.5) Should ((*Laughs*)) we declare war against them?

---

[51] "Major diplomatic and combat events appear here. See what treaties have been signed, wars have been declared, and regions are in conflict." (Making History Manual, p. 12)

[52] "You can use the Select Nation and Select Alliance buttons to propose or modify your diplomatic agreements. To individual nations you can propose various treaties. To an alliance you can only propose or demand peace." (Making History Manual, p. 27)

[53] "Your allies are countries you've agreed to defend and vice versa. If you attack a nation, your allies are expected to join your fight. If your allies attack a nation, you are expected to join them. When other nations want to join your alliance, their membership must be approved by all major allies (all playable nations)." (Making History Manual, p. 25)

R: ((*Scrolls over 'Declare War' in the 'Diplomatic' menu choices*))
¤<364237> (.5)
L: >NO NO, CHINA, CHINA< China, cuz they (.5) we need their oil.
¤<369021> (1.0)
R: Where the hell is China? ((*Clicks on 'X' button to return to previous screen*))
((*Clicks 'Select Nation', then clicks China*)) (1.0) So like, declare war against [China?] ((*Laughs*))
((*Clicked on 'Declare War' button*))
L: [Yeah I] don't know why. ((*Laughs*))
R: Cuz we need their oil. ((*Laughs*))
L: ((*Confirmed war against China*))
¤<390533>

In this case, students were learning how to play the game (early in the first day of gameplay) and chose to follow a peer team's lead in declaring war on another country. While this example may fit well with the category on testing out the interface functionality, it is also an early game strategy. The awareness of peer team activity aided their formation of an initial strategy in the game. Declaring war set up the ensuing course of the game: after declaring war on China, the rest of the world grew angrier with their country. Additionally, the pair saw the difficulty in waging a war with a country far away, as it was difficult to coordinate military units from afar.

4.5.3 *Civilization IV: Amassing a Military Force*

A third example shows a sequence of episodes from *Civilization IV*, where a war was being waged with another computer-run civilization. In this case, students began to realize that they needed to join and fight with multiple military units for greater success. The first example shows some military battles being lost by fighting with individual units:

R: No send the other guys into the oh ,wait are those warriors too?, ((*Points to warriors on screen*))
L: >Yeah, Yeah, Yeah.<
R: Send them down.
L: ((*Scrolls across map to different locations*))
((*Takes a turn by clicking on the soldiers that R pointed out*))
((*Clicks on a different location and ends his turn*))
¤<268159> (2.0)
L: ↓Whoa↓ ((*Clicked on warriors in enemy territory*))
((*Clicked on enemy warriors fighting began*))
R: Uh oh. That's not good. ((*The warriors are dying from battle*))
¤<284433> (.5)
L: ((*Moves warriors to another location on enemy territory*))

L: ((*Clicks on promotion icons for military*)) [54]

R: °Uh yeah they have more people now.° We need more archers.

L: Where's our barracks? (1.0) ((*Scrolls over map*)) °What is this thing?° ((*Moves mouse over to an active ring but no one is in it*)) [55]

¤<307049> (.)

R: There. Barracks?

L: ((*Clicks on undeveloped barracks where building has not been finished*))

R: °It needs to be built I think.° (1.0) Tell them to make improvements. Improvements. Down here. ((*Points to Improvement icon at bottom of screen*))

¤<327697> (2.0)

R: Ah send them down. ((*Points to group of warriors at top of map*))

L: ((*Clicks on the group of warriors that R suggests to move*))

L: ((*Moves the warriors four spots to the South where R suggested*))

L: ((*Ends turn*))

¤<339460>

---

[54] "Promotions are special abilities awarded to units that are victorious in battle. In addition, some units begin the game with one or more special abilities." (*Civilization IV* Manual, p. 136)

[55] When a character is active, a ring will appear around them with circular arrows.

Early in the episode, a battle is lost with an enemy civilization. This appears to motivate the pair, as plans are made to send more military units down to fight the battle.

Figure 33: A battle animation in *Civilization IV*

After initially losing military battles, the pair strategizes that grouping military units on a single tile of the game (amassing a military force) will improve their military success:

L: Should we attack them? ((*Clicked on own warriors*))
((*Clicked on enemies warriors; fighting began*))
R: °Aren't they both there at the same time or no?°
Oh no. ((*Laughs*))
L: Yeah dude. ((*The pair's warriors defeated the*

enemy warriors))

¤<1083042> (.)

R: Promote him to be king. ((*Points to one of their warriors*)) Did it do anything? °No.°

L: Yeah. ((*Clicks on warrior that R suggested but the Promotion icon is not available for the chosen character*)) I think after a while they like get the other guys back. You can only attack one section.

R: Yeah.

¤<1098393> (.5)

L: [((*Looks over at peer team screen*))]

R: [((*Looks over at peer team screen*))]

L: Can you combine forces?

Peer team: Yeah.

L: How do you do that?

¤<1106131> (.5)

Peer team: Well uh (.5) I'm not sure you can put them together but you like

L: I mean can you like attack them with each other?

Peer team: Um ↓I think so.↓

¤<1115201> (.)

L: Ok I don't know if we can do that or not.

R: What is that thing? ((*Points to an icon option for the character chosen*))

L: ((*Moused over icon that R was pointing to*)) ((*Clicks on icon to move warrior*))

R: Isn't that like move all (.5) see the 'order the selected unit to move to another tile' ((*Reading from the screen prompt*)) (.5) and then put them altogether or something?

L: ((*Clicks on different characters*))
¤<1126378> (1.0)
L: What's the span though? ((*Clicks on 'Go To Mode' icon*)) [56]
¤<1134786> (.5)
R: °What does that do?°[57]
¤<1142620>

After learning of some military enhancements early in the episode, the pair questions a peer team, asking them if it is possible to join up military units (combine forces); thus making use of the peer team as a source of information. The peer team responds and offers advice. This results in the pair searching for a way to group military units together on a single tile in the game (a land area). Once this is completed, they try moving the military as a whole to fight the enemy civilization:

L: ((*Pair moves amassed military forces into Greek city*))
R: Oh that thing is deep in their village isn't it?
Uh huh. ((*Enemy was killed by military*))
((*Military takes conquered city*))
¤<1504522> (1.0)
R: ↑Yeah.↑ We need to keep it. ((*Given the choice*

---

[56] "Go to Mode icon orders the unit to move to a square." (*Civilization IV* Manual, p. 38)

[57] Referring to the icon just clicked, labeled 'Go to Mode'.

to keep the city or to burn it to the ground)) Hold on. Ok. We need to keep it?
¤<1518443> (1.0)
L: ((*Clicks on burn the city to the ground*)) No. ((*Laughs*)) We just earned money from destroying the barracks.
R: We destroyed three of something.
¤<1524249>

The pair successfully won the battle and took away the enemy civilization's city. From here onward, the pair shows a change in behavior, and travels with amassed military units when engaging in battles where possible. This is illustrated by preparing multiple military units before engaging a battle later in the game.

Breaking down what happened, the strategy of building forces was rewarded when the pair took control of the enemy civilization's city. The game rewarded their behavior, which may have resulted in the continued use of their strategy in joining military forces.

4.5.4 *RollerCoaster Tycoon 3: Making Money*

Finally, another example of advanced strategy while gaming comes from *RollerCoaster Tycoon 3*. An obvious goal of the game is to build theme parks and make them profitable, and learn to pay careful attention to the configuration of

ride prices as well as food stand prices. The first episode in the sequence shows the first successful construction (and opening) of a ride by the pair:

L: ↑Let's just do um↑ (.5) [let's do] ((*Pulls up the ride list choices menu*))[58]

R: [Water?]

L: ↑No. Let's do some uh↑-

R: Thrill rides, Junior Rides? ((*Reading options from 'Rides' menu*))

L: ((*Clicked on 'Junior Rides'*))[59] Yeah that's fine. Well there's only the one so

R: The Merry-Go-Round ((*Laughs*))

L: Yeah so we'll do that one like [here] ((*Clicks on Merry-Go-Round*))

((*Places the Merry-Go-Round in a clearing*))

R: [Yeah]

¤<1408782> (.)

L: Is that cool?

R: Yeah that's good.

L: <And>

R: A path. (.5) What's that? Oh the booth to get in. ((*Ride entrance for the Merry-Go-Round appears*))

---

[58] The Ride Menu lists all of the different rides that are available to be built. As gameplay progresses, more rides are researched and become available. Some rides can be custom built, where each piece of the ride is manually assembled.

[59] Junior rides are rides for children. All of these rides have pre-made designs and can be placed anywhere in the park.

60

L: ((*Placed entrance to get into ride*)) °Yeah.°

¤<1416805> (.)

L: ((*Placed ride exit*))

R: Exit booth and entering booth. Perfect.

L: ((*Clicked on 'Paths'*)) [61]

((*Successfully connected the path from the entrance / exit to the main path*)) Cool.

R: [Is there any]

L: [Go on the Merry-Go-Round] Yeah I think people are getting on.

R: [What are] all these things mean? ((*Points to the ride options*)) Can we change them?

¤<1435180> (.)

L: ((*Scrolls over the ride options*))

((*An explanation of what each ride option appears as the pair scrolls over each option*))

R: 'Test Results, open' Make sure it's open.

L: 'Not assessed yet.' ((*Reading ride status. Not yet assessed because it hasn't been tested*))

R: Go to.

L: °Vehicles.° ((*Clicked on the 'Colors' icon for the vehicles of the ride. A selection of colors popped*

---

[60] Entrances need to be built for each ride so that the customers can get on the rides. This option is located in the ride option menu and appears once a ride has been placed in the park.

[61] Footpaths need to be made from the main pathway to the entrance and exit of each ride. Paths guide the customers to the ride's entrance and exit. Without a path, customers can not get on to the rides.

up))

R: All the colors of the ride. Oh that's cool.

((*Clicked on the 'Colors' icon*))

((*Changed the colors of the vehicles*))

L: °That's good.°

¤<1455555> (.)

R: Go to this one. ((*Point to the 'green flag'*)) [62]

[Click extension]

L: ['Guest Thoughts'] none. ((*Scrolls over the ride options*))

((*Clicked on 'Guest Thoughts' icon*)) [63]

R: Make sure it's open.

L: ((*Continues to scroll over ride options menu*)) 'Maintenance'. ((*Reads from the pop up of the icon he just scrolled over*)) [64]

¤<1462611> (.)

R: Go the flag

L: ((*Clicks on the flag and changes it to green*)) [It

---

[62] When a ride is placed, ride option icons appear around the central ride icon. One icon consists of a green and red flag. The green flag, once clicked, opens the ride for business. Clicking the red flag closes the ride down.

[63] An icon labeled 'Guest Thoughts' shows the thoughts of people on the ride. Reading the thoughts of the guests on the ride can help determine whether to raise prices, fix broken down rides, or schedule more frequent inspections for rides.

[64] The 'Maintenance' icon shows how frequently a ride is scheduled for inspection. The gamer can change the frequency. It shows the last time the ride broke down and what failed when it broke down.

is open.]

R: [Then hit] the green. There. Yeah see now it's open.

¤<1467398> (.)

L: Have we tested it? ((*Clicks on 'Test Results' icon*)) [65]

R: 'Excitement Rating'. Low.

L: °Whatever. It's all good. I don't care as long as people go on it.°

R: ↓Oh we got a visitor.↑

L: Let's build more <u>rides.</u> ((*Clicks on 'Rides' icon on left side menu*))

¤<1477672>

The pair appears to figure out a sequence to construct theme park rides, including: building it, constructing entrances and exits, constructing a footpath to the entrance and exit, and opening the ride for business. Next, a second ride is created. This time the ride is created faster, and the pair discovers how to set its admission price:

---

[65] The gamer can check to see if the ride has been tested. Testing gives specific features of the ride, such as maximum speed, G forces, excitement rating, etc. Testing can be done by clicking an orange flag (between the green / red flags to open / close the ride). In this case, testing was not completed by the gamers.

L: Let's do ↓um ((*Pulls up 'Ride' menu*)) [66]
((*Scrolling through 'Ride' list*))
R: You should put another one right here. ((*Points to top of screen in a clear location*)) Or no?
L: No we don't have any more junior rides. ((*Clicks on 'Rides' icon and then 'Junior Rides'*))
¤<1484527> (.)
R: We need to get rid of all these trees. I don't like all of these trees. I say we keep those bushes but get rid of the <u>trees</u>. ((*Points to the bushes and trees around courtyard area of park*))
L: How do we get rid of them?
R: °I don't know.°
L: ((*Clicks on the 'Delete Object' icon*))
R: °There. (.5) Yeah.°
L: ((*Successfully deleting the bushes and trees by clicking on the trees that are highlighted after L clicks on them*)) ↑[We lose]↑
R: [I just think there's too much]
¤<1500855> (.)
L: ↑We lose money.↑
R: ↑We do?↑
L: ↑I think so [watch]↓
R: ↑[We could] put rides there.↑
L: Watch. [67] (1.0) Yeah we lost money every time we do

---

[66] The Ride menu displays all of the rides that are available at the time.

[67] When the gamer clicks on a bush or tree to delete it, a minus sign appears and they lose money.

it so we're not [doing it anymore.]

R: [Alright, put in rides first.]

¤<1514744> (.)

L: ↑Ride, Ride↑ 'Thrill Rides'? ((*Pulls up 'ride' menu*))

R: Yeah do Thrill Rides like over here. ((*Points to the left of the screen where the terrain is clear*))

L: ((*Clicks on 'Thrill Rides'*))

((*Three different rides appear - chooses 'Chair swing'*)) Ok Let's do Chair swing. ((*Places the Chair swing ride in an open area*))

R: Yeah then do a 'Sky Sling', There's no music, oh we pick the music. Yeah.

¤<1530624> (.)

L: ((*Clicks on 'Entrance'*))

((*Places the entrance / exit for the ride*))

R: Oh good now it's gonna rain.

L: ↑NO↓ ((*A Windows Update for the computer popped up and booted them out of their current game*))

((*Clicked on 'restart later'*))

R: Restart later. You're interrupting our game.

L: I know. Um paths now?

R: Yeah.

¤<1553639> (.)

R: We need to make a path.

L: ((*Clicked on 'Paths' icon*)) °Ok.° ((*Clicking on tiles near ride to place the path*)) (.5) I should do

[where's the other one?] [68]

R: And [where's that other one?] It's right there.

L: It is?

R: Yeah. So just connect there. ((*Points to the entrance for the ride*))

L: Cool. (hhh) And then lets open it. ((*Clicks on green flag icon to open ride*)) [69]

R: Yeah click on that. Green. ↑Then pick the music.↑ Where's that music thing that came up? [70]

¤<1579223> (.5)

L: ((*Placed an additional path piece*))

R: Oh you just put something.

L: ↑Oops.↑ ((*Clicked on trash can icon, then clicked on new path tile and removed it*))

¤<1584048> (3.5)

R: 'Finances', 'Maintenance' ((*Reading from pop up window*))

L: ((*Scrolling over the ride option icons*))

R: What's this?

L: ((*Clicks on 'Test Results' icon*)) [71]

¤<1592359> (5.0)

---

[68] Referring to the other entrance where a path needs to be made.

[69] When a ride is selected, icons pop up around the ride icon. One icon that pops is a green / red flag. Clicking on the green flag opens the ride for business. Clicking on the red flag closes the ride down.

[70] A customizable ride option is setting the music (to be played) on the ride.

[71] The 'Test Results' icon displays ride properties (speed, G forces, ratings, etc.) after the first test is conducted on the ride.

R: How about this one? ((*Points to the 'Colors' icon for the ride*)) [72] (.5) °No that's not it.°

L: ((*Clicks on 'Finances'*)) ↓Admission price is going up.↑ ((*Moves cursor over to 'price', raises price*))

R: ((*Laughs*))

L: How much money do you want it to go up? ↑Because there's a lot of people coming.↓

R: Make it like 2 dollars. ((*Laughs*)) More?

L: ↑Suckers.↑ ((*Raises the price on the ride*))

R: We have to go see if they come in or not.

L: Uh oh they're stopping. ((*Laughs*))

R: ((*Laughs*)) Oh they're going in.

¤<1630459>

In comparison to the first ride they created, a change in behavior can be seen: the creation of the ride is quicker, and the pair explores the ride's many options after opening it up for business. Financial options are discovered, and the pair attempts to raise prices without alienating their clientele. It appears that the pair infers they cannot make the price as high as they want, or people will not pay to get on the ride.

Continuing the game play, the pair decides to add food stands to capitalize on their profits:

---

[72] 'Colors' icon can change the color (paint) of the ride.

(first part of episode omitted: starting in middle)

L: ↑We're making money↑

R: Let's put some food restaurants in. ((*Points to 'Stand' icon on left side to build a restaurant*))

L: Alright. ↑Well let's get more rides.↑ We need to put more rides but we'll do that to. Um so-

R: Just put um all yeah put um like around like the pathways.

L: ((*Clicked on burger stand*)) Uh no, no, no ,no, no. ((*Placed burger stand in park*)) Do do we have to have a path?

¤<470734> (.)

R: I think maybe.

L: ((*Clicks on 'Paths' icon*)) [73] No. ((*Attempts to place a path between burger stand and adjacent foot path but it does not work*))

R: No?

L: Yeah let's put it >where where< a ton of people are too. Ok?

¤<478809> (.)

R: Wait how much are the burgers? Make sure they're a lot.

L: No not here.

R: Cuz you know people will buy it.

L: Yeah.

---

[73] The path icon is needed in order to connect rides to footpaths in the park. The paths allow the customers to enter and exit the rides.

¤<485922> (.)

R: ↓Ok well we gotta open it.↑ ((*Points to the green flag*)) [74]

L: ((*Clicks on green flag to open burger stand*))

R: Open. Then go to the price.

L: ((*Clicks on 'Financials' icon*)) [75] Oh those are extras. ((*Shows prices of burgers, onions, ketchup, mustard etc*))

¤<497256> (1.0)

R: Yeah. The biggest burger make like 2 dollars. No make it 3.

L: ((*Clicking to change price of burger*)) No make it 2.

R: 2!!!!

L: We got a quarter pound burger.

¤<508528> (.)

R: You go to like Six Flags and it's like 6 dollars for a burger and people buy 'em. ((*Laughs*))

L: This isn't Six Flags, ok?

R: Well [it's not Disney World either. Not Disney World either.] ((*Laughing*))

L: [↑K Jackie↑, this isn't ↓Six Flags.] ((*Laughing*)) OK, well, Disney World is a little bit better than Six Flags. •

---

[74] When the green flag is clicked it will open the ride for business, and when the red flag is clicked it will close the ride.

[75] The financials icon displays what the ride is making per hour, any losses, and total income from the ride.

¤<522049> (.)

R: Make that like

L: ((*Continues to click to change prices*)) This is 3 dollars. ((*Scrolling through list of menu items for the burger stand*))

((*Changing the prices at every food stand*)) [76]

R: Ok. 'Quarter Pounder' ((*Reading from 'Product' cost list*))

L: [No we'll do three fifty.] ((*Laughs*))

R: [No that's half]

¤<531560> (1.0)

L: ((*Clicking and changing the prices on all the food items sold at the burger stand*))

R: There and that can be-

L: That should be more

R: Yeah I was gonna say that should be more. And make that three.

L: °Two Seventy° ↑yeah three.↑

¤<543400> (1.0)

R: Ok.

L: ((*Scrolls through food menu items for the burger stand*)) That's good.

R: What do these check things mean? 'Check these to add pickles to your standard burger' ((*Reading from pop up after scrolling over check box*)) No. They have

---

[76] The gamer can change the prices on all food items for any food stand previously built (a selection box at the bottom, which propagates price / menu changes to all food stands of that type).

to buy extra for everything. ((*Laughs*))

L: Ok.

¤<559688> (.)

L: Yeah let's put in another burger place. Like in front. Ok?

R: Oh go to their ice cream place and open it up first. (1.0) We've got to make their ice cream more expensive.

L: ((*Changes price of ice cream*)) It's good to go.

R: Uh a single scoop should be two dollars.

L: ((*Clicks on ice cream stand*))

((*Clicks on 'Product' cost list and changes price of single scoop*)) How much?

R: Make it one-

¤<589805> (.)

L: Gosh ((*Computer booted them out of their game again for updates clicked restart later*))

R: One seventy five.

L: >A single scoop?< dollar fifty. ((*Laughs*))

((*Changes the price on each item served at the ice cream shop*))

R: ((*Laughs*))Ok

¤<600591> (.)

R: Double [two]

L: [Two]

R: Two twenty five

¤<604207> (.5)

R: 'Chocolate single scoop' ((*Reading from 'Product' cost window*)) A dollar

L: [Seventy five] ((*Continuing to change prices on*

the ice cream shop))

R: [Seventy five] ((*Laughs*)) It's more if you like that chocolate.

L: Mmm Hmm.

¤<614222> (.5)

R: Two dollar or no? Two fifty I guess.

L: ((*Clicks the price to two fifty*)) That's it.

R: Ok. What are people's ↑thoughts on these ↓places?

L: ((*Clicks on 'Guest Thoughts' icon*)) [77]

R: There are no thoughts.

¤<627852> (.)

L: ((*Clicks on burger stand to see guest thoughts*))

R: No thoughts either.

L: Awesome. Thanks people.

R: Do we have enough ↑people? Go to customers.

L: ((*Clicks on the 'Stats' icon for the ice cream and burger stand*)) [78] [Zero]

R: [Zero]

L: ↑Awesome.↓

R: It is, both of them are open right?

L: Yeah. Let's go get some more rides.

¤<641477>

---

[77] The 'Guest thoughts' icon displays the thoughts of the customers. Viewing the thoughts provides information on customers' thoughts and can influence the adjustment of the attraction's price or options.

[78] The stats menu shows specific stats of the ride or stand in graph format.

As can be seen above, careful attention is paid to the pricing of things at the food stands in order to maximize profits. In *RollerCoaster Tycoon 3*, it is possible to view guest thoughts for each ride, as seen below in Figure 34. Feedback is given on the game interface: gamers can read 'Guest Thoughts' in order to grasp whether people think the prices are appropriate (a good feedback channel).

Figure 34: Guest thoughts on a ride in *RollerCoaster Tycoon 3*

A final episode in the sequence shows careful attention to prices, and watching whether customers get on the ride. This is another feedback channel

offered by the game: players are able to find a sweet spot in the price by paying attention to whether nearby park guests get on the ride or walk away from the ride. In *RollerCoaster Tycoon 3*, if the price is too high, many people approaching the ride will turn away rather than pay admission.

L: Right? ((*Scrolls through 'Rides' menu*)) [79]
R: Yeah.
L: 'Water' (.5) 'Gentle' (.5) 'Thrill' (.5) ↓Let's just do thrill rides. More thrill rides.↑ ((*Clicks on 'Thrill Rides'*)) [80]
((*Four rides pop up to choose from*))
R: Do do a Sky Sling. That looks cool.
L: Where is it?
R: Right there. ((*Points to the ride that says 'Sky Sling'*))
L: Right here? ((*Scrolls cursor over the icon that R pointed at*))
R: Hmm Hmm
¤<656918> (1.0)
R: People are thrown into [the sky]
L: [Whoa ho ho ho] ((*Places thrill ride that is rather large in size*))
R: ((*Laughs*))
L: °Nice.° ((*Places ride in an open area*))

---

[79] The ride menu shows all of the types of rides that are available to the gamer to build.

[80] Thrill rides are pre-designed rides and typically less expensive than roller coasters.

¤<664189> (.5)

R: You have to make sure that the price on that is expensive.

L: ((*Placed the entrance and exit to ride*)) Yeah. (.5) ↑Because they are super expensive.↓

¤<675702> (.5)

R: Love how it's right near to the burger and ice cream place. ((*laughs*))

L: ((*Clicked on 'Paths' icon*)) ((*Started building a path from new ride to main pathway*))↓<Yep.>↑

¤<681574> (1.5)

R: ↑Then connect it. Yeah do that.↓

L: ((*Continues to place the path from the entrance / exit to the main path*)) ((*Connects the two paths*))

¤<695262> (.5)

R: Can you put benches in here and stuff?

L: ((*Continuing to place paths*)) Hmmm Hmmm.

R: We should put some benches. 'Scenery'.

L: ((*Scrolls over left menu bar where the names of the icons pop up*)) What's mix master? ((*Scrolled over 'Fireworks'*)) [81]

R: °I don't know.°

¤<721193> (.5)

R: °Don't want that.° Yeah. And marble bench. (.5) Yeah, it's a dollar, perfect.

---

[81] It is possible to have a fireworks show in your park. Fireworks can help attract customers.

L: ((*Clicking through menus / icons*))

((*Finds and chooses a bench*)) It won't go. [82]

R: Why don't you go off the screen and see if it's clicked. ((*Points off the screen*)) Yeah it's clicked.

¤<750276> (.5)

L: Alright, well. ((*Places benches all over pathway*))

R: Is this one open? ((*Points to a ride*))

L: Hmmm Hmmm

¤<771528> (.5)

L: Should we open it now?

R: Yeah. (.5) Make sure the price is up.

L: ((*Clicks on Sky Swing ride*))

((*Clicks on the green flag to open it for business*))

[83] Where were the prices again?

R: Is it operating? Mode. Hmmmm.

L: ((*Clicks on all icons surrounding ride options*))

Those are just the colors.

¤<793280> (.5)

R: This one ((*Points to the 'Financial' icon*))

L: A lot of people are going. So, that's really good.

R: We got to raise the price though.

L: I don't think there is a price. ((*Clicks on 'Financial' icon*))

((*Changes the price of the ride*))

---

[82] It is possible to add garbage cans, signs, path lights, etc. to the park.

[83] When a ride is placed, ride options / icons appear around the ride icon. Green and red flag icons appear. The green flag, once clicked, opens the ride for business. The red flag, once clicked, closes the ride down.

R: There's no price for it?

L: No.

R: What's financial or finance?

L: ((*Clicks on the 'Financial' icon*)) Oh yeah there we go.

R: Yeah it should be more than a dollar.

¤<812536> (1.0)

L: ((*Clicks at the price to change it*))

R: You could, like, seven

L: No way.

R: Not seven? Otherwise it's four. Watch put seven and see if these people go on it?

L: We'll go five. Five fifty, or [six?]

R: [Six]. Go six.

L: Ok.

¤<828513> (.)

R: If people don't go on the ride then we will lower it. But I think they will.

¤<832673> (.5)

L: Dude, a lot of people are going. So let's start a new ride.

¤<838185> (.)

L: Yeah.

R: Are people gonna get on it though?

L: ((*Clears throat*)) Hmmm Hmmm. ((*Pulls up 'Ride' menu*)) I think so. Yeah. Uhh (.5) no.

R: Lower it. Oh no people are going on it. Oh look we already made thirty four dollars. (.5) No it's good.

¤<855547> (.)

L: I'm just gonna make it a five. ((*Clicks price higher*)) Honestly.

R: Five?

L: Yeah, honestly I think like that's a better idea. ((*Readjusts price on ride*))

R: Well all those people just went on it.

L: I know. I still think five's more reasonable.

R: ↑Mmmm,↑ ↓K...↓

L: Well we can always change it so...

¤<871235>

As the pair continues to build rides, more attention is paid to setting prices of attractions. Players negotiate prices with each other attempting to maximize profits. However, in the above transcript, the left student appears to invoke a sense of ethics in not setting prices *too* high. The pair acknowledges that too high of a price will result in few people paying to get on a ride, and often opt for a lower price to raise the popularity of an attraction.

In games with many dynamic systems to manage, such as the games used in this study, a strategy is needed to be successful and meet goals in the game. Well designed simulations rules and good feedback assist gamers in making decisions supporting their strategies to win at the game. Many of the learning situations described above are provoked by features of the game being played, which are discussed in more detail in the next section.

4.6 *Game Features That Trigger Task Pursuit*

As mentioned at the beginning of the chapter, it was found that specific game features can provoke pursuit of tasks and lead to episodes of learning. This section is dedicated to that idea: specific features of games can trigger the pursuit of a task where learning can occur. While a game or social cue can trigger collaborative task pursuit, it is not a guarantee that learning will occur. However, as Hidi & Renninger (2006) point out, sparking interest with cues can develop interest and add motivation to complete a task. This positively influences learning, and in most cases where cues lead to task pursuit, some sort of learning occurs.

Examples in this section highlight the use of artificial intelligence (AI) of games, as well as game representations and behaviors that trigger actions on the part of the student gamers.

4.6.1 *Cognitive Offloading of Repetitive Tasks to Game AI in RollerCoaster Tycoon 3*

A game feature that can improve learning and game play is cognitive offloading. This occurs when some responsibility in a game can be delegated to

artificial intelligence of objects in the game (responsibility handed back to the computer). A previous example of this was shown with *Civilization IV*: the Technology Advisor in the game takes some of the responsibility of presenting and remembering what advancements in the game lead to other advancements. In *RollerCoaster Tycoon 3* and *Civilization IV*, artificial intelligence (AI) is built into game staff or workers, allowing them to automatically fix things (mechanics in *RollerCoaster Tycoon 3*) or automatically build or improve things (workers in *Civilization IV*).

For example, *RollerCoaster Tycoon 3* has notification messages that occasionally pop-up to the game player. While playing, gamers receive messages about successes and failures in their park. For instance, when a ride or attraction breaks down, a message is displayed to the user. Also, when things are fixed, a message is displayed. In *RollerCoaster Tycoon 3*, employees have some built-in intelligence. For example, mechanics will attempt to fix broken rides on their own. This can be seen in the following example:

L: High flyer has got its doors stuck open. ((*Pop up window appeared stating that High Flyer has its doors stuck open; suggesting to send a maintenance person*))
NO! Go to high flyer.
R: Maintenance.
L: Where's High flyer?

R: Is that High flyer? ((*Points to a ride on the screen*))

L: ↓Yeah, probably.↓ ((*Clicks on the ride that R pointed to*))

¤<1642036> (.)

R: We should definitely raise the price on these huge long wait ones.

L: ((*Clicks on maintenance man icon*)) That ↑high↑ flyer?

R: Maintenance. (.5) Ok now he's going.

L: ((*Clicked on maintenance guy walking to ride*))

R: ((*Reading game dialog*)) 'Put me down. My work is varied. Bored bored bored.' ((*Reading thoughts of maintenance man*))

¤<1662405> (.5)

L: I don't think ↑that's high flyer is it?↑ ((*Scrolls over ride just chosen*))

((*Name of ride appears*))

R: I dunno. We should -

L: ((*High flyer does not appear for the ride chosen*)) >TUMBLER. That's tumbler.<

R: Oh shoot. Where's the high flyer?

L: ((*Changes camera view to find high flyer ride*)) Is that the high flyer? ((*Scrolls over the Chairswing to have name of ride pop up*))

R: No that's the Chairswing.

¤<1677029> (.5)

L: We don't have any more rides. ((*Changes view of camera again*))

R: Oh [there it is.]

L: [Oh there it is.]

R: Oh I didn't see that one.

L: ((*Window pops up saying that high flyer has been fixed*)) >Has been fixed. Has been fixed.< Maintenance guy did it.

R: ↑Try to click...↑

¤<1686230>

In this situation, the game notified and switched attention to a broken ride. By the time the pair found the ride, the automated mechanic (employees have built-in intelligence) had walked over to the ride and fixed it. This accomplished a few things: it redirected the pair's attention to the broken ride, reminding them that they need to maintain them with a maintenance staff; and it showed that their maintenance staff has intelligence which can assist the fixing of rides in the future. This is illustrated in the following episode:

L: ((*Zoomed out from park*)) °Nobody's on this <u>ride.</u>°

R: ↑No one is on the ride?↓

¤<3071208> (.)

L: Well (.5) I don't know see. ((*Zooms out with camera*))

R: Is it broken?

L: Yeah.

¤<3076200> (.)

R: How much does it cost for that one? (.5) 'Minutes from last' ((*Reading from ride menu the last time the ride was checked by maintenance*)) ↑Uh↑ it should be

like every minute. (.5) Get pick the janitor for the thing. ((*Points to maintenance man icon*)) [84]

L: ((*Clicks on maintenance icon*)) Oh [yeah.]

R: [Like I] mean this thing so he can fix it.

¤<3100207> (.5)

L: °Can I pick him up and have him go over° ↑here?↑((*Maintenance guy is nowhere near the ride*))

R: I don't know.

¤<3104792> (.)

L: ((*Clicked on maintenance guy*)) °Well we need him because we're losing money.° (.5) There he is. He's coming.

R: Yep. ((*Teacher came in to ask the students a question*)) (1.0) How much is this ride?

L: ↑A lot↑

R: It is?

L: °We're making cash on it.°

¤<3158361> (.)

R: Fast forward it I hate it when it's dark. ((*The game has turned night mode on and screen is darker*))

L: ((*Clicks the fast forward button*))₂ Ok <u>hopefully</u> uh the janitor went to go or the -

R: ((*Yawns*)) Mechanic.

---

[84] Every park ride has a ride inspection interval. Increasing the frequency of inspections increases ride reliability, but burdens the park's mechanics, resulting in the need for more mechanics to keep up with maintenance and repairs.

L: Yep. ((*Clicks on fast forward again*)) [85]
((*Zooms out from park*))
¤<3207491>

In the episode above, the pair expects that their maintenance staff automatically made it to a broken ride in order to fix it for them. Initially, the pair was surprised that a ride was broken down, as mechanics automatically make their way over to broken rides and repair them. After losing track of the mechanic, they trust that he had made it to the broken ride and repaired it. This was followed by the 'fast-forward' being clicked, which speeds up time in the simulation.

Intelligent agents in the game (e.g., mechanics in *RollerCoaster Tycoon* 3) are a game feature that allows the pair to focus on other managerial tasks in the game, rather than playing as mechanic every time a ride breaks down.

A counter example of this occurs in *Making History: The Calm & The Storm*. In this example, the pair needs to raise their production (economic output) to support their military objectives. With little artificial intelligence built into the

---

[85] At the top left of the screen there are buttons to play, pause, and fast-forward time. At any point in play gamers can pause time until they want to resume business, or fast-forward the game play to speed up time (to watch the park / profits change over time).

game, they are required to manually adjust the output of individual factories, for individual provinces of their country:

```
L:  ((Clicked on 'Production' of a city))
((Clicked 'Air Force'))
((Clicked on 'New Production Order'))
((Clicked on an Air Plane))
((Clicked on 'Production'))
((Production window popped up))
((Clicked on 'Air Force'))
((Clicked on Military))
((Clicked on 'New Production Order'))
((Clicked on a 'Goods'))
((Clicked on 'Air Force'))
```

[86] "When MAKING HISTORY starts, your cities might produce a mix of arms, goods, military units, and research. Additionally, cities can invest in expansion and upgrades and port cities can produce Transport Capacity credits and repair naval forces. The Industry summary shows how many IPUs (Industrial Production Units) your economy produced this turn. Production can be dampened by insufficient supplies, military attack, dissatisfied workers or workers from a different culture." (Making History Manual, p. 31)

[87] "Goods keep your workers satisfied and bring you money. When you produce goods, you can sell them to your citizens and trade them on the World Market. These profits strengthen your financial score (important to your overall score) and give you money to spend elsewhere. If workers lack goods, production can suffer. You can review goods levels in the Supplies panel." (Making History Manual, p. 32)

```
((Clicked on 'Fighters'))[88]
((Clicked on 'New Production Order'))
((Clicked on three different areas of the map))
((Clicked on 'Production'))
((Clicked on 'Air Force'))
((Clicked on 'Bombers'))
((Clicked on 'New Production Order'))
¤<1853906>
```

In this case, a lack of cognitive offloading takes away from the game play, hurting factors like immersion and learning. Some built in automation of characters would be beneficial, as would an easily accessible summary screen showing what all factories were producing. *RollerCoaster Tycoon 3* and *Civilization IV* have several automation and summary features built in that assist with the game play, serving to avoid lengthy amounts of time being spent doing repetitive tasks.

4.6.2 Forcing Strategic Decisions in Civilization IV

Sometimes, learning can occur as a result of a game forcing decisions to be made that affect the course of the game. In *Civilization IV*, computer competition

---

[88] "Fighters are strong in air-to-air combat. They can patrol, support land battles, and attack land pairs and resource producers." (Making History Manual, p. 17)

forces game players to attempt to match (or beat) the skill of the computer in order to succeed. With regard to diplomacy, often the computer avatars (computer generated civilizations) will make trade or diplomatic offers that can be accepted or rejected.

In the following example, the pair had been at war with another civilization for some time. While they enjoyed some early success, they had slowly been losing battles with the other civilization, which had developed a more powerful military over time. Facing destruction by the other civilization, the computer player approached the pair with an offer of peace with concessions:

R: °Alright, lets this one° ((*Leader popped up for trade*))
L: ↑NO.
¤<2699940> (.)
R: Yeah. Dude they're going to kill ↑us. ((*Laughs*))
L: ↑Feudalism↑? ((*Points to what the pair has on the trade table, Feudalism*))
R: Craig, they're gonna kill us.
L: ↑We're giving 'em↓ ↓our crap for ↓nothing dude!↑
R: ((*Clicked on 'Can we negotiate'*)) Give us the city.
¤<2707629> (2.0)
L: ↑Tell him to give us Delphi↑. ((*Laughs*))
R: ((*A note from the leader popped up*))
((*Clicked 'Ok'*)) °Whaaa ha what?° ((*Offer rejected*))
¤<2714967> (.)

L: ↓Whatever I don't care.↑
R: ((*Clicks to accept the original offer of a peace treaty with concessions*))
((*'We would like to make a proposal' pops up*))
°Where's the city?° ((*Clicks on the leaders city to trade*))
((*Trying to click on 'Declare War'*)) (.5) How do I declare war against someone? ((*Clicks 'Farewell'*))
¤<2733235>

As a concession to the more powerful civilization, the pair was faced with surrendering some of their technology (Feudalism) in the treaty, or continuing the war. One student did not want to surrender some of their technology to the other civilization, but cool heads prevailed: and the peace offer (with concessions) was accepted.

In this case, the game presented a major decision to the game players. Had they chosen otherwise, they may have been defeated by the enemy civilization (or severely weakened from a long war). In either case, learning occurs. The game presented a major diplomatic decision, which largely affected the game's outcome. Another example of diplomacy from *Civilization IV* is presented later in the game as the world's civilizations begin to crowd and compete with each other:

L: Ah, we would lose our Explorer. ((*Leader has popped up to start trading*))
((*Clicked on offer that is on the table*))
R: No.
L: And we can't construct harbors.
R: No. Say no.
¤<1144743> (4.0)
L: ((*Clicked on 'Farewell'*)) °Trader.° ((*Isabella popped up wanting to talk*)) °'It can no longer be tolerated we demand that you leave the Egyptians'° ((*Reading what the leader has to say*)) What's our deals with the Egyptians? (.5) ↑We should probably cancel it because she's right next to us.↑
R: Yeah. Let's do that.
¤<1176840> (1.0)
L: ((*Clicked on 'What do you think of...'*))
((*Clicked on 'Alexander'*))
L: 'Annoyed.' ((*Reading from screen*))
((*Laughs*))
R: ↑See if you can declare war with her.↓ Make a trade proposal. °No that's something else.°
L: ((*Clicked on 'Farewell'*)) Oops.
R: Click on ((*Pointed to Isabella's name*)) (.5) Isabella.
¤<1205424> (.)
L: [Trade Proposal?] ((*Reading from list of options from trade screen of Isabella*))
R: [Trade Proposal?] Yeah.
¤<1210415> (.)
L: ((*Clicks on 'Trade Proposal'*))

((*Items to be traded for both sides pop up*))
R: °Like declare war on her. (.5) Scroll down. 'Alexander'.°
L: For what?
R: Click on that.
L: What?
R: Click on 'What do you want for this'. ((*Choice on screen*))
L: ((*Clicks on 'What do you want for this' option*))
R: No what? ((*Isabella is shaking her hand and her head no*))
¤<1230760> (1.5)
L: [Gold going up] ((*Clicked on their gold*)) ((*Closed gold option*))
R: [Gold going up]'Can you trade this for a good friend?' ((*Points to option on Isabella's trade screen*))
¤<1238360> (.)
L: ((*Clicks 'Can you trade this for a good friend?'*)) ((*Isabella shakes her head no and her hand no*)) I don't know what we're doing.
R: Ok never mind. Go back to. ↑Try to declare war.↑
L: ((*Clicked on 'Farewell'*))
¤<1246311>

In the above example, the world is becoming crowded and 'small' enough that the pair has to choose sides. In this case, after waging a war with a nearby civilization, they realize that they should appease nearby civilizations to avoid

war. The pair had learned the hard way by waging war on a neighbor: neighbors can easily amass troops and send them over a border. In the above avatar interaction, even though they had nothing against the Egyptian civilization, the pair chose to alienate them in order to preserve relations with a neighbor civilization.

Another 'forced' decision in all games used was that of initial scenario selection. Pairs that had the opportunity to play more than one game often exercised much more care in selecting their scenario after losing a game. The game scenario being played (difficulty level, etc.) has a large effect on the nature of the game, so careful attention should be made to this initial decision. Transcripts of scenario selection can be seen in Appendix H.4.

4.6.3 *Redirection to Neglected Game Aspects in Making History: The Calm & The Storm*

As mentioned earlier, specific game features can serve to redirect attention to other aspects of the game. Examples from *RollerCoaster Tycoon 3* and *Civilization IV* have already been mentioned: *RollerCoaster Tycoon 3*'s console messages (a ride has broken down, etc.); and *Civilization IV*'s avatar interactions (prompts for trade proposals, peace, etc.). These redirections can cause learning to occur by focusing attention on other areas of the game, which can easily be

forgotten or neglected. Additionally, they can draw game players towards new features of the game that have not yet been used, allowing game players to make use of those features. An example follows from *Making History: The Calm & The Storm,* where the pair receives notification of another country (Canada) taking control of one of their states (Michigan):

L: We can declare. ((*'National Events' popped up telling the pair that Canada seized control of Michigan*)) [89] What Canada seized control of Michigan?
R: Oh crap.
L: What? ((*Clicks on 'Mini Map'*))
¤<1347166> (.)
L: Where's Michigan? ((*Scrolls over continent to find Michigan*))
R: Oh shoot there it is.
L: Not occupied, Oooh who did?
R: We can take that back. Canada. We can't take ↓that from Canada.↑
L: Dude, ah. ((*Zooms in on map*))
¤<1362601> (.5)
R: Do we have like any armies ↓over there?↓ ((*Clicks through the different map views*))
L: I don't know where the °hell (.5) our armies are.°
L: Alright this guy (.5) ((*Clicks on a plane in*

---

[89] "Here you can learn about production, idle cities, resource shortages, trade changes, completed research, and industrial upgrades." (Making History Manual, p. 11)

Georgia)) needs to go (.5) over here. ((*Clicks on an area in Michigan*)) (1.0)

L: ((*The plane does not move*)) How do you move 'em again?

R: The planes won't move (1.0) like I can get the (1.0) armies to move but I can't get the planes to move.

¤<1383789> (.)

L: ((*Clicks on a plane in Georgia*))

((*Clicks on Washington*)) Do you know how to move planes? ((*Clicks on the same plane in Georgia*))

((*Clicks on Washington*))

((*Moves cursor to 'Mini Map' of nations*))

((*Clicks on 'Ideology' map*))

((*Clicks on 'In Supply' map*))

((*Clicks on 'Operational' map*))

((*Asks the peer team for help with moving planes*))

Peer team: Do you?

L: Do you know how? ((*Scrolls through US continent*))

Peer team: No. Do you know how?

L: No ((*Laughs*))

Peer team: ((*Laughs*))

¤<1410157> (.)

Peer team: That would be really helpful. How do you get your file like that? It would make it so much easier. Having this crazy...

L: ((*Changing the view of the map*))

((*Zooming in and out on map*))

((*Zooms in and out on Michigan*)) You just right click it.

Peer team 1: Ohhhh ((*Laughs*))

Peer team 2: Oh it's so much easier.

¤<1423605> (.)

L: Alright, somehow we just need to get... uh↓ what the heck?↓

L: What the heck? ((*Scrolling across Midwest region of US*))

((*Right clicked on an army in Canada*))

((*Clicked on an army in US that was engaged with Canadian forces*)) °What the heck?°

R: We are going to kill them. ↓How do you move those planes?↓

¤<1441149> (.5)

L: ((*Clicked on an airplane in Georgia*))

((*'Air Force' menu popped up*))

((*Clicked on 'Rebase' in the 'Air Force' menu*)) Oh here we go. (.5) Canada. What the heck? Why isn't Canada in here? ((*Scrolls through list of states / countries to find Canada*))

R: Maybe you gotta send (.5) try sending the one from New York to Canada.

¤<1465364> (.5)

L: ((*Continues to scroll through states / countries*)) ,Or to Michigan., ((*Continuing to scroll through list of states / countries*))

¤<1472733> (1.0)

L: ((*Continues to scroll through the list of states / countries to attack*))

R: Yeah go to Minnesota. Then we can attack them from there.

¤<1491532> (1.0)

L: ((*Clicks on Minnesota*)) Go ((*Scrolls over continent*))

((*Sighs, places hands up by mouth*))

((*Scrolls through map along green active path from Georgia to Minnesota*))

R: Oh man we're °going down.°

¤<1513209> (.)

((*Mouse controls traded*))

L: Canada is seizing control of oh my gosh. Alright, how do we declare war on Canada?

R: ((*Clicks on 'International Events'*))

¤<1524474> (.)

L: Canada joined them? ((*War Extends popped up*))

R: Stupid Canada. ((*Laughs*))

L: Dude

R: Wait where are these armies going? We can send this army, (1.5) wait come over here.

L: Here did we ever (.5) did we declare war on Canada? Did we ever do that?

¤<1550569> (.)

L: What ah... ((*Points to score details*))

R: Yeah I think we did. Alright, there we'll move back the °

¤<1563739> (.)

R: Yeah see Canada is one of the allies (.5) they don't like us. (1.0) Oh geez.

L: Here move (.5) uh (.5) some of them right here. ((*Points to Canada*))

R: Where the hell was this?

¤<1592517>

As can be seen above, the pair gets fired up when Canada takes a state away from them. The game notified them (a message was displayed) saying that Canada had seized control of Michigan. This resulted in a redirection of attention to Michigan, and lead to strategizing of how to get it back. Incidentally, this also led the pair to discover how to make use of their airplanes in attacking Canadian forces.

A final example of redirection from *Civilization IV* is discussed (for more, see Appendix H.4). In this example, a game icon is highlighted, provoking its exploration and discovering its functionality:

R: ↑What are these people doing?↓ ((*Scrolled cursor over to group of warriors at top of map*))
((*Game has an icon highlighted and blinking to build a city*)) [90]
¤<2962311> (.)
R: ↑Oh, you can, you can build a city! Anywhere!↑ I can build a city somewhere. I'm gonna send them somewhere else. ((*Scrolls around map to fight a spot*

[90] "If an action icon is flashing, the computer is telling you that action is particularly useful. For example, the "fortify" action will flash if an archer is in an empty city. (But remember that the computer doesn't know about your strategic situation that archer may very well be more needed elsewhere." (*Civilization IV* Manual, p. 38)

for a new city)) Like down here. Like right here I can build a city. ((*Points cursor to a spot on map*))
¤<2973747> (.)
L: Yeah do it right there. ((*Points to a different spot on the map*))
R: ((*Scrolls over to spot where L suggested*))
((*Clicks on the spot*))
L: It can be like our defense city.
¤<2980072>

Figure 35: 'Suggested' actions in *Civilization IV*

In the above transcript, as can be seen in Figure 35, a settler in *Civilization IV* has some of his functionality being 'suggested' through a blinking and highlighted icon. This led the icon to be explored (mouse-over icon to read a textual description of its purpose), and for the first time, utilized. This redirection by the game was a major step in the advancement of the pair's civilization and marked an important learning event in their game. Well designed machine intelligence discovered that the pair had not yet taken up an action to utilize a game feature, and then directed their attention to that feature.

4.6.4 An Unexpected Discovery: Unhappy City Residents in Civilization IV

Unexpected discoveries of game information can lead to a learning event. An example of a sequence of episodes in *Civilization IV* shows the discovery of an unhappy population, which the pair appeared not to expect. This redirected the pair's attention to fixing the problem and making their civilization's residents happy.

The first episode shows the discovery of the problem, after a peer team mentioned that their 'people were mad':

```
Peer team:  Our people are mad.
L:  ↑Our people are mad too it, it doesn't make
sense.↑
¤<1431145>  (.)
```

R: °Click, click on our city.°
¤<1433745> (.5)
L: What do all these symbols mean? ((*Double clicked on a city*))
((*City screen popped up with many new symbols placed on the city map*)) [91]
((*Clicked on 'Happiness' Display and a window popped up, informing that people are unhappy due to the city being overcrowded*))1 (1.0) Oh it's too crowded. (4.0) ((*Clicked on the 'Happiness Display' icon again and same message came up 'it is too crowded'*)) It's too crowded. ((*Laughs*)) What does that mean like?
¤<1460507> (.)
R: °Too many people.° Make more cottages or something.
¤<1464634>

The peer team prompted the discovery of a game feature that provided some unexpected information: the people of their civilization were not happy. The game suggested that the cause of the problem was overcrowding. This led to subsequent information being discovered:

---

[91] "The city screen is where most city management takes place. The City Screen also tells you how happy your city is. Further, if a city is unhappy, an "Unhappy City" icon will appear next to the city's name on the Main Screen. Unhappiness is caused by a number of factors, including overpopulation and war." (*Civilization IV* Manual, p. 146-149)

R: ((*Scrolls around map*))
((*Clicks on a military group*))
L: We need to figure we need like (.5) to make it less crowded somehow. ((*Points at screen to area where it is too crowded*)) I don't, I don't know what that means.
¤<1549093> (.5)
R: ((*Clicked on City screen*))
((*Scrolled over 'Food Bar'*)) [92]
((*Clicked on 'Food Bar'*))
((*Message came up stating 'Starvation'*))↓Starvation?↓
L: WHAT? ((*Laughs*)) We need more food.
R: ((*Clicks on the keyboard to get back to the main game screen*))
L: (5.0) ((*Looks over at peer team's screen*)) Get more food.
¤<1582010>

After learning that their civilization had a food shortage, the pair attempted to resolve the situation by purchasing (trading gold for food) from other civilizations:

((*A leader appears with a trade offer*))
L: Look at all the resources we have.

---

[92] "The Food Bar will usually show the number of turns needed for the city to increase in size; moving the mouse over the Food Bar will show the exact amount of food stored at the moment and the amount of food needed to be grown." (*Civilization IV* Manual, p. 147)

R: °I know.° ((*Clicks on accepting trade offer*))
L: Just give her gold dude, we have so much ↑gold. ((*Points to their gold resources on right side of screen*)) ↑Look how much↑ gold we have compared to her. ((*Points out that the leader, they are trading with, has little gold*))
¤<1597070> (.)
R: We need like, she doesn't have anything good. ((*Scrolls through what the leader has to offer for trade*))
(.5)
R: ((*Clicks on 'Farewell' to current trader*))
L: Look at all these workers we have.
R: ((*Another leader pops up to trade*))
L: That's probably why it's too crowded.
¤<1610182> (.5)
R: ((*Places cursor over tradable items from leader*)) ((*Moves cursor over tradable items from leader, as well as own items for trade*))
L: There's twenty gold.
¤<1616838> (1.5)
R: ((*Clicks 'Farewell' without trading anything*))
L: ((*Tells peer team*)) Our people are starving.
¤<1637929>

After canceling the trade offer, the pair attempts to move workers out of the city area to reduce crowding (this does not work: workers are simply objects

with which they produce goods for the civilization). Another strategy is attempted to solve the problem:

R: °What do we want at the market?° ((*Civil Market window popped up*)) [93]

L: °I don't know.° (.5) ((*'What would you like to research now' window popped up*)) [94] Yes. Commerce. Paper.(.5)

R: ((*Clicked on 'Paper'*)) [95]

L: Alright now build some farms.

R: ((*Clicked on 'Skip Turn'*))

¤<1820893> (.5)

L: How many towns do you guys have?

Peer team: Um (.5) like five.

R: ((*Clicks on the highlighted 'Promote Unit' icon*)) [96]

¤<1843680> (.5)

L: Yeah build, build uh

---

[93] Civic market increases the wealth of a city.

[94] The research window gives options for what should be researched next. The game also provides recommendations for two of the items offered by putting the word 'Recommended' after the technology name to be researched.

[95] "'Paper' enables map trading." (*Civilization IV*: Tech Tree & Specifications Charts)

[96] "Some promotions are available only to certain unit types; some require that the unit possess other promotions before they are available. There is no limit to the number of promotions a unit can receive." Sometimes the game will offer suggestions by highlighting icons in blue. (*Civilization IV* Manual, p. 43-44)

R: ((*Scrolled over 'City Build Menu' icons*)) [97]

((*R scrolled over a 'City Build Menu' icon 'Plantation'*)) [98]

L: >ahh build to increase food.<

R: ((*Clicked on 'Chop Down A Forest' icon*)) [99]

((*Clicked on a group of workers*))

¤<1860559> (2.0)

L: Hit farm. ((*Points to 'Farm' icon on screen*)) [100]

R: ((*Continues to try to move selected military to a new spot but it does not work*))

((*Scrolls over the 'Farm' icon but does not click it*))

L: ((*Yawns*))

¤<1878699> (.)

R: ((*Drama has been unlocked on the Technology Advisor*)) [101]

((*The game asks 'What would you like to research*

---

[97] "City build screen where most of the management for a city takes place." (*Civilization IV* Manual, p. 146)

[98] "Building a plantation will increase food production. Plantations provide access to bananas, dyes, incense, silk, spices, and sugar resources and can be built only in those spaces." (*Civilization IV* Manual, p. 75)

[99] "The 'Chop Down A Forest' icon instructs the workers to remove the forest." (*Civilization IV* Manual, p. 75)

[100] "The worker builds a farm improvement in the space. Farms improve the food output of a space. Farm improvements must be built adjacent to 'fresh water sources': rivers, oases, or lakes." (*Civilization IV* Manual, p. 74)

[101] "Drama is a technology that can be unlocked. Drama can produce theatre, globe theatre, and can adjust culture rate." (*Civilization IV*: Tech Tree & Specifications Charts)

next?' from a list of new technologies from the Technology Advisor)) [102]

((Clicks on 'Philosophy')) [103]

L: The cottages, the cottages look different. *((Puts hands over mouth))*

¤<1884178> (.)

R: *((Continues to have workers build in different locations))*

((Clicks on 'Go To Mode' icon)) [104]

L: We're in the 1800's.

¤<1893801>

At this point, the problem is resolved by adding more farms and increasing the overall food supply.

In the above sequence, an unexpected finding in the game causes redirection and the learning of a new, undiscovered game feature. Discovery of new icons led to the new feature being discovered, allowing for the pair to make

---

[102] Once the gamer has completed their last research technology then the game prompts them to do more research in order to unlock other technologies. The game will place the word 'Recommended' next to the technologies that the game suggests should be done next.

[103] "Philosophy enables pacifism" (opposition to war or violence as a means of settling disputes). (*Civilization IV*: Tech Tree & Specifications Charts)

[104] "The 'Go To Mode' icon orders the unit to move to a square that you select." (*Civilization IV* Manual, p. 38)

their residents happier. In turn this improved their civilization's overall happiness and productivity.

Learning with games can be a result of many things, one of which is good intelligence in the game itself. This can reduce the frequency of failures and help prevent repetitive mistakes, as well as promote under-used or undiscovered game features. The next section addresses failures (in collaborative game play), which can also serve as a trigger for the pursuit of a task.

4.7 *Failure as Motivation For Task Pursuit*

When students experience failure in a game, or when the game behaved in a way conflicting with expectations, pairs often responded to that failure with the subsequent pursuit of a task. Typically a reaction occurs (often a display of frustration, surprise, etc.) followed by a corresponding behavior (usually the pursuit of a task addressing the failure). This change in behavior relates to learning: something unexpected occurred, and needs to be resolved or grounded. The unexpected 'thing' that happened serves as a focus for analysis, as it provides an opportunity for learning to occur. Additionally, failure seems to add motivation to learning (by both drawing attention to a task and creating a desire to be successful at the task). However, too much failure (such as frequent, repeated failure) can detract motivation to learn, leading pairs to focus on other tasks that they feel they can accomplish. Episodes were found that illustrate these ideas, and full transcriptions are available in Appendix H.3.

4.7.1 An Unexpected Failure in Civilization IV

A simple example from *Civilization IV* shows how an expectation mismatch can lead to a change in behavior. Earlier analysis showed how the pair

had learned to build military forces and move them as conglomerated units for a better chance of military success. In this example, the pair was expecting to easily win a battle with an enemy, and was presented with an unexpected loss:

R: °Should I attack them?°
L: Which era are you guys in? Oh you guys are in 100 B.C. ((*Talking to peer team*)) (.5) Yeah attack 'em. ((*Talking to R again*))
R: ((*Clicks on 'Pillage' icon*)) [105] Uh sweet. ((*The enemy has turned around and killed their military*)) [106]
¤<2099324> (0.5)
↓No this did not ↓happen.
L: ↑WHAT!↑
R: If we would leave that would not have happened.
L: ↑He killed all three ↑guys? ((*Talking to peer team*))
R: ((*Pressed 'Enter' to end turn*))

---

[105] "The unit destroys an improvement in the space it occupies. If there is more than one improvement in the space, the unit will destroy the most valuable. (In other words it would take two actions to destroy both a farm and a road in a space.)" (*Civilization IV* Manual, p. 39)

[106] A possible reason for losing the battle that the group seems unaware: "Cities are defended from capture by the units inside them. Archer units get a defensive bonus when defending inside cities; this makes them particularly good choices for early garrisons. You can construct a number of buildings to enhance a city's defense: walls and castles, for example." (*Civilization IV* Manual, p. 49)

¤<2107311>

The unexpected loss caused a change in strategy: the pair was less aggressive with the enemy civilization, eventually resorting to a treaty with them; and the pair realized that the enemy can also amass military units and easily defeat their forces in a battle.

4.7.2 *Repeated Failure: Diplomacy in Making History: The Calm & The Storm*

Other unexpected failures can arise from repeated failure in a game. An example of this is in *Making History: The Calm & The Storm* as game players attempt to create successful diplomatic acts but are rejected repeatedly; similar to what is seen below in Figure 36:

Figure 36: Diplomatic relations menu and a rejected treaty in *Making History: The Calm & The Storm*

The first episode below illustrates the pair learning that they need to create treaties with other countries in order to succeed in the game:

L: It's ah, It's Germany. Didn't we declare war with them? ((*'War Expands' window pops up*))

((*Clicks 'Ok' to close window*))

R: ((*Laughs*))

¤<856285> (.)

L: ((*Alliance screen pops up showing a Chinese alliance was formed*)) Our enemies (.5) ↑oh God.↓

R: The Chinese alliance. ((*Laughs*))

L: ((*Laughs*))

((*Clicks 'Ok' to close Alliance window*))
¤<863164> (.)
Peer team: So who are you guys joined up with now?
L: Dude, we are all by [ourselves because we declared war] on everyone. ((*Clicked on 'Military' icon*))
R: [Yeah we're attacking everyone.]
Peer team: Awesome. ((*Laughs*))
¤<871691> (.5)
L: Yeah let's see (.5) we're ((*Clicked on 'Diplomatic Agreements' icon*)) (.5) We have no alliances.
((*Laughs*))
((*Scrolls over combat reports*)) [107]
R: ((*Laughs*))
Peer team: Everyone hates you. Nice.
¤<887407> (.)
L: ((*Clicks on 'Select Nation'*))
((*Selects a nation*))
((*Clicks on a diplomatic action*))
((*Confirms the action taken*)) ↑OOOH.↑ Both of em.
((*'Peace offering fails' window pops up*)) [108] Do we get to play RollerCoaster Tycoon?

---

[107] "In the Turn Summary panel, the Combat Report summaries show the attacking nation's flag on the left and the defending nation's flag on the right. Next to each flag is a set of numbers. The black number shows how many forces remain, and the red number shows how many forces have been lost. When a battle is won, the losing country is grayed out in the combat summary." (Making History Manual, p. 15)

[108] "If you want to demand peace or offer surrender, you must first seek alliance approval." (Making History Manual, p. 26)

R: Yeah I want to play that that would be fun.
¤<910814> (.)
L: ((*Clicks on 'Diplomatic Agreements'*))
((*Clicks on a nation*))
((*Clicks on a diplomatic action*))
((*Confirms the diplomatic action*))
((*'Treaty Rejected' window popped up*))
((*Clicks 'Ok' to close window*)) Alright. Wait are these our allies? ((*Clicks on a nations flag*)) °Wait, wait° ((*Uses the keyboard to go back to the previous screen*))
R: No (.5) those are just what they are called. We don't have any allies.
L: ((*Scrolls to Northeast United States on map*))
¤<928781> (.)
L: Alright let's find someone in the air. ((*Zooms out from map*))
R: Oh go take that plane.
L: ((*Clicks on the plane that R suggests*))
¤<933191>

At the start of the next day, the pair makes it evident that they understand diplomacy as being important to their success:

L: No. We need to find out (.5) if we are at war with anyone.
((*Clicked on 'Diplomatic' icon*))
No current wars. ((*Scrolled across map*))
Let's get some alliances before we start any wars with anyone. (2.0) Should be alliances with people around

us or with people from far away and then take over all these?

((*Scrolls around Europe*))

Teacher: ((*Giving advice to both pairs; telling them to vocalize their strategy*))

R: We should make alliances with bigger countries. Like USA and stuff, Russia.

L: Alright.

¤<227997>

Following are attempts to make alliances with other countries before beginning any military campaigns:

L: ((*Scrolled across United States*))

((*Clicked on 'Mini Map'*))

((*Zoomed out from map*))

((*Clicked on 'Diplomatic Agreements'*))

((*Clicked on a Nation*))

((*Clicked a Diplomatic action*))

((*Clicked 'OK' to confirm action*))

((*'Treaty Rejected' window popped up*))

R: Aww, come on! What do we have to get?

L: ((*Scrolls around world map*)) I don't think we're friends with them man. ((*Clicks on 'Mini Map'*))

¤<263376> (.)

L: ((*Clicks on 'Diplomatic' icon*))

((*Clicked on 'Diplomatic Agreements'*))

((*Clicked on a Nation*))

((*Clicked a Diplomatic action*))

((*Clicked 'OK' to confirm action*))

((*'Treaty Rejected' window popped up*))
¤<279386> (2.0)
((*Scrolls over to Europe*))
((*Clicks on 'Diplomatic' icon*))
((*Clicked on 'Diplomatic Agreements'*))
((*Clicked on a Nation*))
((*Clicked a Diplomatic action*))
((*Clicked 'OK' to confirm action*))
((*'Treaty Rejected' window popped up*))
¤<308041> (.)
Alright, we're gonna have to start some wars now.
R: Definitely. It's the only way to uh, (.5) to win this game.
L: ((*Scrolls over to Europe*))
((*Zooms in on Europe*))
Then -
((*Clicked on 'Military' icon*))
R: Stay, stay on this for a second. (.5) Is there like a (.5) what the hell? °
L: ((*Opens up instruction manual to game*))
R: ((*Picks up Game Interface brief booklet*))
¤<348531>

Learning from their experiences on the first day, the pair realized the need for alliances with other countries. However, they were unable to create any successful alliances. Repeated failure at diplomacy leads the pair to begin fighting wars, even though they realize success will be very difficult without

alliances. This leads to the purpose of the game breaking down a bit, which can be seen as the pair begins to declare war on random countries:

```
R:  ((Has control of mouse))
((Clicks on Spain))
((A warning screen pops up))
((Clicks 'ok'))
((Chuckles))
((War is declared by Spain))
L:  What?
R:  ((Clicks 'OK'))  It's just Spain.  Spain sucks.
¤<417757>  (.)
((Mouse controls traded from R to L))
```

Later in the game, a successful alliance is made with Italy. The pair is surprised, based on their lack of success in previous diplomatic efforts. However, little reasoning is given as to why the treaty was successful:

```
L:  Move all of our (.5) yeah like take over this.
((Scrolled over continent))
R:  Try to make friends with Italy. (.5) More to the
right.  In the green there on the bottom.
L:  Here?  ((Scrolls around Europe))
R:  Yeah.
¤<1656460>  (.)
L:  ((Clicks on Italy))
R:  ((Laughs))
L:  ((Clicked on 'Diplomatic' icon))
((Clicked on 'Diplomacy Agreements' icon))
```

((*Clicked on a nation*))
((*Clicked on a diplomacy action*))
((*Confirmed the diplomacy action*))
((*'Our Alliance Forms' popped up*))
R: ↑YEAH. ((*Laughs*)) Yes. Nice. Alright.
((*Scrolls across continent*))
¤<1680210> (.)
R: Can we use their troops?
L: °Let's try this.° No they'll just back us up now.
R: Good we need some back up.
¤<1687428>

Further alliances were attempted after the alliance with Italy, however all were unsuccessful. Most of the gameplay following focused on military conquest. The pair spent most of their time moving around military forces, attempting to gain territories. Often the pair lost wars after spreading themselves too thin on too many different battlefronts.

The lack of diplomatic success or feedback in *Making History: The Calm & The Storm* severely inhibited the nature of the game play, which was typified by lost military campaigns. While the game successfully tied military operations to diplomacy, the lack of successful diplomacy created situations where winning at the game was very difficult. While failure can often motivate and lead to learning, repeated failure in the game might lead to the redirection of game players' attention to other game areas. In this case, even though the game

communicated to game players that diplomacy was important for their success, students gave up after experiencing repeated rejection of treaties and alliances (with little feedback as to *why* they failed). This may be a missed opportunity: while some failure may help bring attention to a feature of a game, repeated failure eventually might detract attention from the particular game feature. A similar problem occurred in *RollerCoaster Tycoon* 3 in the linking of ride entrances and exits to a footpath, which seemed to negatively impacted gameplay. This sequence of transcripts is lengthy, and can be found in Appendix H.3.

In the following section, missed opportunities for learning are discussed. Missed opportunities may be opportunities for game designers to introduce features that can lead to learning, as discussed above. The next section will introduce episodes where learning could have occurred; however, a detailed analysis of affordances explaining why learning was missed is reserved for Phase II of analysis (Chapter 5).

4.8 *Missed Opportunities for Learning*

Missed opportunities for learning are opportunities where learning might have occurred, but were missed. Often this can be caused from an oversight on behalf of game players or a particular game feature not being evident enough for use or pursuit by the pair. Other cases might result from a particular game feature being too difficult for use by novice gamers (it was not introduced at the proper stage in the game). Whatever the cause, further analysis is warranted and is discussed in greater depth in Phase II (Chapter 5) of the analysis. Full transcripts of selected episodes are in Appendix H.5.

4.8.1 RollerCoaster Tycoon 3: Firing Staff

An example of a game feature not being evident enough for use is in *RollerCoaster Tycoon 3*. The pair is attempting to fire a disgruntled employee (he is dissatisfied with his job, and has a low work ethic). The following episode illustrates frustration with the interface after failing to fire him:

R: What's these little glasses for? ((*Points to the courtyard area of the park*))
L: Here it is.
¤<1295838> (.)
L: ((*Scrolled over left menu icons*)) Staff.

R: 'You've won an award' (.5) best- ((*Reading the prompt that popped up telling them that they won an award*))

L: ((*Clicked on 'Staff' icon*)) Reliability. (.5) This is so strange (.5) ugh. Wait, who was thinking about quitting?

¤<1307382> (.)

L: Mechanic 2 and 3 both are! ((*Clicks on the mechanics unhappy face*)) How do we move?

R: Look at their pay. What is their pay? Maybe we only need one mechanic. Maybe they're bored because they have nothing to do.

L: ((*Clicks on each mechanic*)) ((*Scrolls over each mechanics pay rate*)) Maybe they have too much to do. ((*Clicks on a mechanic in the park*)) (.5) Let's change the uniform. ((*Clicks on 'Uniform' icon*))

R: ((*Colors pop up for uniform colors*)) Pink. (.5) Purple.

L: Red.

R: They're still not happy. ((*Opens 'Staff' screen*)) ((*Scrolls over mechanics emotions represented by faces*)) (1.0) ((*Scrolled over how many rides the chosen mechanic has fixed*)) He hasn't fixed, any rides. =

L: Let's fire him.

¤<1345608> (.)

R: = And he got employed in March. And it's July.

L: Let's fire him.

¤<1349780> (.)

R: How do you fire him?

L: ((*Moves cursor to 'Staff' window*))

((*Scrolls over different icons*))

((*Asks peer team*)) Do you guys know how to fire people?

R: What's the 'i'?

L: Yeah, well, one of 'em is bored so, I'm like get out of here.

Peer team: I know the feeling.

L: Yeah. Umm hmm. It happens. It happens when we're making the most money. What's up Liz? ((*Talking to peer team; bragging / flirting*))

¤<1384886> (.5)

L: ((*Closes the 'Staff' window*)) 'K, well, you know what? If they're unhappy, guess what? I don't care. They're gonna do their job.

R: They'll still quit.

L: Yeah. (.5) They're still working.

¤<1393125>

The pair gives up trying to fire the unhappy employee, and moves on to work on other things. This is common with missed opportunities: repeated failure to complete a task often leads to abandoning it. The pair displayed this behavior multiple times while playing: after repeatedly failing or struggling unsuccessfully with a task, they often abandoned the task and would start a new one, not coming back to finish the original task.

4.8.2 *RollerCoaster Tycoon 3: Failure to Find Pre-designed Roller Coasters*

Another example from *RollerCoaster Tycoon 3* is a failure of the pair to find a feature on the interface. In this example, they fail to find a 'pre-made designs' button when building roller coasters, causing them to have to make coasters from scratch, piece by piece (one section of track at a time).

L: ↑What rides you wanna do?↓ ((*Scrolled through the rides they can create*))
R: Do a thrill one.
L: Let's do a rollercoaster. ((*Partner's request ignored*)) ((*Clicks on 'Rollercoaster' icon*))
¤<1720795> (.)
R: ↑Yeah that's what↓ °I meant.°
¤<1724134> (.3)
L: Which one you wanna do?
R: Suspended swinging roller.
L: ((*Scrolls over roller coaster options*)) ((*Clicks on a different roller coaster*))
R: Ok do that one.
L: ((*Zooms out from ride*))
R: We should do it towards. Oh, we actually build it?
¤<1732440> (.)
L: Yeah.
R: Oh God.
L: ((*Clicked around the grounds of the park in an empty area*))
¤<1736044> (.)

L: ((*Clicks on the one piece that he already placed and nothing happens*))

((*Clicks a different piece to build- from the building menu*))

((*A game prompt appears, saying that the two pieces they are trying to connect will not connect together*))

Never mind. ((*Continues to click on different pieces to connect to their original piece already placed on the park grounds*))

¤<1751063> (.)

R: How do we go up? We should make it really really high.

L: ((*The new piece chosen works*))

((*They continue to click and build pieces in a circular pattern, higher and higher*))

R: Oh that's how? ((*Laughs*)) Oh my God.

¤<1762222> (.5)

R: ↑Okay, go straight across, then dip down.↓

L: ((*Clicks on a new piece that is straight*))

¤<1767590> (.5)

R: Yeah, do straight, and then go. ((*Laughs*))

((*Prompt comes up saying that the two pieces do not connect*)) [109]

L: ((*Clicks on another piece to build*))

((*Another prompt comes up telling them that the piece*

---

[109] The construction icon allows you to build a ride from scratch by placing each piece of the ride. Each piece must fit together properly or the game will prompt an error message stating that you cannot place the piece selected.

chosen will not connect))

R: You know people are gonna get sick on this ride.

L: Yes ma'am.

¤<1781755> (.4)

L: That's my goal. ((*Clicks on a different piece to build*))

((*Moved cursor to the ride being built*))

((*An outline of where the piece would go started swinging everywhere without L doing anything*))

R: °What?° (.5) What happened to the top? ((*Points to the top of the ride they are building*))

L: No idea. ((*Clicked to place a piece but the blue outline is still swinging everywhere*))

R: What's going on?

¤<1798121> (.)

L: ((*Clicks on another piece to place*))

((*A prompt comes up telling them that it cannot connect to the other piece already placed*))

((*Continues to click on different pieces*))

((*The same prompt pops up saying that they cannot connect the pieces*))

R: Maybe you can't do anymore.

L: ↑Probably out of money.↑ ((*Laughs*))

¤<1810841> (.)

R: °No, we have five thousand dollars.°

L: ((*Closes building ride menu*))

¤<1813358> (.)

L: ↑OK this one is not working out for us. ((*Clicked on the 'Delete Object' icon instead*)) [110] So let's go↓ °work on this ride.° >Should we just delete this ride?<

R: Yeah. [It's gonna cost more.]

L: [And work on it later?] Yeah. No. ((*Clicked on single trash to delete ride*))

((*The ride is not deleting*))

¤<1822739> (1.0)

L: Ok you guys, lets uh...

R: Time to delete.

L: ((*Clicking around the ride trying to delete it*)) Yeah, lets delete this man. ((*Clicked on the double trash can to delete more space*))

((*Prompts keep coming up saying that they cannot delete the ride*))

¤<1844057> (.)

L: ((*Deleting ride pieces one at a time*)) What? Why can't we delete it? Delete! OK. I guess we just have to work on it then.

¤<1860844> (.)

R: Let's put some food places in there, so that people are hungry. ((*Points to food stands menu*))

L: No, well no, we gotta work on our ride, dude. ((*Clicked on 'Rides' menu again*))

((*Choose to build a ride from scratch*))

---

[110] Delete icons appear as a garbage can (delete single item) and a double garbage can (delete multiple items). The gamers try to delete the trees using the 'delete multiple' button.

((*Build menu popped up for new ride to be built*))
¤<1868231>

In the above example, the pair failed to create a custom roller coaster, and gave up trying to design a custom one. They had overlooked an icon when selecting to make roller coasters: that of pre-made designs that were available. Below in Figure 37, roller coaster designs are shown. In order to select pre-made roller coaster designs, one has to click the little yellow folder icon to the right of the coaster pictures and description:

Figure 37: Roller coaster creation in *RollerCoaster Tycoon 3*

Clicking on the picture of the roller coaster will cause the game to go into the mode of creating a custom roller coaster of that type. In custom roller coaster

design (as done by the gamers in the transcript), each piece of track must be manually placed, as shown below in Figure 38:

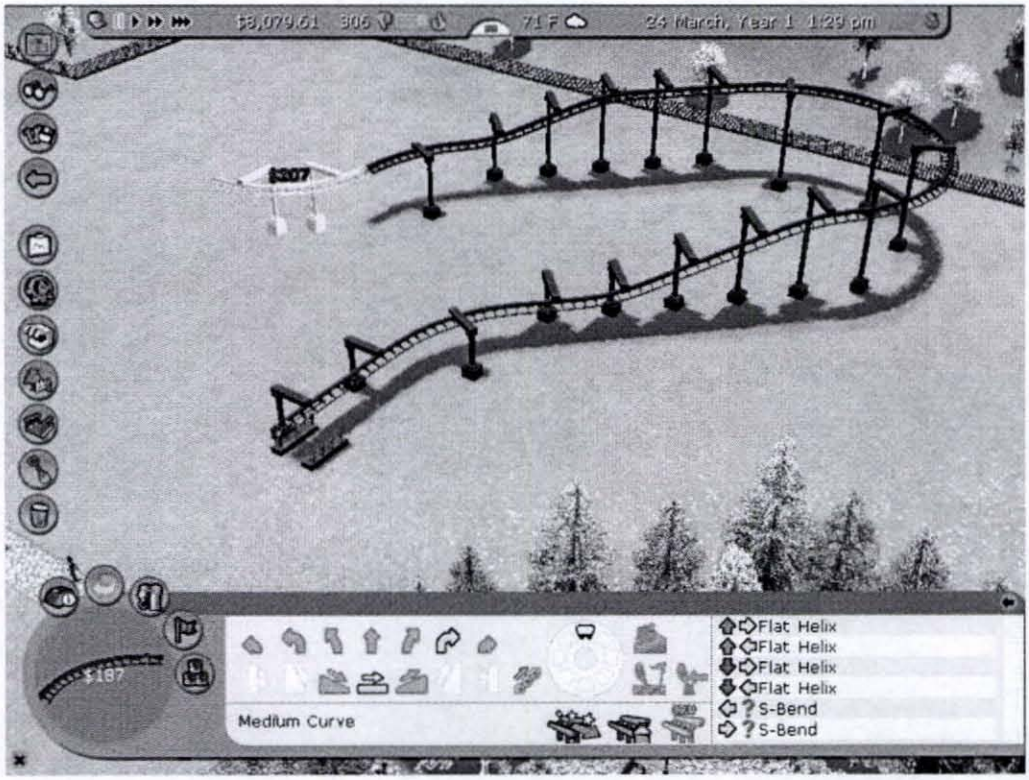

Figure 38: Custom roller coaster creation in *RollerCoaster Tycoon 3*

Even after being surprised that they had to make their own coasters (the point of the game is to run a park, make money, etc: not necessarily to engineer roller coasters), the pair continued for the rest of the four days of game play making custom roller coasters (they never found the pre-made roller coaster designs).

While this may have been the fault of the pair, the game might have made a suggestion to find the pre-made roller coaster designs. The icon for pre-made designs is easy to miss, and no game intelligence assists in discovering the icon if it is missed for a prolonged period of time (something that *Civilization IV* does well). Regardless of the reason for missing pre-designed coasters, the pair spent a lot of time unsuccessfully attempting to make customized roller coasters in the game.

4.8.3 *Making History: The Calm & The Storm: Activity Generates Trivial Feedback*

A final episode showing a missed opportunity for learning occurred in *Making History: The Calm & The Storm* (other transcribed examples are available in Appendix H.5). In this example, a lack of game feedback may have caused an important piece of information to be overlooked. In *Making History: The Calm & The Storm*, representations of battles are simply static icons, and major events such as battle outcomes are not as visual as they could be; they appear in a list of events after the end of a turn, as seen in Figure 39. If this information is not read, battle outcomes can be easily overlooked.

Figure 39: Display of a battle and list of combat reports in *Making History: The Calm & The Storm*

In the following example, there appears to be some confusion about with what the pair was engaged in and what was accomplished:

L: We have regained (.5) ↓did we take over?↑
¤<2696526> (.)
R: Wait we gained control.
L: Check this out, that's where I sent everyone, I think that was like right (.5) here or something.
((*Moving cursor over continent*))
¤<2706524> (.)
R: °Didn't even know Germany took something from ↓us.
L: I just remember I was moving a lot of people over

to (unclear speech) because that was a country I had to select. (.5) Look at all (.5) we must have won, cuz look at all the planes. ((*Scrolls over continent*))
R: Oh, yeah.
L: We'll stop these ((*Clicks on a military unit*)) ((*Clicked on five different military units*))
¤<2736616>

In this case, a simple animation showing a battle taking place, or a message placed in an obvious place may have informed the pair of what had taken place. The structure of the game is such that moves are planned in 'turns' (similar to *Civilization IV*), then one ends their turn to proceed to the next turn (at this point, other countries controlled by the computer make their moves as well). Since the 'End Turn' has little feedback of events (the map simply is updated without transitions, and text appears in a side window in the game notifying the game players of changes during the change of turn), major events can easily be overlooked. Additionally, there was often a long pause between turns. Often flow and the degree of immersion were broken while waiting between turns, as students became bored waiting for the computer to execute orders and calculate the moves of all other countries. Simple battle animations or something to hold players' attention (while the computer works at the end of each turn) might help

to maintain flow, as well as some sort of display of transition between turns (show movement of game icons that were given orders to move, etc.).

Missed opportunities are a fruitful area of exploration in Phase II (Chapter 5) of the analysis, because they provide aspects of games that can be improved. An analysis of affordances might reveal how the introduction of additional affordances could improve the problems being highlighted.

4.9 *CHAPTER SUMMARY*

An analysis of episodes of learning in the data revealed several properties of learning in collaborative game play. Episodes of learning appeared to be done at different granularities, occurred through different levels, and were often triggered by specific game features or cues (both from the game and from social interaction).

A common property among the learning episodes was that they had a certain granularity, occurring either as a *short episode*, a *sequence of short episodes*, or a *trend* spread over time. Trends were often observed in a moderately used game feature whose complexity and use increased over time. Short episodes and sequences of episodes often followed the initial focus of problematization where pairs discovered a problem and pursued a task, followed by the problem's later resolution (when the task was successfully completed). Cases where tasks were not completed successfully, or appeared to be inhibited by action that did not move pairs towards their goals, were marked as missed opportunities (to learn) and reserved for further analysis in Phase II (the following chapter).

Learning appeared to be done at several levels: first by learning the *physical interface* (high school students seem to have already mastered using a computer interface); learning the use of the *game interface* (its basic usage and corresponding functionality); and learning *advanced strategies* required to win the game (behavior in line with achieving goals set forth by both the game and game players).

Finally, learning often appeared to be triggered by peer activity or by particular game features, often serving to add motivation and shift attentional focus to another aspect of the game. Failures often served to draw attention and motivate pairs to work on tasks related to the failure. However, failures could hinder interest and task pursuit when negative conditions exist, such as the lack of feedback or the experience of frequent, repetitive failure.

Moving to the next phase of analysis, an analysis of the use of affordances will examine the collaborative appropriation of game resources and peers in game play that lead to successful instances of learning. Additionally, an analysis of affordances in episodes demonstrating a missed opportunity for learning will reveal potentials for improvement of the games. Following Phase II of the analysis in Chapter 5, suggestions are offered to instructional designers, game

designers, teachers, and students regarding how successfully create and apply individual and collaborative video game learning experiences.

CHAPTER 5:

ANALYSES OF USE: AN AFFORDANCES ANALYSIS FOR LEARNING

5.1 *INTRODUCTION*

A brief discussion and definition of affordances will assist us, serving as an entry into analysis of the learning episodes. Learning episodes in this chapter are limited to the learning episodes already selected and transcribed for the previous two chapters.

5.1.1 What is an Affordance?

As discussed in the literature review, affordances are simply *potentials for action* provided to an actor by the environment. Some debate over affordances exists, and needs resolution before further use of the term. As outlined in Kaptelinin and Nardi (2006), affordances can occur on different levels: on the operational level, on the action level, and on the activity level. Following is a brief history of the development of affordances, along with different viewpoints that focus on the use of affordances at these three respective levels: Gibson's ecological perspective, the human-computer interaction (HCI) perspective, and a broader perspective taken by activity theory that accounts for motivations. These levels can be seen in Table 6:

Activity Level: Accounts for motivation and cultural-historical meaning to be assigned to objects (objects subject to cultural-historical interpretation)
Action Level: Focuses on an actor performing a task in their environment (goal achievement)
Operational Level: Breaks down actions into sequences of tasks, examining how each supports the objective (physical level: usability, etc.)

Table 6: Levels of activity as described by Kaptelinin & Nardi, 2006, p. 80-83

Gibson (1977, 1979) took an ecological perspective in defining affordances; and focused the term affordances at the operational level. Gibson's perspective looks at an actor (or animal) in its environment, focusing on potentials for immediate operations (action) by the actor with things visible in the environment.

About a decade later, as HCI became an important area of study, authors like Norman (1988) and McGrenere & Ho (2006) focused the use of affordances on the action level, putting more emphasis on how the actor achieves goals by acting on objects and their properties. This level of focus served HCI well, and helped produce methods for HCI such as usability tests. Following, Norman's 'Gulfs of Execution and Evaluation' are presented, which highlight users'

processes of both acting and interpreting feedback that those actions were successful:

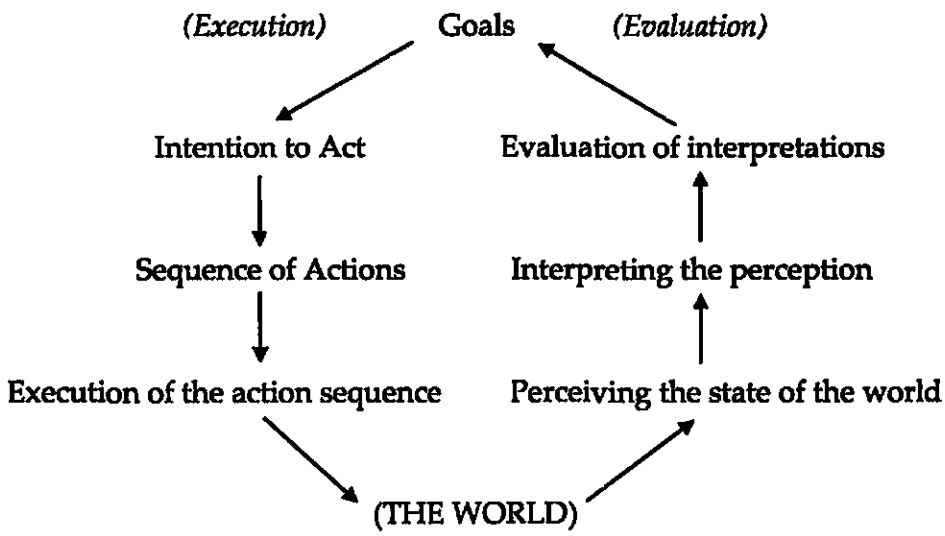

Figure 40: Norman's Gulf of Execution and Evaluation (Norman, 1988)

A third perspective of affordances taken by activity theory (Kaptelinin & Nardi, 2006) looks at the use of affordances on the level of activity, a level broader than that of Gibson (which focuses attention at the action level), which focuses on cultural and historical meaning that can be given to objects as well as motivations for goal formation.

One of the main themes among perspectives is whether to place preference on the actor or the object. If preference is given to the object, then a perspective like McGrenere & Ho (2006) can be taken, separating of affordances and perception. This facilitates examining things like hidden and false

affordances, as discussed earlier in the literature review (see Figure 9). The viewpoints of Gibson (1977, 1979) and Kaptelinin & Nardi (2006) give precedence to the actor in the environment, and would argue with the idea that perception and affordances can be separated, as suggested by McGrenere & Ho (2006). Kaptelinin & Nardi argue the activity theory perspective, stating that "since affordances are a property of interaction between an animal and the world, an animal cannot engage an affordance without perception" (Kaptelinin & Nardi, 2006, p. 81).

5.1.2 *Choosing an Initial Perspective on Affordance Use*

A theoretical debate will be avoided; however, it seems that a commitment should be made in the conception of an affordance in order to frame analysis. Table 6 considers activity at three levels, all of which could be considered a level at which affordances exist. While the higher levels are more contextual and abstract and the lower levels are more operational and concrete, it is possible to examine affordances across the three levels. As humans carry out actions, they simultaneously manipulate objects, achieve goals, and associate the meaning of objects based upon cultural and historical values. While examining sequences of interaction for affordance use, the theoretical viewpoint of

affordance use is consistent with that of activity theory, as affordances are examined at all three levels presented in Table 6.

The activity theory perspective of affordances also considers increased temporality: affordances may not present potential for immediate action; rather, potentials for action may be realized and not acted upon until later in time. For example, with games, a student may discover a game feature that they feel is useful, but save its use for later in time after completing their current task.

5.1.3 Selection of Learning Episodes

Learning episodes from the previous chapter's analysis were revisited in this chapter to identify how game affordances influenced and were appropriated in those learning events. Reuse of examples also aids the reader in familiarity with the content, as well as provides a reduction in the rich video data that was collected. For a more detailed description of the process of data reduction and choosing episodes of learning, see the beginning of Chapter 4.

Analysis in this chapter is in greater depth than the previous chapter, so a similar approach to filtering episodes is used: those selected are those that exhibit the most frequently recurring patterns of use by students, warranting a higher priority of discussion. Again, further analysis of the less common patterns (that are not analyzed in this study) is an opportunity for future work.

5.1.4 *An Interaction Analysis*

Analysis in this chapter will examine the use of affordances, through a sequential analysis of interaction (similar to Jordan & Henderson, 1995, as diagrammed in Phase II of the methodology). Video episodes are presented in segments, as logical 'chunks' of transcripts. These pieces are a few lines of transcript (of an episode) at a time. Transcripts are separated into chunks based on the sequence of interaction among participants while engaged in collaborative game play.

Two questions aid the discovery of interactional trajectories and the use of affordances while conducting this portion of the analysis:

1. *How do teammates' individual trajectories play off each other while engaged in collaborative game play?*
2. *How do game representations influence the possibilities for action?*

These questions assist in revealing relevant features of the episode: focusing on what the pair is engaged in doing and achieving by examining the evolution of students' conversations; how conversational and attentional interactions flow in collaborative game play; and what the game interface makes available for use in comparison to what is actually used by the group.

Additionally, convergence is examined: whether pairs appear to be grounded (on the same page; making a concerted effort), or whether they appear to be on their own train of thought. Ethnomethodological principles of *indexicality* and the *social construction of order* are especially relevant, as they examine ways in which context and understanding are built through the unfolding of interactions among participants.

5.1.5 Overview

Learning episodes are presented in eight main sections in this chapter, in terms of the affordances for learning they create: the first five categories will focus on the game interface and its representations; followed by the latter three, focusing on affordances of social peers. Organization of the chapter is as follows:

(a) Visual Representations Affording Specific Activity

(b) The Persistent Display of Past, Potential Present, and Possible Future Actions

(c) Game Cues Grabbing Attention, Redirecting Focus

(d) Consistent Organization, Visualizations, and Behaviors

(e) Plurality of Channels of Information to Aid Understanding

(f) Collaboration Norms: Disclosure and Negotiation

(g) Peer team Cooperation: Awareness, Assistance and Guidance

(h) Peer team Competition: Checking Performance

Following these sections, a summary of the sections is offered, followed by a conclusion offering an abstraction of the findings. Full transcripts of episodes in this chapter, and all corresponding footnotes, are in Appendix H.

5.2 *Visual Representations Affording Specific Activity*

Game representations can create different kinds of affordances on the level of activity, actions, or operations. For example, summary screens might be at the action level, affording management, while icons might be on the operational level, affording clicking.

Four examples are presented in this section. First, the discussion of students' use of the staffing screen in *RollerCoaster Tycoon 3* focuses on how the game affords managerial action, a main goal of the game. Second, repetitive action in *Making History: The Calm & The Storm* shows the need for a summary screen to ease the management of resources. Third, a short example from *Civilization IV* is presented, showing how players learned to build their first city based on the game representations. Fourth, an example from *Making History: The Calm & The Storm* shows game players struggling to use airplanes, perhaps due to the visualization presented.

5.2.1 *Staffing in RollerCoaster Tycoon 3*

In *RollerCoaster Tycoon 3*, staffing represents a moderately used aspect of gameplay that is important in maintaining one's theme park. Staff includes

janitors to keep the park clean, mechanics to fix rides, entertainers to entertain guests, etc. Some of the goals of playing *RollerCoaster Tycoon 3* are to learn to manage all the aspects of a theme park (building rides, managing staff, setting prices), and realizing a profit. Therefore, in hiring staff, a fine balance must be learned by game players: too much staff is too expensive (hurting profits); while too few staff results in park problems (broken rides, a dirty park, and unhappy guests). As the pair plays the game, it becomes apparent that they have a better idea of approximately how many of each staff type is ideal for their theme park. Additionally, game players become more efficient in adding staff to their park.

The first episode shows the first hiring of staff for the park:

```
L:  We want staff.  ((Clicked on 'Staff' icon))
((Opened up all of their current staff members))  Ok.
(.)  We want Janitors.
R:  Janitor 1.  We can name 'em.
L:  ((Clicked on Janitor 1))   Ok. Dooo   ((Double
clicked on the name 'Janitor 1' and hit the backspace
button to put in a name))
¤<1195012>  (.)
```

As afforded by the staff management screen, the representation of staff names in text boxes affords giving the staff names. As shown in Figure 41, the pair changes the default name 'Janitor 1' to something more custom:

Figure 41: Personalizing staff names in *RollerCoaster Tycoon 3*

The 'Staff' summary screen as shown above can be reached by clicking 'Park Operations in the main menu (fifth icon down from the top), then 'Staff' (third from top, highlighted above).

The pair continues to customize staff:

R: Name him Water Boy because he's watering.

L: (hhh) ((*Types in name of janitor*))

((*Humming*))

R: ↑Jackie?↓ ((*Laughs*))

¤<1204200> (1.5)

L: ((*Laughs*)) I'll be the mechanic and you can be the

Janitor.
((*Clicks on mechanics name*))
((*Changes it to a different name*))
R: Ok. ((*Laughs*))
¤<1211364> (1.0)
L: ((*Laughs*)) 'Park Inspector' ((*Reading names of staff off of staff screen*)) His name is Park Inspector. Let's hire him. ((*Clicks at bottom of screen on the icon for hiring a janitor*)) ↓Let's hire a Janitor.↑
¤<1221766> (.)

To hire staff, one needs to click the icons at the bottom of the Staff screen, similar to what is shown in Figure 42:

Figure 42: Hiring a janitor in *RollerCoaster Tycoon 3*

Following hiring (the five icons at the bottom of the Staff screen, listed after 'Hire:' are used to hire employees of particular types), one can place the employee (drop them somewhere in the park to begin working).

The pair continued hiring more employees:

R: You're hiring more. How many [Janitors do we need?]

L: [Let's hire (.) mechanics.] We need mechanics. ((*Clicked on hiring a mechanic*))

R: Make like five janitors.

¤<1228428> (.)

L: We need a bunch of mechanics. And a couple more janitors. ((*Clicked on hiring a janitor*)) Couple of security people. ((*Clicked on security people to hire*)) Couple entertainers. ((*Clicked on hiring entertainers*)) Animal Keeper. Ahh. We don't-

R: Animal Keeper.

L: 'You need at least one enclosure (unclear speech) ((*Reading from pop up when L scrolled over 'Animal Keeper'*)) Alright, we don't need him.

¤<1247701> (.)

R: What is this person doing?

L: It's an entertainer.

R: OH.

L: He's not really entertaining. ((*Laughs*))

R: ((*Laughs*))

¤<1256544> (.)

The pair hired several of each type of employee. The 'Animal Keeper' could not be hired (as conveyed by the pop-up) because the pair did not have an animal enclosure in their park.

Following, the pair customizes an 'entertainer' employee:

L: Like (hhh) ((*Clicked on costume option for entertainer*)) costume to wear.

R: Make it like an animal. Cute one or something.

L: ((*Clicked on costume options for entertainer*)) A shark.

¤<1262119> (.)

R: A <u>whale</u>. Oh [it's a shark.]

L: [It's a shark.]
R: Make it a Panda. Oh ok good.
L: He's not really happy. ((*Viewing face next to staff member*))
R: Click the costume colors.
L: ((*Clicks on costume colors as suggested by R*))
R: Oh pink.
¤<1271881> (.)
L: ((*Clicks on pink*))

Similar to the menu presented by rides and food stands, selecting an employee (clicking on the employee in the 'Staff' screen) will pull up a menu in the bottom-right corner of the screen, along with icons surrounding the employee (things that can be done with the employee). Discussion focused on exploring these icons and negotiating the choice of employee characteristics. The pair customized the employee's costume, and then proceeded to explore other icons, starting with the employee's thoughts:

((*Clicks on the entertainers 'Thoughts' icon*))
R: It's just just his [thoughts.]
L: [Thoughts.] 'I hate working [here.']
R: What the - hate working [Here]. Make him like (.) happy.
L: Uh ok. 'Laziness.' ((*Laughs*)) 'Happiness'
((*Reading icons that are options for the entertainer*))
((*Clicked on wage*))
¤<1285147> (.)

R: Oh no. Don't make his wage higher.

L: Why? That's why he's sad.

R: Well. ((*Laughs*)) Make it higher and see if he gets happier.

L: ((*Clicked to increase wage*)) It only goes up to °there.°

As in Figure 43, one of the icons contains the employee's wage:

Figure 43: Wage and statistics for an employee in *RollerCoaster Tycoon 3*

In the above figure, the employees are happy; however, in the episode transcript, the employee is not happy. The pair attempted to make him happy: they

hypothesized that raising his wage would improve his happiness. After this did not work, the pair considered firing him:

Maybe we should ↑like not have ↓him.
¤<1298829> (.)
R: He's a horrible employee.
L: We should fire him.
R: ((*Points to a different entertainer*)) There he is. Is that him? Oh no that's another entertainer.
¤<1309337> (.)
L: I think that's him. ((*Scrolls across the different staff members at the bottom of the 'Staff' window*)) ((*Clicks on a staff member*))
¤<1314271> (.)

Sad employees appear sad by hunching over, appearing sluggish. The pair noticed that he is now standing up straight, indicating that he is happier. The effect of raising the employee's wage took a little bit of time before manifesting in a better 'happiness' rating:

R: Is he happy now? He's standing. ((*Scrolled to bottom right of screen the entertainer is now standing*))
L: Yep. ((*The entertainer's mood is now happy because his face turned green with a smile*))
R: ((*Laughs*))
¤<1321715> (1.5)
L: Yeah he's happy now. So let's check everybody else what they're doing.

R: Everyone else seems happy. (.) Like Jackie's happy.

L: Everybody else is happy. ((*Scrolling through all the staff members faces*)) °Happy, happy, happy, happy.° Cool.

¤<1339537> (1.5)

L: Awesome. ↑Now↑

¤<1341588>

After verifying that the entertainer was happy, the pair checked the other employees' happiness. Pulling up the Staff screen, as seen in Figure 44, the pair is able to view a summary of their employee's happiness ratings (the smiling or sad face icons to the right of the names):

Figure 44: Staff screen in *RollerCoaster Tycoon 3*

The staff screen affords management, as demonstrated by discourse: providing a summary of employees and some statistics of each employee (their

current task, patrol area, uniform color, and happiness rating) encouraged employee management behavior by the pair, verifying that all employees were happy. Supporting the game goals (of managing a theme park), the Staff screen is a representation affording management of staff, as it can be used in the manner shown above by the pair.

By the third day of gameplay, a difference could be seen in the pair's behavior in hiring staff. After starting a new game, the pair hires some staff:

L: ↓More mechanics?↑
R: Yeah.
L: Alright, where's that again? ((*Scrolls through side menu*))
R: The mechanics 'Park Management'.
¤<876228> (.)
L: ((*Clicked on 'Park Management'*))
((*Clicked on 'Staff'*)) ↓Oh we don't have anybody.↑

The first line of the transcript is a response to a game message about a broken ride. This prompts the pair to pull up the Staff screen. Focus is first on finding the Staff screen as the pair explored the persistent icons on the left side of the screen.

After realizing they had no staff, the pair quickly hired staff:

R: There's a mechanic. ((*Points to Mechanic icon on staff menu*))

L: °We need a janitor.° ((*Clicked on 'Mechanic'*))
((*Clicked on 'Janitor'*))
¤<883799> (.)
L: ° We need a couple of mechanics.° ((*Clicked on 'Mechanic'*))
((*Clicked to add another Mechanic*)) ↓We need a couple of everything.↑ ((*Scrolled over the staff that the pair can hire*))
((*'Animal Keeper' popped up*)) °No we don't need an 'Animal Keeper' though.°
R: nmm
¤<893340> (.)

The students seemed to have an idea of how many of each type of staff they need for their park, possibly based on previous game play.

As the pair played a scenario called 'Fright Night', they proceeded to hire some 'scary' entertainers:

L: °Two 'Entertainers'. ((*Clicked on 'Entertainers'*))
We need to change the 'Entertainers' costumes.
Something scary.°
((*Clicked on 'Costume' for entertainer*))
((*Clicked on entertainer's thoughts*))
¤<903093> (.)
R: We got to drop them somewhere. ((*The staff member that they just hired is in mid air*)) (.5) I think you're holding him.
L: No.
R: Yeah. He's right there.

L: ((*Scrolls through new hires*))
((*Closes staff window*)) Uh yeah?
¤<917467> (.)
L: ↓Ok well then we'll↑ ((*Zoom out from map*)) (.5) put him (.5) let's go over here. ((*Scrolling around park with new employee in air ready to be placed*)) ((*Places the new employee in an open area of map near a ride*)) (1.0) ↑Alright, let's do another ride.↑
¤<940940>

Following placement of the employees, the pair focused on creating rides in the park. A change in behavior was evident: the pair was aware of the Staff screen, knew which categories of employees they needed, and swiftly hired the required employees and placed them in the park.

In the final day of gameplay, the pair repeated the process of hiring staff for their park (again, a new game was being played). Initial focus was on finding the Staff screen:

L: Where is it again? ((*Scrolled over left side menu*))
R: Underneath the eyes.
L: No that's save.
R: No go up again. The eyes. Those little things. This thing. ((*Points to 'Park Management'*))
L: °That's not it.°
¤<746262> (.)
R: It's not?

L: °No.°

R: Are you sure? [Oh no,] it's just the statistics with the graph.

L: [Yeah.] ((*Clicked on 'Park Management' icon*))

((*Staff screen popped up*))

¤<755774> (1.0)

Upon finding the staff screen, the pair learned they had only one mechanic and one janitor, and determined that their park was under-staffed:

R: ↑Hey. We only have one mechanic.↑ (.5) And one janitor.

L: ((*Scrolls over the mechanics and janitors*))

¤<771988> (2.0)

...

R: We've got to place him.

...

R: Just drop him right there.

L: ↑How about (.) a janitor?° ((*Scrolls through staff menu*))

¤<813241> (.5)

L: Ok. He's on his route. (.5) °Janitor do your job.° (.5) 'Going to broken ride. Going to inspect a ride. Rovering. Rovering. Rovering. Entertaining. ((*Reading off what each staff member is doing by clicking on each staff member*)) °You better start entertaining bud. You're not scary either.°

¤<843035> (.5)

R: ((*Laughs*))

Again, as evident by action and discourse, the Staff screen affords management of employees. The pair exhibited this behavior by evaluating employees, one at a time, and reading their thoughts to gauge their effectiveness.

Following, the pair discovered an unhappy janitor and took action to fix the problem:

```
L:  °'I hate working.'° ((Reading thoughts of the
janitor))
Let's go to (.) to there. ((Increased the staff
members pay)) Now he's happy.
¤<859592>  (.)
L:  Happier.  So I'm ok with.  What's this?
R:  Janitor.
L:  Alright, now what.
R:  Drink spot and then delete that ride.
L:  Alright.
¤<877354>
```

After improving the janitor's happiness by increasing his wage, a strategy that worked previously, the pair returned to working on their theme park's attractions.

Again, a slight change in behavior can be seen from the previous episode: in this case, the pair also appeared to have a handle on how many staff they needed for their park, and proceeded to quickly hire them. However, in this episode, the pair made use of the Staff screen to manage their employees,

verifying that employees were happy before moving on to other tasks. This additional behavior demonstrated a greater degree of understanding how to manage employees: the pair grasped that happy employees are more effective and less likely to quit. After several days of gameplay (including observation of game console messages of employees quitting, etc., which is discussed later) their actions showed importance being placed on their staff's happiness.

By checking staff happiness before leaving the Staff management screen, the pair avoided the need to manage staff for a while. In doing so, the pair made use of the Staff screen as a management tool, a representation provided by the game lending itself to management of staff. In *RollerCoaster Tycoon 3*, the game provides other 'summary' style screens that lend themselves to management of other aspects of the game. While not mentioned in this sequence of episodes, management screens summarizing rides and attractions, park visitors, and finances are available.

5.2.2 *Repetitive Tasks in Need of Offloading in Making History: The Calm & The Storm*

The following example might be a missed opportunity for learning, as much time is spent doing a repetitive task that could have been alleviated through a better management interface, such as the summary screens discussed

above. In the following episode from *Making History: The Calm & The Storm*, the pair adjusts the production (factory output) of their nation's cities individually. As nations have many cities, this can be a time consuming process that might have been avoided through some sort of 'production management' interface.

The repetitive nature of tasks is such that much time was spent on the task that could have been spent learning new things elsewhere. The pair was playing as Russia, and learned that the adjustment of factories outputs (products) can be used to provide military support to ongoing battles, effectively replenishing lost units (such as soldiers, tanks, and airplanes). The following episode took place over the course of several minutes:

```
R:  ((Scrolled around Russia))
((Clicked on Russia's flag))
((The 'Turn Summary' menu popped up for Russia))
((Clicked on 'Military' icon))
((Clicked on 'Diplomatic' icon))
((Scrolled to the West side of Russia))
((Clicked on a ship in the Baltic Sea))
((Scrolled to a different spot in the Baltic Sea))
((A green lined appeared showing that the ship chosen
was on the move))
((Scrolled back over to the East side of Russia))
¤<414588>  (.)
R:  ((Clicked on a military unit several times -
nothing happened))
```

```
((Clicked on an Alliance))
((Clicked on 'Production'))
((Production window popped up))
((Clicked on Military))
((Clicked on a factory))
((Clicked on 'Production'))
((Clicked on 'Air Force'))
((Clicked on 'Bombers'))
((Clicked on a 'Military' unit))
((Clicked on a army division))
((Clicked on the map))
```

Production orders for a city can be changed by selecting the city, then editing the production orders, as seen below in Figure 45:

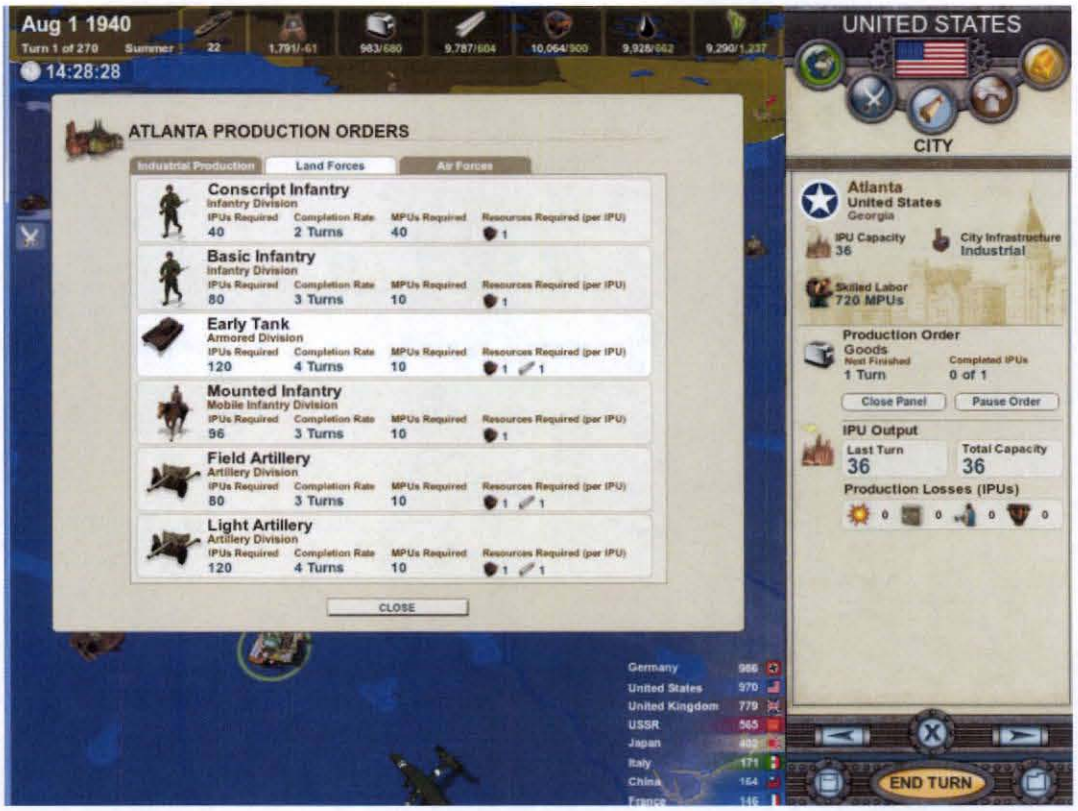

Figure 45: Production orders for a city in *Making History: The Calm & The Storm*

The students, playing as Russia (with many provinces and cities), have to adjust the production of many different cities. Each city must be selected, and production orders must be manually changed. Later that day, the following episode occurred over the course of about a minute:

```
L:  ((Clicked on 'Production' of a city))
((Clicked 'Air Force'))
((Clicked on 'New Production Order'))
((Clicked on an Air Plane))
((Clicked on 'Production'))
```

```
((Production window popped up))
((Clicked on 'Air Force'))
((Clicked on Military))
((Clicked on 'New Production Order'))
((Clicked on a 'Goods'))
((Clicked on 'Air Force'))
((Clicked on 'Fighters'))
((Clicked on 'New Production Order'))
((Clicked on three different areas of the map))
((Clicked on 'Production'))
((Clicked on 'Air Force'))
((Clicked on 'Bombers'))
((Clicked on 'New Production Order'))
¤<1853906>
```

While not too much of a drain on the gameplay, the pair spent time adjusting the output of several cities to produce similar goods. The above episodes highlight several things: the lack of discourse between participants, potentially highlighting boredom from the repetitive task; and the repetitive nature of the pair in changing the production orders of several cities to produce the same item. A summary screen could be beneficial, similar to what is seen in *RollerCoaster Tycoon 3*'s staffing screen, allowing easier management of game resources.

5.2.3 *Building The First City in Civilization IV*

In *Civilization IV*, the pair learned how to build their first city, marking an important point in their developing civilization (and learning in the game). Several things occurred on the game interface, along with several visual changes. The game's visual representation as well as the prompting for a city name forces attention to be drawn to the event.

```
R:  Press 'Enter' already.
L:  Oops city.   >↑WHAT?< ((A window popped up telling
the pair that they created a city)) [111] <↓YEAH.>
((Laughs))
```

Focusing on the visual representation provided by the game, following are figures that illustrate a reproduction of the changes on the game's visual interface. First, Figure 46 presents the view before building a first city:

---

[111] "Cities are built by settler units. If the settler is in a place where a city can be built, the "build city" action will appear in the settler's action box. Simply click on the action button and the settler will disappear, to be replaced by the new city. The program suggests a name for this city, or you can give it any name you want. (Once built, city names cannot be changed.)" (*Civilization IV* Manual, p. 45)

Figure 46: Before building a first city in *Civilization IV*

Following the selection of a group of 'Settlers' in the game, the visual representation changes on the map:

Figure 47: Selecting a settler in *Civilization IV*

As can be seen, the visualization changes after selecting a Settler: a border around the Settler is visible, and actions at the bottom of the screen for the Settler (the last icon on the right, resembling buildings, will build the city). Additionally, resource icons appear on the map, noting the availability of resources such as grain, stone, metals, etc., assisting in the placement of the city. This display of resources before building a city affords its placement: near tiles containing more resources.

Following is what appears after clicking the icon to build the city:

Figure 48: Naming a new city in *Civilization IV*

A pop-up appears, asking for the city a name, as seen in the remainder of the transcript:

```
((Game prompts for city name.  L erases the city name
suggested by the game))
R:  That was all me. ((Laughs))
¤<280410>  (.)
L:  City name?  Whatever we will just leave it the
same.  ((Retypes the suggested name back in))
¤<284838>  (.)
R:  ((Laughs))
L:  Whatever ((Clicks 'Ok'))
```

((*Laughs*))

R: What? ((*Laughs*))

L: Ok whatever. Alright. ((*'What would you like to build next' window pops up with recommended choices*))[112]

R: °Like you could build another city?°

¤<292779>

An affordance of the pop-up window is to draw attention to the text box, where game players can enter a name for the city. It is interesting to note that game players must respond to the pop-up: one cannot proceed back to other parts of the game until clicking 'OK'. This serves to focus attention, forcing game players to acknowledge the new city; and by naming it, potentially making an investment in identity (similar to Gee's projected identity, as presented in Gee, 2003). In the above transcript, discourse is focused on the creation of the city and naming it.

The transcript also shows players' excitement upon building their first city. While the left hand player considered naming the city something unique,

---

[112] When you build a new city, a window appears saying 'What would you like to build in (your city name)?' 'The units and buildings you construct should reflect your objectives. Your specific objectives will vary from game to game and over time during a game, but the "Early Objectives" list is a good place to start." (*Civilization IV* Manual, p. 59)

he changed it back to the original name, perhaps due to some social awareness that he was playing collaboratively (it was his teammate's city as well). The right hand player appears proud of the accomplishment as well in saying "That was all me" after the creation of the city. Additionally, he hints at future strategy in the last line of the transcript, when he questions whether they could build more cities later on in the game.

5.2.4 *Using Airplanes in Making History: The Calm & The Storm*

The following example is a sequence of two episodes, showing the learning of the control of airplanes in *Making History: The Calm & The Storm*. The first episode presents the pair struggling to use their airplanes to bomb Canada (they are playing as the United States, and are at war with Canada):

```
L:  Alright this guy (.5) ((Clicks on a plane in
Georgia)) needs to go (.5) over here.  ((Clicks on an
area in Michigan))  (1.0)
L:  ((The plane does not move)) How do you move 'em
again?
R:  The planes won't move (1.0) like I can get the
(1.0) armies to move but I can't get the planes to
move.
¤<1384390>  (.)
```

The pair identified their problem: to move and use airplanes. The goal appeared clear: to use airplanes to fight Canada; but the execution of the goal appeared difficult. The left hand person asked how to move planes around, and the right person restated the problem based on previous experience trying to move airplanes (unsuccessfully). Following, the pair consults the peer team for information:

```
L:  ((Clicks on a plane in Georgia))
((Clicks on Washington))  Do you know how to move
planes? ((Clicks on the same plane in Georgia))
((Clicks on Washington))
((Moves cursor to 'Mini Map' of nations))
((Clicks on 'Ideology' map))
((CLicks on 'In Supply' map))
((Clicks on 'Operational' map))
((Asks the peer team for help with moving planes))
Peer team:  Do you?
L:  Do you know how?  ((Scrolls through US continent))
Peer team:  No. Do you know how?
L:  No ((Laughs))
Peer team:  ((Laughs))
¤<1409599>  (.)
```

No help is given by the peer team. The pair continued to struggle with the game interface, similar to what is seen in the following figure:

Figure 49: Airplane actions in *Making History: The Calm & The Storm*

Perhaps potentials for action on the interface are not clear enough for students to learn how to use their airplanes. Movement in the above figure does not appear to be suggested by the interface. Following, the pair continues to lose states to Canada, which frustrates them:

L: Alright, somehow we just need to get... uh↓ what the heck?↓

L: What the heck? ((*Scrolling across Midwest region of US*))

((*Right clicked on an army in Canada*))

((*Clicked on an army in US that was engaged with*

Canadian forces)) °What the heck?°
R: We are going to kill them. ↓How do you move those planes?↓
¤<1442484> (.5)

The loss of states seems to re-motivate the students into learning how to use their airplanes. While discussed in more detail later, this appears to be a feature of games: a bit of failure can often increase interest and add motivation to win to a game. In this case, failure to move planes frustrated the pair, as they saw an opportunity for action (a military unit of airplanes on the map that the gamers inferred could be used in warfare), coupled with a goal (using the airplanes to fight Canada). However, the students could not seem to determine how to make this happen through the game interface. Generalizing to other games, a bit of failure might be challenging when presented at the goal-level; on the other hand, it appears to be frustrating for game players when encountering failure at the operational level (failure to execute the goal).

Following, the pair attempts to move airplanes, located in Georgia, to fight the Canadians:

L: ((*Clicked on an airplane in Georgia*)) ((*'Air Force' menu popped up*)) ((*Clicked on 'Rebase' in the 'Air Force' menu*))₆ Oh here we go. (.5) Canada. What the heck? Why isn't Canada in here? ((*Scrolls through list of states / countries to find Canada*))

R: Maybe you gotta send (.5) try sending the one from New York to Canada.
¤<1465659> (.5)
L: ((*Continues to scroll through states / countries*)) ,Or to Michigan., ((*Continuing to scroll through list of states / countries*))
¤<1472521> (1.0)
L: ((*Continues to scroll through the list of states / countries to attack*))
R: Yeah go to Minnesota. Then we can attack them from there.
¤<1498749> (1.0)
L: ((*Clicks on Minnesota*)) Go ((*Scrolls over continent*))
((*Sighs, places hands up by mouth*))
((*Scrolls through map along green active path from Georgia to Minnesota*))
¤<1506771>

The pair appeared frustrated by their inability to attack Canada with their planes from Georgia. The game offers the ability to rebase their planes, which seems to hint to the game players that their planes might need to be closer to the enemy in order to launch missions. While this does not achieve the goal of bombing the enemy, the 'rebase' option seems to properly infer to gamers that they need to first move planes closer to their targets. Generalizing to other game play, this seems to be a helpful feature of games: displaying potential actions

that can both hint at and lead to solutions of a problem. Players hypothesized in the above episode that moving the planes closer would allow them to be used to engage the enemy. This led into the next episode in the sequence, after moving planes further North:

```
R:  ((Clicked on different airplanes around the map))
(('Air Force' menu popped up))
((Right clicked on an airplane))
((Options for the airplane popped up))
¤<1706739>  (.5)
((Clicked on American flag))
((Clicked on a plane in Massachusetts))
(('Army' menu popped up))
((Clicked on an airplane in New Hampshire))
(('Air Force' menu popped up))
Oh they took over so many of our ((Scrolling map
across Northeastern U.S.))
¤<1716872>  (.)
```

Success was achieved after airplanes had been moved closer, and the pair employed the strategy of right-clicking enemy targets (a technique used to move other types of military units):

```
R:  ((Right-clicked on an enemy target in Maine))
((A menu appeared offering the option to bomb them))
((Mouse control traded from R to L))
R:  Oh crap =
L:  Oh how did you =
```

R: = They're taking over all of our states.

L: = no we can actually bomb someone now.

¤<1724524> (.)

R: Oh (.5) how did you do that?

L: I don't know you did it. ((*Laughs*))

R: ↑Did I?↑

L: Yeah ((*Laughs*))

R: Ah geez↓

¤<1729912> (.5)

L: Ah sweet (1.0) alright bomb them. ((*Clicked on one of their airplane units*))

Apparently both students were confused about how they achieved bombing enemy targets. Both attributed success to the other game player. Both game players seem to have overlooked exactly how success was achieved, potentially because the game interface did not make evident what had actually happened. However, they seemed excited that their airplanes could actually be used, and went about determining exactly how they accomplished bombing the enemy:

((*Clicked on an enemy targeted army*))

R: It's like (.) hold it down or something.

L: ((*Double clicks on airplane*))

((*'Air Force' menu pops up*))

((*Right clicks on enemy army*))

((*Clicks on their army*))

((*Clicks on an airplane*))

((*'Air Force' menu pops up*))

¤<1749253> (1.0)

L: There. (1.5) Wait. (8.0) ((*Clicked on airplane*))

((*Mouses over airplane*))

((*Options for the airplane moused over pop up*))

((*Chooses air mission*)) Air mission. Alright there we

↑go.

The pair learned how to conduct air missions and use airplanes. Right clicking on *nearby* enemy targets, after selecting a plane, displays a menu with an option for air missions, similar to what is shown in the following figure in the top-center of the screen (the mouse pointer was not captured in the screen shot):

Figure 50: Bombing enemy targets in *Making History: The Calm & The Storm*

This sequence of actions was not made obvious by the game: students may have struggled to figure out the correct sequence of actions because the game representations do not suggest what sequence of actions leads to the desired result. While a common method of right-clicking is present for moving other military units, the lack of a common place for action-items (like icons) or the means to accomplish military action appeared to hurt gameplay. A great amount of time was spent by game players attempting to figure out how to control the game interface to achieve a simple goal.

5.2.5 Summary

The representation of information lends itself to ways of use by game players. *RollerCoaster Tycoon 3* puts much emphasis on management of one's theme park, which is correspondingly represented well through the game's many summary screens. The representation of summary screens affords the management of game resources, similar to what is shown above by the use of the 'Staff' screen. Similarly, in *Civilization IV*, the sequence of visualization changes helped the pair figure out how to create their city. However, the use of airplanes in *Making History: The Calm & The Storm* showed a bit more of a struggle by students to execute their goal of bombing enemy targets. Several additional factors such as the way actions were performed (having to right-click airplanes),

or the inadequate amount of visual feedback given when exploring the interface could help explain the difficulty encountered.

5.3 *The Persistent Display of Past, Potential Present, and Possible Future Actions*

Maintaining context through the display of historical activity was beneficial to learning: it provided a frame of reference to students in the generation of future strategies, and displayed historical activity through the representation of previous actions. Additionally, future affordances can be suggested by the game through its visualizations, as shown through the two examples in this section from *Civilization IV*.

5.3.1 *Exploring the Civilization IV Interface*

Early in the first day of gameplay of *Civilization IV*, game players explored the visual interface presented to them. Discussion was focused on determining what the various buttons on the interface were meant to do, and were tested by clicking on them to see what happened:

> R: °What are these things?° ((*Points to 'Advisor Buttons'*)).
> L: I don't know I think that just tells us what we have.

The pair discussed the 'advisor buttons' in the upper-right corner of the screen, as seen in Figure 51:

Figure 51: Advisor buttons in *Civilization IV*

A recurring pattern used when discovering items was to verbalize questions in order to initiate discussions with teammates, as shown above when referencing the advisor buttons. Game players appeared to use the social plane as a resource for checking to see if shared understanding had been reached. Typically, peers would verbalize a response to the question if they had a different understanding; perhaps due to socio-cognitive conflict (their peer's definition caused cognitive disequilibrium, prompting its correction). This is an affordance of collaborative game play: the ability to suggest to peers particular items for discussion in order to gain shared meaning.

Returning to the above figure, the pair appeared to explore the buttons to gauge their purpose. Perhaps the presentation of the buttons (several buttons in a row, persistent on the interface, with significantly different pictures on the

icons) lends itself to being interpreted as major game functions. Looking at the icons, there appears to be: a house, a dollar sign, a ring of some sort, a scroll, a shield, a beaker, some clasped hands, a red fist, and then a chart. Action in this episode seems aimed at brief exploration: not much discourse took place regarding selecting the icons to click; rather, just a few icons were chosen rather quickly.

Following, the pair began to click on the advisor buttons, which presented new windows (in full screen):

```
((Clicked on 'Financial Advisor' icon))
R:  Zero.
L:  ((Laughs)) Cuz we suck. ((Clicks on 'Religion
Advisor'))  (.5)  We have no religions founded yet?
((Exits out of 'Religion Advisor')
```

Above, the 'Financial Advisor' and the 'Religion Advisor' were clicked. These icons are represented by the '$' (dollar) sign and the praying hands icon, third from the right. Following is an example of the 'Religion Advisor', in Figure 52:

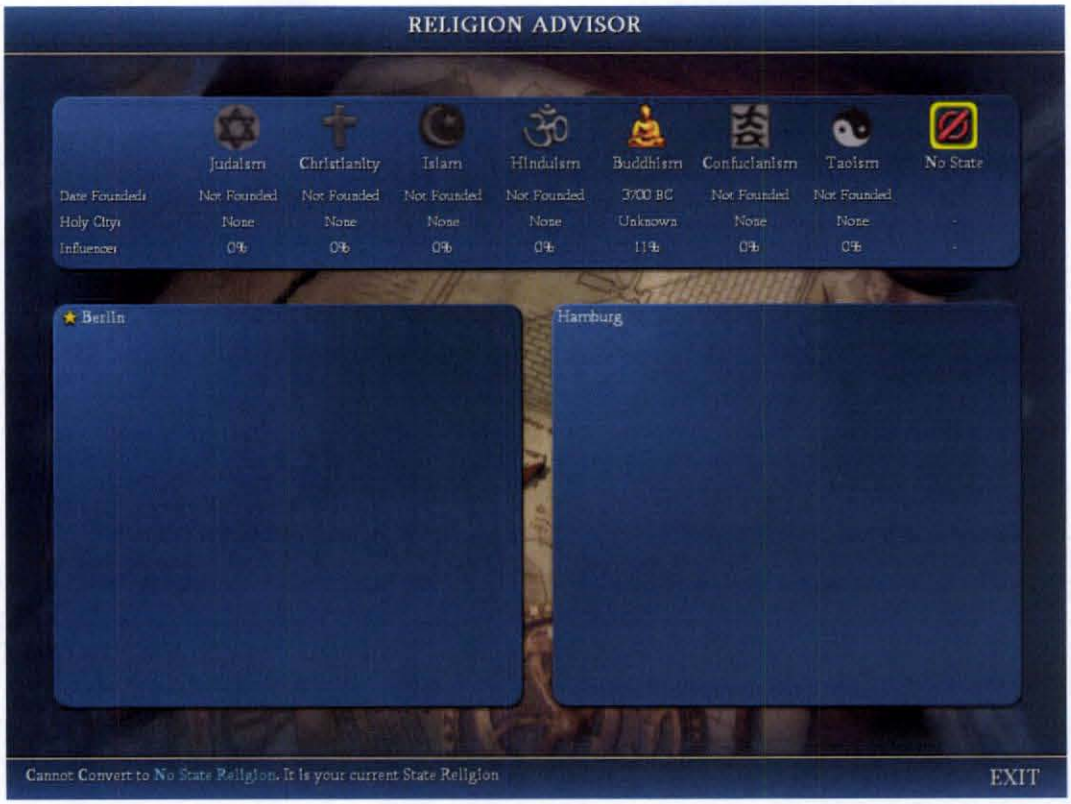

Figure 52: 'Religion Advisor' in *Civilization IV*

The 'Religion Advisor' makes clear the current religion (above, no religion adopted yet), and others available (in the above figure, only Buddhism had been founded as a religion, which is why the other religions are grayed out). In the game played by students, no other religions were yet founded. It was, therefore, not possible to adopt any of them yet. The pair exited this screen rather quickly, which made sense because they did not have any potential for action. However, the screen showed future potentials for action: the grayed out religions suggest future religion adoption.

Above, in Figure 52, *Civilization IV* could have presented a simple list that said something like "No religions founded yet"; however, potentials for *future action* are presented by the game. This encourages learning, and expands the definition of affordances: showing an increased temporality (not necessarily located in the present moment). Learning can be encouraged through the visualization of future action, by making game players aware that religions can exist in the future even though they are not present at the current moment. A potential for action is not currently available, but the visualization implies that future action will become available: the visualization suggests grayed-out religions will become available (and usable somehow) later in the game.

The above action appeared to be exploratory, as action was taken rather quickly (possibly just exploring the game interface), and not much potential for current action was available: the 'Financial Advisor' revealed zero money was available, as read by the right hand student (it was early in the game), and the 'Religion Advisor' revealed that no religions were available yet, as read by the left hand student. However, this information implied future actions would become available: that it is possible to acquire money and establish religions through future action.

Moving on with the episode, the pair began exploring the map and objects on the map:

R: (unclear speech) Is that what it is behind you?
L: Yeah. (.5) Alright, now ((*Scrolls to a different part of the map*))
¤<425567> (.)
R: What are these guys doing?
¤<427343> (.5)
L: ↑They're like↑
R: They're like digging, or mining.
L: ((*Points with finger to the group of workers who are mining*)) Yeah they're mining.
¤<431019> (.)

Above, the pair explored some workers that were part of their civilization. These workers appeared as animated objects on the map. Again, some discussion occurs, attempting to gain shared meaning on objects in the game. After the right hand student raised the question of what the workers were doing, the left hand student pointed his finger at the animation of the workers (who appeared to be digging something). Additionally, mousing-over a worker reveals some information about the worker, as seen in the light text in the lower-left corner of the screen (above the 'Scout' information). Clicking the workers reveals that they are mining, as seen in Figure 53 below.

The game lists objects' actions: "Build a Mine (5)". The pair appeared to have a preference for visual information first (viewing the animation of workers swinging a pickaxe). *Civilization IV* effectively provides information through different channels: the game presents a visual animation along with a secondary source of textual information upon moving the mouse over the workers (textually displays what they are doing).

Figure 53: Building a mine in *Civilization IV*

Although difficult to see, the workers in the middle of the screen have pickaxes and are animated, digging at the ground. After several turns, a mine was

operating, implying that the mine building has been completed. In the above figure, another previously built mine is shown directly above the workers (a mine that they previously built, near the top of the screen).

After determining that their workers were building a mine, the pair explored other objects on the map, namely their explorers:

R: What are those two doing?
L: ((*Scrolling over map*))
((*Clicks on group of scouts*)) These are like, our explorer guys. The scouts. We have to do some exploring to find ↓some stuff.↓ ((*Scrolls to another part of the map*))
((*Clicks on a part of the map*))
((*Clicks on group of scouts again*))
((*The map shows that the scouts can move three turns to the left*))
((*Clicks on a different part of land where it will take four moves for the scouts to move*)) (2.0) °Where should we go, like over here? ((*Scrolls map to upper left of screen*)) (.5) No we should go this way.°
((*Gestures with cursor to lower-right of map*))
¤<453514> (.)
L: ((*Clicked on scouts again*))
((*Clicked on land that is not available yet to discover in black*))

Conversation focuses on determining the purpose and movement of objects on the map. While the transcript is vague in terms of where the left hand

student was clicking and pointing, he appeared to be exploring directions in which to expand their empire (the team was located on a peninsula, and expansion could occur to both the upper-left and bottom-right of their location). Above, the left hand student answers his own question after not receiving a response back from the right hand student. However, the right hand student appeared engaged and was closely watching the actions of the left hand student in exploring the map.

The pair discovered their scouts (explorers) and made use of them to uncover portions of the map. Perhaps the naming of the objects (Scouts) led to their interpretation as 'explorer guys' that explore the map for the pair. Map exploration consists of uncovering 'black' areas, which represent portions of a map that have not yet been visited (uncovered) by the civilization, as seen below in Figure 54:

Figure 54: Scouts in *Civilization IV*

The representation of the map creates an affordance for exploration by projecting action into the past and into the future. The game does this by coloring parts of the map black that have not yet been explored and revealing parts of the map as one's objects pass over them, thus creating an affordance for exploration. Additionally, the visualization of movement (as represented by the circles with numbers inside them) creates another affordance for future action. Game players can also see a history of past action based on parts of the map that are already uncovered. This generates motivation to explore the map further. The visual

affordances of future action as well as the display of past action help to frame the discourse and action of the pair in their focus on exploration.

In the above figure, parts of the map that have been explored but are not current appear slightly dimmer. This representation is used to convey that one has seen a portion of the map previously, and that it may have changed since that portion of the map was last explored (for example, other civilizations may have built objects on it).

The above section of the transcript illustrates the learning of the interface (movement) as well as functionality (uncovering and exploring the map). Following, the pair attempted to send workers down to a recently uncovered portion of the map:

```
L:  ((Clicked on group of workers))
((Scrolled map South))
((Clicked on a different area of the continent))
((Two turns showed up in order to move the workers to
the new area))
((Scrolled map back up to left corner))
((Clicked on a different open area of the continent))
((Clicking several times around on continent nothing
is happening))
((Clicked on a different group of workers))
((Game popped up showing it would take two turns to
move the current selected group of workers to new
area))
```

((*Scrolling over icons in 'Unit Action Box'*))
((*As L scrolls over icons the names are popping up on screen*))
((*Scrolls over same icons a second time*))
¤<526982> (.)
R: Try to send them down further this way. ((*Pointed to an open area in the southern part of the map*))
L: ((*Clicks on open area, where R pointed*))
((*Clicks on group of workers*))
((*Game shows it will take two turns to move the workers to the new spot that R suggested*))
R: Let's see if we can explore more.
L: ((*Clicked on group of workers*))
((*Clicked on open area where R suggested*))
((*Game popped up three turns for this move*))

In the above interaction, the pair learned how to use objects on the map (workers, scouts, etc.) to uncover new parts of their map. Additionally, the representation provided by the game showing the number of turns to move objects helps to reinforce the turn-based style of the game, as seen in Figure 55:

Figure 55: Turn-based movement in *Civilization IV*

The idea of turn-based movement is learned by the pair, as it is evident they realize it takes turns to relocate objects on the map (as inferred by the game's representation of movement). *Civilization IV* will move around to all one's objects (those needing a new task to do) each turn. After each is assigned a task, the game will flash a message at the bottom of the screen that says "Press Enter to end turn." This suggests the need to advance the turn after all moves have been planned for the turn. The pair made their understanding of the turn-

based style of the game clear after moving units and saying 'press enter' to each other in order to advance the turn and their game objects:

```
((Clicked to have workers build a road))
R:  And then (1.0) press enter.  Press enter for them.
L:  ((Clicked on workers again))
((Game indicated four turns to move the workers to
where R suggested))
R:  Like when you're on them press Enter.
```

The above example presents important findings, e.g., how the representation presented by the game can lead to the learning of particular interface functions, and how questioning and disclosure among peers can prompt between-participant negotiation (to achieve shared meaning) of the functionality of particular game features. Compared to other games, discourse around the functionality of objects in *Civilization IV* seemed higher (*Civilization IV* was the most complex of the three games used).

5.3.2 *The Technology Advisor in Civilization IV*

The final example in this category focuses on the 'Technology Advisor' in *Civilization IV*. The representation of the technologies and their contingencies in *Civilization IV* assists in the development of strategy by the game players. In this example, two episodes are presented: the first focuses on the first use of the

Technology Advisor; followed by the second episode, where the Technology Advisor is used in strategy formation. Much attention is paid to the representations provided by the game and how they influence discourse. Again, due to video tape resolution, figures are presented from a separate game's screenshots that are analogous to what is occurring in the students' games.

First, the pair unlocked a new technology item. In *Civilization IV*, unlocking a technology item is marked by several events: first, a pop-up appears, similar to what is shown below in Figure 56, highlighting the significance and corresponding buildable items possible; and a sound is played, followed by an audio quote relating to the technology. The pair experienced this:

> ((*Window pops up in game, explaining the new technology item the pair unlocked*))
> ((*A description of the new technology item is listed; as well as new items that can be built*))

Figure 56: A new technology in *Civilization IV*

Several aspects of the game design should be noted:

- The representation of the technology item is presented in several ways
- Attention is shifted to focus on the new technology through the visualization (prominent pop-up window)
- Students may not proceed in continuing the game without acknowledging the technology and clicking the 'Continue' button.

The representation of the technology item is presented in several ways: A related historical quote is displayed, hinting at the usefulness of the technology, and is spoken (a sound clip plays audio; the quote is spoken out loud). An icon associated with the technology is displayed, which affords performing a mouse-over for more information, as seen below in Figure 57 (again, the pointer is not visible in the screen shot, but is currently over the 'Bronze Working' icon in the upper left of the pop-up window):

Figure 57: Mouse-over of a new technology item in *Civilization IV*

The information presented when mousing-over the icon is the same information available in the center of the pop-up window, listed under 'Special Abilities' and

'Allows' (the now available items which can be built with the technology). The 'Special Abilities' items are blue and underlined, affording clicking (similar to a hyperlink), and the 'Allows' items are represented as icons (affords mousing-over and clicking as well). Clicking on any of these items will present a separate screen providing more information on those respective items, as done quickly by the pair:

R: ((*Clicks on one of the items that can be built, then exits back to pop-up*))

Clicking one of the links or icons will jump to the 'Civilopedia', an in-game encyclopedia describing game items. A sample is shown in Figure 58:

Figure 58: Item description in *Civilization IV*'s 'Civilopedia'

In the episode, the pair moused-over some of the items in the pop-up, clicked one in the middle of the list (pulling up the item description in the Civilopedia), and quickly exited the Civilopedia (returning them to the pop-up window displaying the new technology). They clicked 'Continue' to proceed:

((Clicks 'Continue' to proceed in game))
((List of future / researchable items appears, prompting pair what they would like to research next))

After clicking 'Continue', the pop-up disappeared, and the screen changed to one resembling the following:

Figure 59: Choosing a new technology to research in *Civilization IV*

In order to proceed in the game, one is forced to make a choice of a new technology to research.

The first item in the list says "Let's see the Big Picture…", and clicking this item will lead to the display of the 'Technology Advisor', similar to that what is shown below in Figure 60:

Figure 60: The 'Technology Advisor' screen in *Civilization IV*

Behaving similar to the 'Civilopedia' above, the pair briefly looked at the screen and exited out to the previous menu:

> *R: ((Clicks first button called 'Let's see the big picture' which pulls up the 'Technology Advisor'))*

After quickly exiting back to the menu of technology items (about one second was spent looking at the 'Technology Advisor'), exploration and discourse of technology items ensued:

R: ((*Mouses over the different items to be researched next*))
L: ↑Iron working. Can remove jungle↑ ((*Laughs*))

Similar to Figure 59 (two figures above), the game players moused-over technology items, briefly pausing to read pop-up information about each of the technology items. Pausing the mouse over the top of an icon reveals some properties of the item, such as things one can build with the technology, and technologies that are researchable following the acquisition of the current technology. However, the representation of item properties in list form creates an affordance: displaying only one item in the future (leads to X) only shows one level of contingencies in the future. This limits planning of future technologies to the immediate. Following, the pair clicked the first item in the list ("Let's see the Big Picture") in order to return to the Technology Advisor:

R: ((*Scrolls through the 'Technology Advisor' from left to right according to advancement*))
R: "Build a Winery"? ((*Surprised*))
¤<2626940> (1.0)
L: °So much stuff.° 'Electricity'? ((*Scrolls through the 'Technology Advisor' at all the different technologies listed*))
R: ((*Clicks on 'Electricity'*))
¤<2632656> (.5)
R: °Slow down° ((*Moused over a few of the different*

technologies in the 'Technology Advisor'))

R: *((Clicked on the keyboard))*

¤<2633941> (.)

R: *((Scrolled to the end of the technology list))*

This time, much more time was spent looking at the Technology Advisor. It appears that the pair was able to infer the meaning of the representation of technologies in the Technology Advisor: different technologies appear as blocks, with lines connecting them to represent contingencies between technology items. The pair appeared to grasp this; as they scrolled from left to right, taking time to read the future technology items, they expressed amazement at the complexity of the game and all its technologies. Again, the game projects both past action (historical context of gained technologies) as well as future affordances (future technologies to strive for, and achieved based on the visually displayed contingencies).

Students read about several of the more advanced technologies out-loud, as if to express amazement: such as 'Electricity' and 'Robotics', as presented below. The episode resumes as the pair exits out of the Technology Advisor (back to the list of technologies to research):

R: Let's go with uh = *((Game gives them a list of technology items to work on next))*

L: Robotics? *(('Robotics' was listed last on the*

technology list))

¤<2637558> (.5)

R: = °Pottery.° ((*'Pottery' chosen as next technological advancement*))

R: ((*Game moves the view to a character needing a task for the turn*))

L: You can get like into the (.) you can get advanced in this game.

¤<2644970>

Above, the pair negotiated a technology to research next. While the left hand student says 'Robotics', it is not a choice in the menu of technologies. It appears that he is verbalizing a technology he saw on the previous screen (one of the more advanced technologies towards the end, or right side, of the Technology Advisor). After choosing a technology, the left hand student expressed amazement at the complexity of the technology choices in the game.

Following, in the second episode of the sequence, the Technology Advisor plays a larger role in selecting a technology to research (and a game strategy). Pair behavior showed a greater understanding of the complex relationship between the game goals and the selection of a technology.

Initially, a similar process of unlocking a technology is presented, and the pair is presented with a menu of technologies to choose from. The pair began the process of selecting a technology to research:

L: What should we (.) 'Code of Law'? ((*Scrolling through the list of technologies that can be researched next*))
((*Some technology items have the word 'Recommended' after them*))

Similar to Figure 61, the game has some built-in artificial intelligence, making some recommendations for technologies to research:

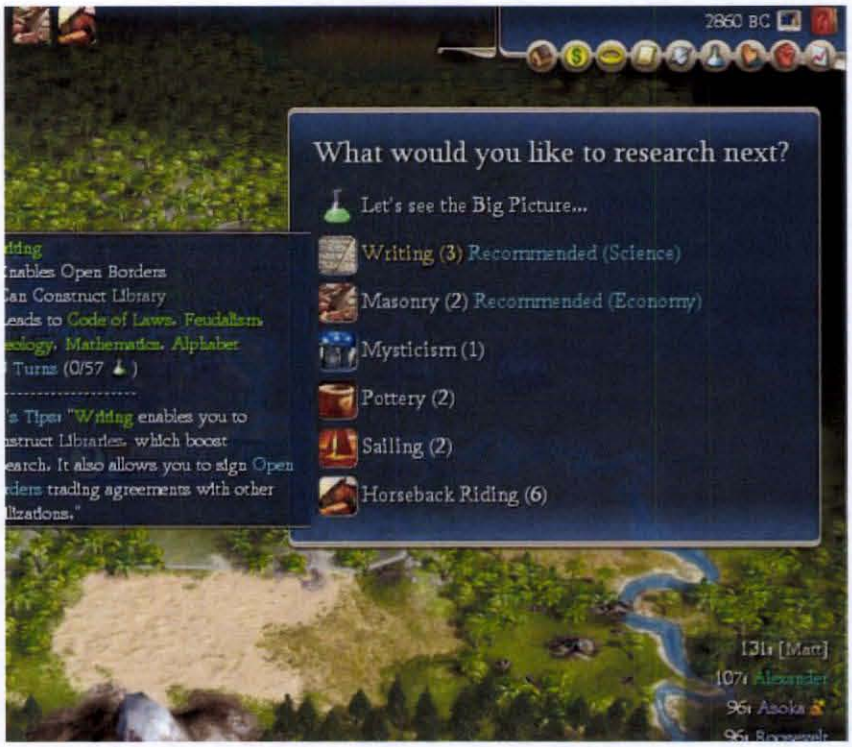

Figure 61: Recommended technology items in *Civilization IV*

The game does not enforce the following of its recommendations; however, the representation can be used to aid selection of a technology item. A modest amount of built in game intelligence (detecting player behavior) can be very

useful to beginners in the game, helping them make good selections for initial technologies to research.

Following, the pair decided to make use of the Technology Advisor in the selection of their next technology by clicking "Let's see the Big Picture...":

```
R:  Hold on.  Look for other kind (.5) click on 'Let's
see the big picture' (('Let's see the Big Picture…'
pulls up the 'Technology Advisor'))
¤<1159936>  (1.0)
```

Next, a key question was presented by the right hand student, exhibiting understanding:

```
R:  What do we need? ((Looking at the 'Technology
Advisor' screen))
¤<1164032>  (.5)
R:  Hold on.
L:  ((Laughs))
R:  Like, what stuff do we have that we (.5) Mining
leads to Masonry?
```

The right hand student, in viewing the Technology Advisor, questions what the pair would most benefit from selecting to research. At the end, he displays knowledge of the meaning of the visualization: "Mining leads to Masonry" conveys the representation is understood, as "leads to" is substituted for the white line between technology items, which conveys contingencies.

Meanwhile, the left hand student explored some of the technologies, and discussed his interpretation of the colors of items:

```
L:  ((Mouses-over different technologies listed in the
'Technology Advisor'))
¤<1171711>  (1.0)
R:  ((Looks over to peer team's screen))
L:  I think the green ones are the ones we have.
((Scrolls through 'Technology Advisor' screen from
left to right))
¤<1182120>  (.)
```

Interpreting colors of items in the Technology Advisor is equally important, as it conveys the items that the pair has already obtained (green), as well as ones that have not yet been unlocked (blue). Accordingly, the representation given by the Technology Advisor shows both a history of completed action, as well as potential futures (of potential actions). In Figure 62, a view of the Technology Advisor is shown with the mouse-over of one of the items on the screen (the mouse cannot be seen in the screenshot; however the pointer is currently over 'Monarchy'):

Figure 62: Additional information about technologies in *Civilization IV*'s Technology Advisor

L: We should probably get this. Says it leads to Monarchy. ((*Mouses over 'Monotheism'*))

L: ((*Monotheism is not colored green*))

¤<1185752> (.)

R: 'Monotheism'?

L: Yeah.

R: Really? ((*Laughs*))

L: Oops. ((*Didn't click on 'Monotheism' from 'Technology Advisor' screen wrong menu popped up*))

¤<1190680> (.)

L: Alright ((*Clicks 'Monotheism'*)), now I think we can get other guys. ((*Scrolls across map*))

¤<1196318>

Above, the pair makes use of the Technology Advisor to select a strategy. The representation provided by the Technology Advisor seems to affect the choice of a strategy. The pair saw the item 'Monarchy' on the display of the Technology Advisor, something in the future that they deemed important (or wanted to obtain), and therefore chose to select 'Monotheism' as their next technology to research.

It is important to note that the representation offered by the Technology Advisor, showing both past action and future potentials for action, was referenced in the pair's negotiation of a technology to research. Students illustrated this in their behavior of selecting technologies and through their discussion such as: "what do we need?", "mining leads to masonry", and "you can get advanced in this game". Without the Technology Advisor, the reasoning behind the choice of a technology to research may not have been as clear, and goals probably would not have been as well developed (for example, Monarchy would not have been a part of their future goals).

Additionally, the Technology Advisor is a persistent icon on the screen, facilitating cognitive offloading of information by students. Students are not required to remember all the technologies they have unlocked or future

technologies (and contingencies) that they wish to pursue, as the Technology Advisor can be pulled up at any time by the pair to aid their strategy development.

5.3.3 Summary

In the development of game strategies, pairs illustrated the key role of game visualizations in plotting their strategies and future courses of action. Well designed representations often highlight a particular game function, focusing on past actions (a recorded history), as well as possible future actions. Much of the discourse relating to game strategies was focused around specific representations provided by the game interface.

For example, *Civilization IV*'s Technology Advisor clearly presented the relationships between different technology items in the game. Students readily understood the visual information. This enabled them to properly interpret screen elements like colors and lines between items. Secondary and tertiary sources of information aided interpretation as well by helping to lower uncertainty.

5.4 *Game Cues Grabbing Attention, Redirecting Focus*

Particular visualizations served the purpose of grabbing attention and occasionally redirected the pair's focus to a different task. Often suggestions for action were made by the game by using some sort of built in intelligence that detected an unused game feature. Messages can come from a message console, as in *RollerCoaster Tycoon 3*, or from blinking icons as in *Civilization IV*. Additionally, failure caused attention to shift to other tasks and impacted player motivation, depending on the kind of failure experienced. Seven examples are presented in this section highlighting situations where attention was shifted by a particular game feature (the first four examples) and by failure (the latter three examples).

5.4.1 *Game Messages Leading to Staffing Changes in RollerCoaster Tycoon 3*

In the following example from *RollerCoaster Tycoon 3*, the pair was working on another task in the game when a message from the game console grabbed their attention:

> L: High flyer has got its doors stuck open. ((*Pop up window appeared stating that High Flyer has its doors*

```
stuck open; suggesting to send a maintenance person))
NO!  Go to high flyer.
```

Upon reading the message, the pair's attention was redirected to a broken ride called 'High Flyer'. Following in Figure 63 is a similar view of *RollerCoaster Tycoon 3*, highlight the game message console:

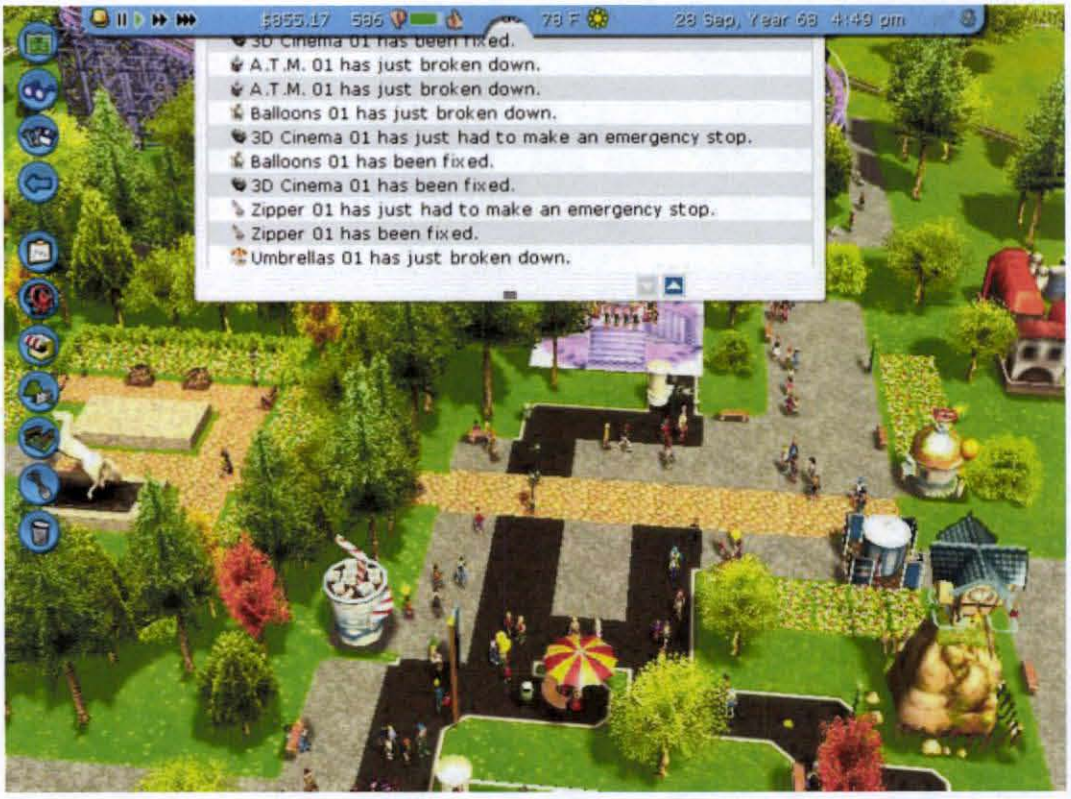

Figure 63: The game message console in *RollerCoaster Tycoon 3*

When a game message appears, the white drop-down box appears as above, along with a beeping sound. Messages display information about park operations such as rides breaking, being fixed, staff quitting, etc. At any time,

this information can be pulled down by dragging the edge of the message console down, or can be pushed back up into the top menu by dragging the bottom edge back up. This allows the display of more or less history of game console messages. Clicking the icons next to the information will focus the camera view in the park on the corresponding ride or attraction.

Before continuing with the episode, the representation of the game message console should be discussed. First, it appears as a list, and can be dragged up and down to display more or less of a history of messages. By default, the message console is 'tucked' into the blue menu above it, and will slide down whenever a new message appears (along with a beep). After a few seconds the message will be tucked back into the above menu. This behavior serves game players by giving them an opportunity to read the message and continue game play however they choose (it is not a forced redirection of attention).

While the game messages are an interruption, it should be noted that the interruptions are not context shifting. While messages can serve to direct attention elsewhere, they do not remove the game players from the context of whatever they were working on. Game players can choose to ignore the message, and the view of whatever was being worked on is not replaced or

obstructed. This gives control to the gamer of what to work on or manage. Alternatively, in other games such as *Civilization IV* or *Making History: The Calm & The Storm*, often these types of messages remove the gamers from the context of their work. For instance: in *Civilization IV*, when a technology is unlocked, a large pop-up window obstructs the view and a button must be clicked to dismiss it. In *Making History: The Calm & The Storm*, conflict notifications (of warfare) will replace the context of what the gamers were working on, which often redirects their attention elsewhere (as they often forget to return to the task they were working on). Again, this shows the importance of the design of visualizations: the design of representations and their behaviors affords certain kinds of action, and influence the communication being done regarding them. The message console in *RollerCoaster Tycoon 3* serves to inform without breaking context. Also, the way information is presented (as text) often results in reading the message out loud to teammates: potentially to ensure shared meaning exists with teammates, and to facilitate the beginning of negotiation of whether to pursue a related task.

Continuing the episode, the pair decided to try to find the broken ride by looking around their park, and the right hand student suggests getting a maintenance person to fix it:

R: Maintenance.

L: Where's High flyer?

R: Is that High flyer? ((*Points to a ride on the screen*))

L: ↓Yeah, probably.↓ ((*Clicks on the ride that R pointed to*))

¤<1642036> (.)

R: We should definitely raise the price on these huge long wait ones.

L: ((*Clicks on maintenance man icon*)) That ↑high↑ flyer?

R: Maintenance. (.5) Ok now he's going.

The pair verifies that the maintenance man is walking toward the broken ride in order to repair it. After selecting the maintenance man, the pair can "read his thoughts," similar to the representation at the bottom of Figure 64:

Figure 64: Staff thoughts in *RollerCoaster Tycoon 3*

```
L:  ((Clicked on maintenance guy walking to ride))
R:  ((Reading game dialog)) 'Put me down.  My work is
varied. Bored bored bored.' ((Reading thoughts of
maintenance man))
¤<1662405>  (.5)
```

Similar to selecting a ride, selecting a staff member of the park will create a view of a group of icons around the staff member for information and actions (as shown above in Figure 64). Each icon represents a potential for action.

Above, the pair clicked the second from the right icon to read the maintenance man's thoughts.

Following, the pair questioned whether they found the broken ride:

L: I don't think ↑that's high flyer is it?↑ ((*Scrolls over ride just chosen*))
((*Name of ride appears*))
R: I dunno. We should -
L: ((*High flyer does not appear for the ride chosen*)) >TUMBLER. That's tumbler.<
R: Oh shoot. Where's the high flyer?
L: ((*Changes camera view to find high flyer ride*)) Is that the high flyer? ((*Scrolls over the Chairswing to have name of ride pop up*))
R: No that's the Chairswing.
¤<1677029> (.5)
L: We don't have any more rides. ((*Changes view of camera again*))
R: Oh [there it is.]
L: [Oh there it is.]
R: Oh I didn't see that one.

After determining they were looking at the wrong ride, the pair found the ride that was actually broken. In the meantime, the maintenance man had walked to the broken ride, and automatically repaired it. Feedback came again through the game's message console, notifying the pair that the ride was fixed:

L: ((*Window pops up saying that high flyer has been fixed*)) >Has been fixed. Has been fixed.<
Maintenance guy did it.
R: ↑Try to click...↑
¤<1686230>

The pair realized that the maintenance staff had automatically repaired the ride, and the pair moved on to another task. A second episode demonstrated a different behavior by the pair when discovering a broken ride. This time, the pair discovered the ride was broken after seeing no activity on a roller coaster:

L: ((*Zoomed out from park*)) °Nobody's on this <u>ride.</u>°
R: ↑No one is on the ride?↓
¤<3071208> (.)
L: Well (.5) I don't know see. ((*Zooms out with camera*))
R: Is it broken?
L: Yeah.
¤<3076200> (.)
...
((*Points to maintenance man icon*))
L: ((*Clicks on maintenance icon*)) Oh [yeah.]
R: [Like I] mean this thing so he can fix it.
¤<3100207> (.5)
L: °Can I pick him up and have him go over° ↑here?↑
((*Maintenance guy is nowhere near the ride*))
R: I don't know.
¤<3104792> (.)
L: ((*Clicked on maintenance guy*)) °Well we need him

because we're losing money.° (.5) There he is. He's coming.

...

R: Fast forward it I hate it when it's dark. ((*The game has turned night mode on and screen is darker*))

L: ((*Clicks the fast forward button*)) Ok hopefully uh the janitor went to go or the -

R: ((*Yawns*)) Mechanic.

L: Yep. ((*Clicks on fast forward again*))

((*Zooms out from park*))

¤<3207491>

Behavior in this episode shows the pair expecting the repeated automation of the maintenance man, as represented by their lack of action. In the theme park, time can change from day to night, getting dark when night arrives. The pair sped up time in order to get the screen light (daytime) again. Following, the pair assumed the ride had been fixed by the mechanic.

5.4.2 *Redirection to a Path Problem in RollerCoaster Tycoon 3*

A similar redirection as above occurs in *RollerCoaster Tycoon* 3 after being informed by the game's message console that customers could not reach a food stand:

L: ((*Making a path around the new restaurants*))

((*Zooms in on park*))

R: °People are having trouble getting to the entrance

of burgers one.° ((*Reading from the drop down message console of the game interface*))

The message console seems to afford reading the message out loud, aiding in mutual understanding and in beginning the negotiation of a new task. The pair redirected their attention toward resolving the problem:

R: Oh maybe did just make a path. Try making, I don't get (1.0) Just try putting one right there. ¤<924486> (.)
L: It won't. ((*Trying to make a path from the burger stand to the main path so the people can get to the burger stand*))
R: Just delete the burger.

The right hand student suggests deleting the food stand rather than attempting to fix the problem. In *RollerCoaster Tycoon 3*, food stands must face their entrances toward an adjacent footpath. In this case, the entrance was not properly facing the footpath. In Figure 65, two stands can be seen: one with a connected footpath (a balloon stand on the left), and one without a connected footpath (a drink stand on the right):

Figure 65: Stands and adjacent footpaths in *RollerCoaster Tycoon 3*

In the middle of working on fixing the footpaths to the food stands, the pair was temporarily interrupted with another console message, read by the left hand student:

L: No we have to go to here. Tidiest park and safest park. ((*Reading from drop down menu*)) Nice.

R: Very nice.

¤<934007> (.)

L: Have you guys won that award yet?

Peer team: Which one?

L: [Tidiest Park and safest park.] ((*Reads from drop*

down message board of the game interface))

R: [Tidiest Park and safest park.] ((*Reads from drop down message board of the game interface*))

Peer team: Yeah we did.

L: Probably not.

¤<941839> (.)

L: ((*Laughs*)) We're super good.

¤<945927> (.5)

The 'tidiest' and 'safest' park awards are achievements awarded in the game. After reading the awards out loud, the left hand student focused attention on the peer team, asking if they had achieved the same award. It appears that competitive behavior can be prompted by achievements, as demonstrated by the questioning of the peer team's progress.

Following, attention returned to fixing the food stand:

R: Why won't it work? (.5) Ah we need bathrooms.

L: No we don't. ((*Laughs*))

R: People are gonna be like go on the side. ((*Laughs*))

¤<956862> (.)

L: ((*Clicked on 'facilities' icon*)) ((*Added a Balloon shop*)) ((*Placed the balloon shop*)) ↑Balloons?↑ What?

R: So you can buy a balloon. ↑I feel like we should um oh watch do this. Make a little path like this and we'll put a path of like all different stuff.↑ ((*Points to an imaginary path route around the park*

that R would like built))

L: Ok.

¤<966503> (.)

L: °Good idea.° ((*Clicked on 'Path'*))

((*Started to place a path around the burger stand*))

R: Then we will put a path right here by the burger place so people can get to it. Maybe if we put the burger place backwards. (.5) °Now can people go to it?°

Collaboration continued (following the end of the episode) between students aimed at placing food stands and making sure they connect to an adjacent footpath. As in the previous example, the game message console can interrupt and shift the focus of gamers, but does interrupt in a way that causes a loss of context from what was previously being done. A final episode showed success at connecting food stands to footpaths:

L: ↑Ooooo.↑ Can't mess with us. ((*Building a pathway around the ice cream stand*))

R: °Is it open now?° Put a pathway all around it. ((*Laughs*))

L: We'll decide where it is. ((*Laughs*))

((*Places path around the whole ice cream stand to ensure*))

((*By placing a path around the whole ice cream stand the customers were able to get to the entrance*))

R: You should put some benches over there. So people can sit.

¤<1238705>

By building a path all the way around each edge of the food stand, the pair ensured that customers were able to reach the food stand entrances. After placing a food stand, the pair seemed to struggle to determine which way the entrance was facing, and solved the problem by creating a path that encircled the entire food stand.

Several affordances are shown by the above game representations:

- The game console messages lend themselves to being read out loud, as was done by the students
- Messages highlighting a problem tend to shift attention to address the problem
- Messages focusing on achievement seem to have the social affordance of discussion and the checking of peer team progress

However, in *RollerCoaster Tycoon 3*, the console messages are designed in a way that does not interfere with current task: game players are not removed from their working context by default. Alternatively, the visualization style of combat reports after the end of a turn in *Making History: The Calm & The Storm* or technologies achieved in *Civilization IV* can pull gamers from their current

context or work. Both of these games are turn-based games, and the shifts in context occur after the end of a turn; therefore, game designers may deem the breaking of context acceptable (as focus on a task might be broken following the end of a turn anyway).

Above, some bragging to the peer team and checking their progress ensues after receiving an award in the game. In other games, similar behaviors could be observed after unlocking an achievement or the occurrence of major events (such as in the earlier episode from *Making History: The Calm & The Storm*, when students overhear the peer team declaring war early in the game and ask them how to follow suit).

An episode from *Making History: The Calm & The Storm* demonstrates a similar redirection (as the above example) from a console message, and is available in Appendix H.4. For brevity, the episode will not be discussed here, however a similar pattern of responding to a textual game message was observed.

5.4.3 Game Redirection and Suggestion in Civilization IV

An episode from *Civilization IV* shows the benefit of having some built in adaptivity in the game. In this case, the pair had been playing the game for some time without building a second city (they had previously built their capital city,

but were not expanding their civilization by adding cities). In the following episode, the game detected that the pair would benefit from building more cities, and presented a flashing icon (to build another city) after the pair selected a settler. This drew the pair's attention to the icon, similar to that which is shown below:

Figure 66: Suggestion of action by game interface in *Civilization IV*

In the above figure, one of the Settler's action items appears highlighted and flashing in blue (the fifth and last icon in the bottom-center of the screen). This seems to be a recommendation by the game to make use of the action, based on

some behavior detection by the game (game intelligence). In the corresponding episode, students' attention is shifted to the glowing icon:

R: ↑What are these people doing?↓ ((*Scrolled cursor over to group of warriors at top of map*))
((*Game has an icon highlighted and blinking to build a city*))
¤<2962311> (.)
R: ↑Oh, you can, you can build a city! Anywhere!↑ I can build a city somewhere. I'm gonna send them somewhere else. ((*Scrolls around map to fight a spot for a new city*)) Like down here. Like right here I can build a city. ((*Points cursor to a spot on map*))
¤<2973747> (.)
L: Yeah do it right there. ((*Points to a different spot on the map*))
R: ((*Scrolls over to spot where L suggested*))
((*Clicks on the spot*))
L: It can be like our defense city.
¤<2980072>

While students may have discovered the icon on their own, the representation of a flashing blue icon grabbed the attention of game players. After investigation, they appear excited after learning they are able to construct more than one city in their civilization. One of the students suggested it could be a 'defense city' as it lies near the border of their civilization.

While the game visualization of the icon is of interest, so is the game's built in intelligence to suggest a potential for action. After playing for some time without building a second city, the game chose to highlight the 'Build City' icon after the pair selected a settler (only settlers can build new cities). This simple behavior detection helped to streamline learning: while the pair may have eventually figured out how to build more cities, the game's ability to detect patterns in the pair's behavior was able to speed up the process. Effectively, the game served as a third peer in game play, suggesting action based on previous actions overlooked by the pair.

A little game intelligence can go a long way: other games might be able to benefit from similar strategies after detecting an unused feature in the game. The game representation does not force use of the object; it just creates a visualization serving to direct attention. This strategy works in the above episode, and might be utilized in other games. Game intelligence can detect player behaviors such as an unused feature or repeating cause of failure by game players. For instance, it would be helpful if *RollerCoaster Tycoon* 3 detected failure to control the camera angle (as demonstrated by the pair, after several minutes of focusing the camera view on a mountain) and followed with a suggestion to solve the problem (some sort of visualization that hinted to move the mouse to an edge of the screen).