The Impact of a Multi-user Virtual Environment on Teacher Instructional Time, Voluntary Student Writing Practice, and Student Writing Achievement

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This dissertation is dedicated to my incredibly supportive and devoted wife, Heather Marion Warren

This work is further dedicated to the rest of my family who have inspired, conspired, and listened through all of this:
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Abstract

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Two major obstacles to using PBL methods in K-12 classrooms are the time it takes to design the rich learning environment and the time required for students to interact at their own pace with ill-structured problems. The focus of this study was to determine whether game-design design principles can be used to both compliment a digital PBL environment and improve student learning. Further, this study sought to determine whether such a design could allow teachers to act as a challenger of poorly developed knowledge constructs instead of as a font of directional and procedural knowledge for students To answer these questions a digital learning environment was designed that used embedded scaffolds, nested goals, clue trails, narrative context, and explicit rules to improve student writing. This unit was part of a larger multi-user virtual environment, but was designed to be a self-contained unit that leveraged advanced technologies to establish an immersive experience for learning writing skills. The unit was designed to be two-times per week for four weeks in total length which included student training on the active role of a reporter who investigated mysteries taking place in a virtual town. The learner then composed feature stories relating their understanding of the mystery. A comparison class

was recruited and the teacher was observed teaching the same content and skill standards but through more didactic methods of instruction.

The results of this study showed that the treatment condition had decreases in teacher time spent answering procedural and directional questions, increases in the amount of voluntary student writing activity, and improvements in standardized achievement scores on prompts that consisted of writing tasks similar to those that students participated in during the treatment. Students engaged fully with the learning environment although several tensions emerged. These included tensions between student perceptions of teacher rules versus system rules, student play versus completion of learning tasks, and whether they should learn through the system by reading versus being told what to do. Student disabilities were also encountered during the study which placed the system under a different kind of test than it was designed for, though it successfully engaged these students as well. A final tension arose in the result of the research methods themselves, bringing home the point that a need to capture data may interfere with the learner's experience, possibly reducing or improving the impact of the treatment itself.

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1.0 CHAPTER ONE: INTRODUCTION

1.1 Introduction to the Problem

Successful English teachers have long co-opted the existing interests and activities of their students into their curricular materials and instructional practices. In some instances that may have involved encouraging a young man interested mainly in football to read an autobiography of Joe Montana as his book report choice. In others, teachers may provide optional topics for a required essay such as skateboarding, cheerleading, and favorite toys. Currently, playing video games is one of the more popular activities engaging children in their free time with a reported 35% of the most frequent players being under the age of 18 (Association, 2005). While academic motivations have been shown to decline, especially during the transition from elementary to middle school (Anderman, 1996), video game usage among all age groups has been steadily increasing for the last decade with one recent study suggesting that one in five gamers are individuals over age 30 are gamers (Association, 2005).

Over the course of the last two decades, student interest in video games has rapidly increased in the United States and throughout the world, helping lead to record sales that have outstripped Hollywood movies and spurred game driven economies that have real-world links and consequences. Software developers have tried, sometimes successfully, to leverage this interest into profits by creating “edutainment” titles such as the *Civilization* series, *Math Blaster*, *Oregon Trail,* and others that have shown links to learning when coupled with other forms of instruction such as guided reflection and group discussion (Bezzant, 1993).

However, some of these links are tenuous and poorly researched and many of the games include an impoverished narrative and uninteresting rule structures that fail to fully engage many learners

There is currently little research evidence to support the use of game design principles as part of the development of engaging learning environments. Formal studies are needed to determine the potential value of problem-driven digital learning environments that include game-like affordances such as embedded scaffolds, nested goals, clue resources, narrative context, and explicit rules (Crawford, 2003; Matthews, 2003; Salen & Zimmerman, 2004; Winn, 2002). The research into the promise of video games as a means to reengage students with learning is still largely unexplored. *Can game design principles that support the development of engaging entertainment activities that students spend hours playing voluntarily also be used to develop engaging learning spaces as well?*

This study will investigate this question by examining the experience of students using *Anytown*, a virtual environment designed as part of the Quest Atlantis project. Quest Atlantis is a learning and instruction project that uses a 3-D multi-user environment to immerse children, ages 9-12, in educational tasks. Building on strategies from the genre of online adventure role-playing games, it combines design strategies used in the commercial gaming environment with those from educational research on learning and motivation (Barab, Thomas, Dodge, Squire, & Newell, 2004). *Anytown* is a recent development in Quest Atlantis that was explicitly designed to include some core aspects of gaming

environments such as embedded directions, progressive achievement goals, clues, narrative context, and explicit rules.

1.2 Statement of the problem

Many claims have been made about the effectiveness of instructional media and software on student learning (Clark, 1991; Kozma, 1991). Further, some theorists in the field of education are making broad claims about the power of video games and learning environments to improve student learning (Gee, 2003; Jenkins, Squire, & Tan, 2003; Prensky, 2001; Salen & Zimmerman, 2004; Squire & Steinkuehler, 2005; Steinkuehler, 2004). E-mail list servs such as those created by the Serious Games group contain thousands of messages about projects that have been or are being developed to help students learn. However, much of the research that exists is either poorly documented or the findings questionable, especially in terms of studies that address changes in student achievement. We still do not know if the preparation and use of a digital videogame learning environment for instruction and learning correlates with improved student writing skills, mathematical reasoning ability, or any other academic activity that is measured by and is at the heart of the accountability movement in the United States. While we know that off-the-shelf video games like *World of Warcraft* and *Elder Scrolls IV: Oblivion* are engaging, we do not know if learning games can be designed that are equally engaging while still providing learning gains that match educational standards. By examining whether students are willing to complete voluntary activities that have learning

components within a digital learning environment, we will better understand whether these learning activities can be engaging in a way similar to those in non-learning games.

The specific research questions to be addressed by this study are:

1. Are there significant differences between teachers using the multi-user virtual environment context compared with an equivalent traditional context with respect to amount of time teaching? (data includes a checklist and observations for both comparison and treatment teachers)

2. Are there significant differences between students learning in a multi-user virtual environment context compared with an equivalent traditional context with respect to voluntary writing practices? (data includes non-required Quests and comparison writing activities)

3. Are there significant differences between students learning in a multi-user virtual environment context compared with an equivalent traditional context with respect to *writing achievement* as assessed on proximal and distal measures? (data will include in-class writing activities & student standardized writing)

4. How does learning unfold differently in a multi-user virtual environment context when compared with a more traditional context? (data includes field notes, interviews and student work)

1.3 Purpose of the study

The purpose of this study is to determine whether multi-user virtual environments that combine both strong instructional principles and basic game design principles can (a) reduce the amount of time spent by teachers answering redundant procedural and directional questions posed by student which are administrative in nature, not educational (b) increase voluntary student writing practice which acts as an indicator of student motivation to learn and has been correlated with improvements in student writing generally, and (c) increase student writing achievement as measured by standardized writing assessments. Further, the purpose is to describe the differences between how instruction takes place in the designed learning environment when compared with instruction in a more traditional learning context.

1.4 Hypotheses

The directional hypothesis of the first question is: The amount of time that the teacher spends answering procedural and directional questions regarding the assigned and optional writing tasks in the treatment condition will be, at a statistically significant level, less than the amount of time spent by the teacher providing instruction in a face-to-face, traditional classroom.

The directional hypothesis of the second question is: The number of non-required writing activities completed by students in the treatment condition will be, at a statistically significant level, greater than the number of non-required writing

activities completed for writing practice by students in a face-to-face, traditional classroom writing unit that includes the same objectives.

The directional hypothesis of the third question is: The quality of student descriptive writing achievement in the treatment condition will be, at a statistically significant level, greater than the descriptive writing achievement of students who receive instruction in a face-to-face, traditional classroom writing unit that includes the same objectives.

The qualitative focus of the observational data in this study will be on the conception that learning in a more traditional classroom context will unfold in different ways from the learning in a multi-user virtual environment context.

1.5 Overview of the dissertation

The second chapter of this dissertation discusses the literature on relevant learning theory, beginning with problem-based learning, which undergirds the design of the learning environment, prior to delving into the existing and proposed uses of video games, simulations and digital learning environments for learning. Next, the literature linking these two concepts is explored as it relates to teacher time on task during instructional episodes. Further, the literature informing writing from the area of language education is surveyed. Lastly, Chapter Two explores learning environments within Quest Atlantis and outside of it that inform different content areas, but have similar underlying design constraints and affordances.

The third chapter then delves further into the design methodologies that informed the development of the 3-D multi-user virtual environment prior to implementation. The fourth chapter discusses the research methodologies used in this study for data collection and analysis. In addition, the chapter defends their appropriateness for this study. The fifth chapter presents results from the study. Presented are the quantitative results of the first three research questions: 1) comparison of teacher time on task, 2) comparison of voluntary writing activities completed, and 3) achievement scores.

The sixth chapter presents a qualitative ethnography that presents the comparison and treatment classes to illuminate the differences between the unfolding of instruction and learning in the treatment classroom when viewed in contrast with the comparison classroom. The seventh chapter presents implications of these findings and notes suggestions for future research.

1.6 Definition of terms

The following definitions are drawn from Gall, Borg, and Gall (1996) except where noted.

Analysis of Covariance (ANCOVA). This is a procedure for determining whether the difference between the mean scores of two or more groups on one or more dependent variables is statistically significant. When the groups have been classified on several independent variables (called *factors)*, the procedure can be used to determine whether each factor and the interactions between the

factors have a statistically significant effect on the dependent variable, after controlling for the extraneous variable.

Case study. A qualitative research method that studies a single instance of a learning or curricular act.

Chat. Computer mediated communication in the form of electronic text exchanged by users present in the same digital space.

Codes. Descriptive identifiers used by qualitative researchers to interpret textual data.

Gain scores. A score equivalent to a posttest score minus a pretest score. Also known as Change or Difference scores.

Factor. In a factor analysis of a set of variables, a mathematical expression of a feature shared by a particular subset of the variables.

Game. A game is a system in which players engage in an artificial conflict that is defined by rules and results in a quantifiable outcome (Salen & Zimmerman, 2004). Games include the following components: system, players, artificial boundaries between virtual and real, conflict, rules, and a quantifiable outcome.

Implementation. The use of a designed curriculum or curriculum-based learning environment for a set period of time.

Multi-user virtual environment. These are digital environments that allow many simultaneous participants to engage in virtual contexts, interact with digital objects, represent themselves as “avatars,” communicate with other

participants, and, using their avatars, participate in collaborative learning activities (Dede, Ketelhut, & Nelson, 2004).

Pedagogical agent. "(C)omputer characters that are tied into an artificial intelligence backend. The agent is 'embodied' - meaning it has a visual representation - and can detect external stimuli such as keyboard input, mouse position, and mouse clicks. The AI backend has a mood and behavior system to simulate human emotions and actions, as well as various components tied to learning. This agent has the potential to motivate, engage, involve, and adapt to the individual learner (Slater, 2000)."

Problem-based learning. Stemming from the work of Howard Barrows (1986) with medical students, problem-based learning has evolved for use in all educational settings. Problem-based learning is a sub-segment of the social constructivist learning movement (itself a sub-segment of post-modern contextualist views) which holds as its core tenets that "truth" and "reality" exist in the world for humans to seek; however, because of our limited tools for understanding this "truth," humans must use the only means of establishing it by social negotiation of the content, rules, and values that make up their shared reality as they seek answers to the fundamental philosophical questions about correct actions, consequences and the nature of "truth" (Bernstein, 1983; Hollis, 1994). The core learning aspect of problem-based learning is an authentic, ill-structured problem which is posed to groups of students which the learners must then wrestle with; they then develop a within-group, socially negotiated solution to this problem. Authentic problems stem from the local, state, and national

situations of the learners and are within the learner's zone of proximal development (Vygotsky, 1978) so that the solutions that the learners generate can have real-world impact. The teacher acts as a modeler of appropriate behaviors, provider of resources, and challenger of poor knowledge constructs through cognitively-challenging questions. Outside experts, peers, and the learners themselves engage in assessment of the solution that is presented by each group, also acting to challenge the value of the solution and its practical viability.

Questers. Any child who works on Quests in Quest Atlantis.

Quests. Written learning activities in Quest Atlantis.

Simulation. At its simplest form, a simulation is "an abstraction or simplification of some real-life process" (Heinich, Molenda, & Russell, 1993). Simulations are commonly used to model abstract ideas, scientific processes, and physical actions that become visible through digital or corporeal representation. They are especially valuable in instances when the physical action, such as flying a plane, is extremely dangerous, because the learner can practice skills in a non-fatal environment while they still receive important feedback on their performance.

1.7 Limitations

There are limitations to the generalizability and validity of the proposed study, due to both the choices made when developing the study and to unavoidable problems that cannot be completely controlled. The first threat to validity is that teacher in the comparison group may already have a high level of ability and knowledge relevant to teaching a problem-based learning in a face-to-face learning environment.

Another threat to the validity of the study is the use of only two intact classrooms. This flaw will result in limited generalizability of the results of this study to other classes and contexts. It is also possible that, because these are both intact classrooms with independent histories of student-teacher interaction, that differences may also be due to teacher style of instruction in the comparison classroom and not because of the treatment itself.

Taking a group from only one part of the state will also reduce the validity and reliability of the study. Due to the cultural differences between students within the classes themselves, the scores will be more or less valid dependent on the students' personal experience and relationship to the questions presented in the pretest and posttest. The reliability will also suffer, because the scores of the students will not be easily reproducible due to these cultural differences. Also, the different types of academic ability found among students are not reflected in the change or gain scores of test taking students.

Statistical regression toward the mean is another limitation faced by the study because students who score high on a pretest tend to earn lower scores on

the posttest, and students who score lower on the pretest tend to score higher on the posttest. Therefore, those students with high writing ability prior to the treatment will be seen to have made smaller gains, though they may be at or well above their grade level in terms of ability. Pretest-posttest scores also regularly have a low reliability when there is a high correlation between pretest and posttest scores. The reliability of the gain scores is in turn influenced by the amount of unreliability of the individual pretest and posttest scores.

Further, in terms of the generalizability of the qualitative data, there is expected to be some generalizability to local students, although drawing conclusions in terms of a larger state or national population would likely be fallacious due to the local nature of the student and teacher experience as part of the treatment sample. However, this data's use in terms of framing the quantitative findings, identifying confounding or mitigating factors, describing the learning experiences of students and teacher, and in future design and development of instruction makes it valuable.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

The purpose of this study is to determine whether multi-user virtual environments that combine both strong instructional principles and basic game design principles can (a) increase voluntary student writing practice, (b) student writing achievement, and (c) reduce the amount of time spent by teachers answering redundant procedural and directional questions posed by students.

The proposed study will address the following research questions: (1) does the use of multi-user virtual environments that combine both strong instructional principles and basic game design principles lead to increased *achievement in writing* by students? (2) does the use of multi-user virtual environments that combine both strong instructional principles and basic game design principles lead to increased *voluntary writing practice* by students?, and (3) does the use of multi-user virtual environments that combine both strong instructional principles and basic game design principles *reduce the amount of time* teachers spend answering procedural and directional questions?

In order to address the research question, both the theory supporting a problem-based learning approach to instruction and the research that supports the actual design of the 3-D space must be explored. If a problem-based learning-style, media and content rich digital environment is expected to impact student improvement in writing, student motivation to practice writing, and reduced teacher time spent providing task direction, what is the evidence that leads to this hypothesis? The chapter includes sections on (1.) Writing and

literacy theory, (2.) Learning theory, (3.) Game and simulation theory, (4.) Teacher time on task, (5.) Existing learning environments, and (6.) Instructional design versus game design, and (3.) Summary.

2.2 Writing and literacy

Since the inception of the written word, many forms of instruction have been developed to aid learners in improving their skills at constructing comprehensible texts for the consumption of readers. These forms have run the gamut of repeating behaviors by copying illuminated texts in order to improve the writing of the words themselves, the generation of new texts in response to the prompts of instructors that were meant to engage in the creative process of writing, and, more lately, providing five and six step processes for the creation of a written text that helps to ensure the characteristics of good writing through editing and revision prior to publication. Other methods have also emerged based on later models of instruction from the social constructivists, technology integrators, and bilingual educators.

The goal of this study is to design and test the use of an educational game to support student practice of a six step writing process within the context of a virtual learning environment similar enough to the learners' own that transfer of their practiced skill can reasonably be expected to occur. This section provides a.) an overview of the six step writing process that is scaffolded within the *Anytown* learning environment, b.) a view of constructivist learning environments that helped inform the design, c.) past and current uses of technology to support

writing practice, d.) and efforts to blend technology and social constructivist learning theory in support of foreign language learning.

2.21 Constructivist writing

The constructivist approach to learning to write, as evangelized by Schwartz and Bransford (1998), emphasizes not just telling a story, but focuses instead on using perceived differences to establish contrasting cases as a means of activating student prior knowledge to prepare them for new learning. This form of writing engages students by linking their writing not only to their existing knowledge structures, but also leverages past understandings so that new knowledge is not disjointed and is instead grounded in a shared reality agreed upon by reader and writer. The early results of inquiry into this method have not shown much improvement over more traditional writing methods to date, but fits well with the problem-based learning perspective (Chatel, 2003; Cramer & Smith, 2001; Egbert & Hanson-Smith, 1999; Matthews, 2003; Vilmi, 1999; Windschitl, 2002). For example, one study by Langone, Malone, Stecker, and Greene (1998) examined the use form of constructivist writing based on the concept of "anchored instruction" (Vanderbilt, 1990) focused on multimedia technology use that was used to aid students in writing in a post-secondary learning environment. This early study found that *traditional instruction fared better* on pre-post essay test comparisons with a treatment group that used instruction anchored in video disc and CD-ROM case-based examples [$F (1, 98) 18.20, p < .0005$].

Further, using one-way analysis of variance tests, no significant differences between the traditional [F (1, 98) = 18.20, p < .0005] and treatment classes on multiple choice items were found. However, using a standard t-test, the pre-test scores for the anchored instruction group were found to be significantly lower that the post-test [t(42) = 9.70, p <.0005], and follow-up scores [t(42) = 5.62, p , .0005]. Also of interest is that the participants who were treated using anchored instruction performed better on multiple choice items than on the essay for the pre-test [t(42) = 8.29, p < .0005], post-test [t(42) = 10.42, p , .0005], and the follow-up test [t(42) = 10.42, p , .0005] which indicated an initial preference for multiple choice-type tests over essay tests with the treatment group from the inception of the study. Predictably, the participants in this group had significantly higher scores on the multiple choice follow-up test than the traditional instruction group [*F* (1,97) = 5.85, p <.01], while the reverse was true for the essay test [*F* (1,97) = 7.32, p < .008].

The researchers suggest that the format of the assessments and the instruction itself were likely problematic and it would be better to focus on strategies like technology-based problem solving activities which may be more likely to lead to transfer of learning from the immediate context to future learning and assessment tasks. While this study focused on more advanced learners, the fact that the strategy failed with students who, by their age and experience, should be better able to cope with innovations than younger learners, makes the lesson of these findings even more valuable for informing the design of a learning environment focused on improving writing for younger students.

Part of the challenge of addressing the problems of constructivist writing methods is that researchers who do not find significant results are less apt to want to publish their findings and journals are less willing to publish findings that show the failure of a curricular design than to publish successes. Without access to information about failed experiments, instructional designers and theorists wishing to move forward with new designs are more likely to simply repeat the mistakes of other researchers instead of identifying innovations and finding success.

2.22 Writing and technology

Technological tools for aiding students with writing have become prevalent since the boom in computers in schools starting in the mid-1990s. Microsoft Word™ is used by many teachers for publication of final student writing products as well as for its spelling, grammar checking, and thesaurus features. Technology for writing has also shown improved attitudes toward completing writing tasks (Beck & Fetherston, 2003). However, concerns about student over-reliance on such features have surfaced because of the belief that if students do not have to worry about learning to spell, use proper grammar, or expand their vocabulary, their general literacy skills will decrease (Puntambekar & Hubscher, 2005). Therefore, the unease is that students will become entirely dependent upon the technology for all writing.

Despite this unease, studies into the use of hypertext as a tool for increasing student interaction with text have found that the use of hypertext

improves student writing in science and social studies as a result of providing improved resources for writing workshop-style writing processes (Chatel, 2003). Further, the use of hypertext has also shown improvements in reading whether implemented as part of Literature Circles in which students take critical perspectives on written texts or engage with WebQuests that guide students through scaffolded questions regarding the readings or other student writing that they have recently engaged with as part of their class. This critical ability has shown itself to be important if it is to be used to foster the construction of shared knowledge (Duffy & Cunningham, 1996; Elder & Paul, 2002; Everett & Zinser, 1998; Jonassen & Hernandez-Serrano, 2002; Windschitl, 2002).

Other technology tools such as Inspiration™ and Kidspiration™ have been recommended to teachers and studied as tools for brainstorming and organizing ideas. Brainstorming and outlining processes are pre-writing activities that many teachers expect will take place prior to writing the rough draft of a text. Corporation sponsored research into the use of these tools has shown improvements in the organization in student writing and more imaginative topics than without such tools (Inspiration Software, 2004). However, other forms of graphic organizers without a technology component have been found equally effective (The Institute for the Advancement of Research in Education (IARE) at AEL, 2003). Online tools such as TELE-WEB have been correlated with significant improvements in student learning by scaffolding student writing using alternative tools that link students to human tutors or embedded writing strategies

similar to those their teacher employed in the classroom (Englert, Manalo, & Zhao, 2004).

Another instance in which technology has been used to improve student writing employed distance technology to create digital pen pal correspondence between students in the United States and students in other countries. These pen pals engaged in a five stage writing process similar to the six stage process discussed in the last section. Findings from this study showed improvements in writing for both sets of students in the U.S. and those in other countries, constructing shared knowledge of the characteristics of good writing (Roberts, 2004). This cooperation between schools in U.S. and foreign schools leads to another topic, which is the use of technological innovations to improve English as a Second Language, bilingual, and English as a Foreign Language learning.

2.23 Computer-assisted language learning environments

Computer-assisted language learning, more commonly known as *CALL*, is a theory of language learning that focuses on using the audio-visual, tactile, and interaction affordances of computers to improve student acquisition of second and foreign languages (Egbert & Hanson-Smith, 1999). While many of these products are stand-alone CD-ROM-based computer programs, teachers are increasingly using online learning environments to improve language learning (Vilmi, 1999). Environments like *Tapped In* (http://www.tappedin.org) are now used in English as a Second Language and English as a Foreign Language classrooms to allow primary language speakers and secondary language

speakers to meet online. During their interactions, second language speakers are able to clarify questions about idiom, grammar and spelling rules, as well as discuss cultural issues relevant to learning a foreign language from a peer. Inquiry in this area is under way, but is mainly conducted by researchers in fields lacking knowledge of message design, media design, or production that would generate studies that are more valid.

2.24 The writing process

One common approach to teaching writing in the last decade involves using a step writing process for writing essays in response to prompts (Cunningham, Cunningham, & Allington, 2002). These processes range from two to "6+1" steps in length, often depending on the goals of the writing and the age of the writer (Richards, 2002). One common example of this process includes the following steps: 1.) prewriting, 2.) rough draft, 3.) peer editing, 4.) revision, 5.) teacher editing, and 6.) publication. Several versions of the six step process for creating a written piece have been in vogue in the United States for at least a decade. By participating in this process, it is expected that students will produce pieces of writing that are superior to those that employ a more organic, emergent perspective of writing while they are given a simple structure to follow that includes opportunities for feedback and revision. Calls have come from the National Writing Project (Totten, 2003) for ensuring that step writing processes become the norm for elementary school writers across the country. One study on the use of six step writing processes have shown improvements in the quality of

student writing which includes a reduction in grammar errors, improved standardness of language use, and improved internal structure (Englert et al., 2004). Other studies have correlated the step writing process with improvements for students with reading and writing disabilities by allowing them to compose coherent responses because the process provides a structure to follow, feedback on each step, and opportunities for revision (Cunningham et al., 2002; Diliberto, 2004; Fink-Chorzempa, Graham, & Harris, 2003). When combined with the use of computers for typing their responses, research has also found that students produce longer responses to prompts, edit and revise as they write, and engage in a more social process of writing with peers than with pen and paper (Cramer & Smith, 2001).

The goal of this study was to situate a six step writing process scaffolding for improving student writing within a problem-based learning environment that leverages strategies used in video games. As a result, the next sections present literature and research related to problem-based learning theory, games and simulations, and then provides more detail on learning environments that integrate game-like elements within their broader instructional designs. The following section on learning theory provides the lens through which this work is meant to be viewed and by which the design of the *Anytown* unit was completed.

2.3 Learning theory

2.31 Post-modernist views of learning

According to Bernstein (1976), there are three major perspectives in the philosophical tradition that ground most human activity: a.) positivist, b.) relativist, and c.) contextualist. The positivist stance is that which underlies most technological advancement since the time of Descartes; this view understands the world and everything in it as machines that may be broken down into their constituent pieces and therefore can be understood. From positivist perspectives, *there is objective truth in the world* (ontology) that *we can know* (epistemology) *through our senses* (methodology.) This view still holds dominance in the United States as legislated through the No Child Left Behind Act (Education, 2002) that governs most public education systems in this country. Because of the belief that there is an objective reality that can be counted and measured, it makes research using objective tests based on standards, observations of behaviors, useful to researcher's that proscribe to the positivist view

However, the relativist view of the world in which the belief is that there is *no objective reality* (ontology) that we can know because *reality is completely specific to every individual* (epistemology) and we can only gain glimpses into the realities of those individuals *through their self-reports and long-term hermeneutic observation and analysis* (methodology) (Bernstein, 1983; Hollis, 1994). Even then, the views of that reality that we derive from observing these individuals will be skewed based on any researcher's individual experiences and evolved reality. Everyone's reality is relative to someone else's and therefore attempts to

generalize the findings of research will be useless; everything that we observe is subjective.

Bernstein's final category, contextualism is a philosophical tradition that stems from the postmodern philosophical perspective of the late 1960s and 1970s. Within this view, *there is an objective reality* (ontology), but *we can only know small parts of it* (epistemology); further, despite the existence of this reality, the one we must live in, with its rules, social mores, consequences, and rewards, is generated and understood only through *shared negotiation* (methodology) with other individuals who live in and share the reality. Hence, the specific situation in which the individual finds themselves defines the manner in which they perceive the nature of reality. However, because of the situational or contextual nature of each person's reality, one person cannot really know another person's reality and it is only through communication that an approximation may be perceived (Baudrillard, 1994; Cubitt, 2001; Derrida, 1997; Prawat & Floden, 1994; Saussure, 1974; Wittgenstein, 1968). Resulting from this philosophical perspective, the social context in which knowledge is constructed and held, or in which a learned skill is to be applied holds central importance.

This last view, contextualism, is the foundation of the design of the learning environment researcher for this paper. It is an attempt to meet the needs of two master's, positivist achievement measures and a contextualist view of instruction through interactions with a rich learning environment, ill-structured problems, and challenges by instructor, peers, and experts, that had to be balanced as the design of the instruction and interactions within the environment

unfolded. However, it was a very specific form of contextualism called *social constructivism* that informed this design.

2.32 Social constructivism

Grounded in the contextualist philosophical tradition is the social constructivist view of learning and knowledge. The idea that there is an objective reality, but we cannot know it objectively is central to the philosophical approach of the social constructivist. It is only through socially negotiated agreements that we can communicate, act, and work, never really knowing one another's reality (Prawat & Floden, 1994). As defined by Duffy and Cunningham (1996), constructivism is:

> "(T)he general view that (1) learning is an active process of constructing rather than acquiring knowledge, and (2) instruction is a process of supporting that construction rather than communicating knowledge" (p. 171).

The idea that learning involves an active, central participant in the learning process contrasts with behaviorist, mechanist and modernist philosophical views in which the learner merely imitates the desired behavior and is an empty vessel, waiting to be filled with knowledge (Baudrillard, 1994; Cubitt, 2001; Wilson, 1997; Winn, 2002; Wittgenstein, 1968). This distinction is an important one and is central to constructivism as is the novel idea that the learner is responsible for

constructing their own knowledge through their interaction with dilemmas presented by the others in the social context in which they participate (Duffy & Cunningham, 1996).

2.33 Problem-based learning

2.331 What is problem-based learning? Problem-based learning was popularized by Howard Barrows (1986) as an instructional method to prepare medical students for real-world problems by letting them solve medical problems based on real-life cases, rather than relying on lectures that provided information out of the context of practice. This practice related to problems that approximate those which students may face professionally is expected to contribute to student negotiation of knowledge that they generate with peers as situated within both internal, psychological and external, authentic contexts (Kolodner, 2002). Savery and Duffy (1995) offer the following propositions by way of illustrating the fundamental tenets of problem-based learning:

> "(1.) Understanding is in our interactions with the environment … (2.) cognitive conflict or puzzlement is the stimulus for learning and determines the organization and nature of what is learned … and (3.) knowledge evolves through social negotiation and through the evaluation of the viability of individual understandings." (p. 1-2)

These general principles guide the design of learning environments that allow students to engage with each other as they encounter difficult problems that have no single answer, but solutions must be developed and shared understandings

evolve among students as they struggle to build solutions to authentic problems. Research related to problem-based learning suggests that using authentic contexts can be correlated with increased student-student interaction that allows students to cooperate in more meaningful ways with an *ill-structured problem* (in contrast to a well-structured problem), and can spur them ask more complex questions that result in better shared understandings among learners of the complexity of both problems and solutions (Ge & Land, 2003; Jonassen & Hernandez-Serrano, 2002). According to Jonassen (1999), an *ill-structured problem* is one that has: (1) unstated goals and constraints; (2) multiple solutions, solution paths, or no solutions at all; (3) multiple criteria for evaluating solutions; (4) uncertainty about which concepts, rules, and principles are necessary for the solution or how they are organized; (5) no general rules or principles for describing or predicting the outcome of most cases; and (6) (a requirement that) learners …make judgments about the problem and to defend their judgments by expressing personal opinions or beliefs (p. 219).

A number of tools are also discussed as supports for students' knowledge construction in Jonassen's conception of a Constructivist Learning Environment, which is a form of learning environment which is developed using social constructivist principles and is used to spur problem-based learning. They include (a.) cognitive tools to enhance student cognitive processing, such as visualization tools, (b.) static and dynamic knowledge modeling tools used to build models or simulations of real-world phenomena, (c.) performance support and (d.) information gathering tools for increasing student productivity in repetitive or

difficult tasks. A final set of tools are for (e.) conversation and collaboration with the purpose of providing a method or environment for collaboratively constructing socially shared knowledge within the context of the problem-based learning (Jonassen, 1999, p. 220-230).

The role of the instructor changes substantially in a constructivist learning environment. They are no longer a provider of information to be memorized as in traditional learning environments. They take on the role of a modeler of appropriate performance, an articulator of examples of the reasoning and decision making skills they want students to exhibit, a motivating coach there to trigger reflection as they keep an eye on and regulate the learners' performance, while scaffolding to support the learners as they encounter difficulty with the task or require alternative forms of assessment (Jonassen, 1999; Land & Zembal-Saul, 2003; Lin, Hmelo, & Kinzer, 1999; Vygotsky, 1978).

Problem-based learning in this type of environment requires a number of responsibilities on the part of the learner. This includes that students be self-directed, taking advantage of the great diversity of experience they bring to the ill-structured problem and that are open to learning when they experience a need to know or do something. Problem-based learning also requires that students engage in problem-centered tasks and that they be motivated by internal self-esteem, recognition, need for a better quality of life, and self-actualization rather than extrinsic rewards (Kolodner, 2002; Lin et al., 1999; Liu, 2003; Tiwari & Lai, 2002; Willis, 2002; Yip & Gafarian, 2002).

CLEs such as computer-generated simulations have themselves been used to guide students as they interact with ill-structured problems (Grabinger, 1996; Jonassen & Hernandez-Serrano, 2002; Winn, 2002). In the instance of learning environments such as Quest Atlantis' *Taiga* unit, students work on simulated real-world problems that arise naturally as they interact with the characters and objects that are embedded within the digital space (Barab et al., Under development). This interaction allows students to encounter authentic problems such as identification of the cause of the decline of fish in a river or the unintended consequences of their recommendations for action. By struggling with the ill-structured problem, it is expected that students will generate creative and critical solutions because they will be forced to develop cogent arguments in support of their hypotheses, test their hypotheses, and submit them for critique by peers, teacher, and possibly by experts in the field of water quality.

Because all knowledge constructions do not all hold equivalent validity, students must have a method for measuring the validity of the views they have developed. Teachers can create c*ognitive conflict* to perturb fallacious student knowledge constructions so that the development of new, more valid understandings can occur. Cognitive conflict is a primary element of problem-based learning and is considered a requirement for learning to occur throughout the body of research and theory regarding problem based learning (Barrows, 1986; Jonassen, 1999; Savery & Duffy, 1995). This cognitive conflict often comes in the form of perturbing questions posed by the teacher when they recognize poorly constructed student understandings. What is

problematic in K-12 classroom settings that engage in problem-based learning is that there is often little time for posing such questions as the teacher is primarily engaged in answering student procedural questions about how to do the work of learning.

2.332 Why is problem-based learning valuable? The general theory surrounding problem-based learning claims that the methods are useful in instances where learning outcomes are not predetermined by the instructor. Because many problem-based learning activities are designed to be open-ended learning experiences, they are expected to allow students to become self-directed, negotiate their understandings with peers, and choose the form their learning outcome will take, whether it be a dramatic performance that illustrates their solution, a Power Point presentation that provides the shared knowledge generated by a small group regarding the ill-structured problem, or a workable solution to an authentic problem that can be implemented by a real client which is tested by experts and consumers.

Despite these claims, the results of the use of problem-based learning environments are mixed. One positive qualitative finding correlates problem-based learning with improved critical thinking, noting that it:

> "(E)ncourages students to develop thinking skills including the ability to: (i) analyze and synthesize data; (ii) develop hypotheses; (iii) apply deductive reasoning to a problem situation; (iv) draw conclusions after analysis,

> synthesis and evaluation of new information; (v) synthesize strategies/solutions; and (vi) monitor and evaluate own thinking process."
>
> (Tiwari and Lai, 2002, p. 2)

It is this critical thinking finding that has spurred other authors to design technology-rich problem-based learning environments with the goal of improving analytical skills in learners from grade four through post-secondary. For example, Oliver and Hannafin (2001) designed what they call an "open-ended learning environment" called that includes "four main components: (a) enabling contexts, (b) resources, (c) tools, and (d) scaffolds" (p. 5). Enabling contexts are intended to help students work on problems in an authentic, situated space that presents the problems in meaningful ways. Resources such as data and texts allow students to solve problems while the tools assist students in processing and discussing information. Scaffolds based in these tools help students develop problem-solving strategies and guide their science inquiry into earthquakes. The findings of this study suggest that it is important to identify existing student knowledge constructions about the topic under study in order to use appropriate strategies to challenge poor constructions (Oliver & Hannafin, 2001). Further, they found that the use of simulations in a problem-based learning environment are useful for helping students build on small amounts of existing content knowledge, test and revise their hypotheses, and can help students refine their mental models given sufficient time. However, they also note that without sufficient, appropriate framing of the problems, students are prone to generate

only partial solutions to a large, self-selected ill-structured problem and suggest that students should be provided with additional scaffolding to guide them in narrowing the problem to something manageable. In addition, they noted that without sufficient feedback on their solutions combined with models of problem solutions, students often failed to provide adequate evidence to support their solutions which fell apart under direct challenge during summative reporting.

Other authors have set out to combine a problem-based learning approach with proven critical thinking strategies originally developed in other contexts so as to enhance the existing strengths of the approach while providing additional scaffolding for learners new to working in such an environment centered on mathematics, history, and science learning (Albanese & Mitchell, 1993; Brush & Saye, 2001, 2003; Diekelmann & Scheckel, 2003; DiPasquale, Mason, & Kolkhorst, 2003; Elder & Paul, 2002; Everett & Zinser, 1998; Keller, 2002; Kolodner, 2002; Willis, 2002; Zembal-Saul, Blumenfeld, & Krajcik, 2000). One technique for improving critical thinking has been to require student self assessment so as to encourage metacognition in students in order to revise their thinking and problem-based learning approaches, resulting in improvements in performance (Bransford, Vye, Bateman, Brophy, & Roselli, 2003; Meyerson & Adams, 2003). As a result of this increased metacognition, a problem-based learning approach is also expected to stimulate increased transfer as students are able to perform problem solving in a number of new contexts and settings as was found by Lin et al. (1999) in their study of a video game called *Alien Rescue* that was developed using problem-based learning principles. Qualitative studies

of this same game by Samsonov, Pedersen, and Hill (2006) found that despite the learning gains found by Linn et al, students in a non-cherry picked, at risk found that these students found the game boring, most students engaged in naïve strategies for solving the problems, few used the tools available to them to help organize their thinking, and that students were overly reliant on the teacher for help with the problems and often refused to work on challenging problems. Further, students who were most successful engaged in collaborative work with peers and worked intently on their solution

In a separate context of historical inquiry Brush and Saye (2003), studied the Persistent Issues in History Network online problem-based learning curriculum. They found that the use of online learning environments can be used to scaffold student learning through the use of embedded models, inquiry tools similar to those mentioned earlier by Oliver and Hannafin (2001), and contextual clues embedded within hyperlinked text. They note that by embedding such scaffolds, this reduces student cognitive load during inquiry and frees the teacher to act as a soft scaffold which is a provider of situational feedback to individual learners while concurrently probing student reasoning for areas of weakness to be challenged. Brush and Saye also note that it is a challenge to keep students on-task in such an open-ended learning environment, requiring the teacher to spend time refocusing students on the task at hand.

2.333 Problem-based learning and *Anytown*. It is the social constructivist theoretical stance and its subset, problem-based learning, that ground the development of the *Anytown* multi-user virtual environment that

was employed as the treatment in this study. Learner responsibility, whether taken in a face-to-face classroom context or in an online, digital environment, were taken as central to the completion of authentic work that has meaningful transfer to the future lives of the learners in the treatment group who will write for the rest of their lives. In the context of this digital curriculum, student responsibility comes in the form of the student taking part in a virtual community where they role-play working at an authentic writing job. As a new reporter at the ***Anytown*** *News*, students engage in descriptive writing tasks called Writing Quests that allow them to, with peers, negotiate the shared construction of knowledge about the presented situations and problems. Further, each learner may provide arguments in support of their decisions as they identify which details are most important to them as they write their feature stories and can employ their own sense of personal agency to tell their experiential and observational stories in their own way.

Learner knowledge constructions in the *Anytown* multi-user virtual environment are mediated by characters and objects in the learning environment who act as interactive scaffolds for lower level procedural and directional questions (Barab, Thomas, Dodge, Carteaux, & Tuzun, in press; Brush & Saye, 2001, 2003) in an attempt to free the teacher to challenge poorly developed student knowledge constructions by providing writing feedback through the computer system. The characters and objects that provide scaffolding are also known as “pedagogical agents” because they become a means of delivering instruction about writing, experiences for

learners to describe, and content in the form of stories about the lives of the characters which allow for rich description in the feature stories. These agents sometimes partially replace a teacher task such as explaining a particular viewpoint that is held in a conflict (Baylor & Kim, 2005), providing references for students, or redirecting students to the system.

By reducing the amount of time that the teacher spends on direct instruction or answering the same question repeatedly, it is expected that the teacher will instead be able to focus on perturbing poorly developed student knowledge constructs, providing direct feedback regarding the content and structure of submitted student work, and providing "soft scaffolds" (Brush & Saye, 2001) that aid students to overcome cognitive difficulties with the system, peers, or their own writing. In this problem-based learning influenced system, the teacher is also able to take on the role of a modeler of appropriate performance, an articulator of examples of the reasoning and decision making skills they want students to exhibit in both the virtual system and the real world, a motivating coach there to trigger reflection as they keep an eye on and regulate the learners' performance, while scaffolding to support the learners as they encounter difficulty with the task or require alternative forms of assessment (Jonassen, 1999; Land & Zembal-Saul, 2003; Vygotsky, 1978).

2.334 How does this study advance problem-based learning? The *Anytown* multi-user virtual environment provides an example system and curriculum that reduces the primary problems that have been identified with

the use of problem-based learning. Specifically, the problems with problem-based learning that *Anytown* seeks to address are 1.) the increased amount of time that instruction takes in this kind of setting versus more behaviorist instructional techniques and settings (Airasian & Walsh, 1997), 2.) the difficulty that teachers have setting up grade-level appropriate ill-structured problems (Brush & Saye, 2003; Oliver & Hannafin, 2001), and 3.) the difficulties that students have with self-direction, especially at early grade levels (Airasian & Walsh, 1997; Albanese & Mitchell, 1993; Anderson, Reder, & Simon, 1996; Oliver & Hannafin, 2001).

By designing this system, the goal is that this environment will provide instructional designers, game developers, learning theorists, and curriculum designers with an example of how time-intensive curricula such as those based on problem-based learning theory can be employed in elementary and secondary schools using the advances in technology of the last decade. In this way, it is believed that young students can be provided with a rich inquiry experience that can meet state standards for improving writing, while concurrently offering learners the opportunities for critical thinking and creativity that social constructivists value. *Anytown* is an attempt to meet these needs within self-directed, socially negotiated learning experiences that are engaging while at the same time addressing some of the criticisms of the use of problem-based learning approaches to instruction and learning with young children in the era of No Child Left Behind assessments and accountability.

2.4 Games and simulations

At this point, there is no single definition for the term *simulation* and there is much debate in the literature about how it should be defined. For example, Socrates and Plato developed the idea of *eidolon* or simulacrum in which the reality of an idea stems from the pure world of ideas, but that humans can only know an imperfect copy of any object (Plato, 1955). Later definitions include that of Harold Guetzkow (1963), a pioneer in the field of social simulation, defines a simulation as "an operating representation of central features of reality (p. 6)." The Guide to Simulations and Games for Education and Training (Horn, 1977) defines simulation as "a method of representing reality and as the essence of the physical or social system interaction. Simulations attempt to replicate essential aspects of reality so it may be better understood and/or controlled (p. 3)." A more recent and uncomplicated definition is given by Pearce (1997); "simulation is a model of a system (p. 14)."

While there are nearly as many definitions of simulation as there are theorists, for the purposes of this study, the definition of a *simulation* is "an abstraction or simplification of some real-life process (p. 241)" (Heinich, Molenda, & Russell, 1993). Regardless of definition, simulations have shown their uses in education. For example, those simulations that use pedagogical agents in the form of characters have been found to have affective benefits related to increased amount of time on task due to student engagement with a character they want to interact with (Baylor, 2005). These virtual agents have been found useful for acting in instructional roles that the teacher normally is required to fill

such as provider of motivational prompting (Baylor, 2005). Simulations have also been found useful for practicing dangerous techniques for pilots using flight simulators as well as for providing self-directed learning using situational role-play and team-building games (Winn, 2002). Educational simulations have also been shown effective for giving customized teacher and environmental feedback to address individual learner needs that are often divergent and they have also been shown to allow for authentic, embedded assessments and rapid feedback (Grabinger, 1996)

2.41 What is a game?

Examining definitions and the treatment of the word game in contrast to simulation Heinich et al (1993) suggest that a game is "an activity in which participants follow prescribed rules that differ from those of reality as they strive to attain a goal (p. 243)." However, this vague definition leaves the question: what makes a game? What parts must be present in order for an activity to qualify as a game? Drawing primarily from Crawford (2003) and Salen & Zimmerman (2004), a game must include (a) *a rule-based interactive system*, (b) *a quantifiable outcome characteristic, (c) artificial conflict and play characteristics,* and may also include the *(d) modeling reality characteristic.* Examining these features, the definition of a game and simulation is further explored in the following sections.

2.411 Rule-based interactive system. Despite the frequent misuse of the terms, the only critical characteristic that overlaps in the definitions of both games

and simulations is the idea of a *rule-based interactive system*. In other words, there is reciprocal action on the part of the user and the system based on a programmed set of parameters. For example, in the computer video game *Neverwinter Nights*, based on the popular *Dungeons and Dragons*™ fantasy series, the interaction is between the player and the other people and beasts in the game, which the player encounters as she attempts to end a horrible plague that is devastating the entire land. Sometimes fellow travelers will help, sometimes they will fight; but the important point is that they can be acted upon and act in certain ways.

2.412 Quantifiable outcome characteristic. When examining this feature, distinguishing a simulation from a game is again problematic. One popular criterion used to distinguish the two is that a game has a quantifiable outcome, while a simulation does not; instead, a simulation just models a system. This distinction, however, is problematic. In one instance, the airplane crashes in a flight simulator. In a second, peace negotiations break down and conflict begins in a war game simulation. In yet a third instance, employees are fired in business simulations. As such, there is often a quantifiable outcome in both games and simulations, resulting in this distinction being both flawed and unusable as a discriminating characteristic.

2.413 Artificial conflict and play characteristics. Likewise, several other popular distinguishing features between games and simulations fail to adequately differentiate the two. For example, games are said to entail *artificial conflict* and *play* (Heller, 2003). These same criteria are not considered

necessary for a simulation, but, similar to the criterion of *quantifiable outcomes*, *conflict* may also be found in many simulations. Similarly, *play*, which has been described as a "pleasurable, light, uninvolved, uncompelled activity" (Adams, 1973), is not the sole purview of games. Simulation users can become pleasurably involved in a simulation well beyond the simulation's stated purpose. Flight simulators again are a powerful example. There are clubs entirely devoted to this genre of simulation that extend well beyond the intended use of the product in which members develop modifications that allow players to visit locations that had previously been unavailable or experience weather that challenges their flight skills.

2.414 Modeling reality characteristic. Finally, another distinction between a game and a simulation is often that a simulation must somehow model reality, while a game does not have to meet this criterion. Using this criterion, a flight simulator would be a simulation, whereas software in which the user controls a fantasy vehicle such as a "Wraith" in *Halo* would be a game because there is no vehicle to transfer their learned skills to in the real world, despite the accuracy of the physics engine employed. Hence, nothing is simulated.

However, consider the challenge of a simulation such as Rover Mission to Mars (University & Maas, 2003). There is real data from telescopes, satellites, and recently, rovers incorporated into this simulation which is intended for secondary students. If a simulation is created with just these data and is used to simulate how future rovers will react, it sounds like a simulation based on this

criterion. What if the data is used to decide how humans would live on Mars? Since no one has lived on Mars to actually live life there, is there something being simulated? In such a case, a simulation is being used to predict future behavior based on current knowledge. Since predictions always involve imperfect knowledge, how much guesswork is allowed before a simulation becomes a game? While most simulations could also be considered games, not all games are simulations. Importantly for this study, the design of the *Anytown* environment draws on the more expansive genre of games and less on the concept of simulation although some elements of small towns are simulated.

2.42 Learning through games

During the past twenty-five years, a number of games and simulations with educational goals have been introduced. Beginning with such games as *Math Blaster*, *Lemonade Stand,* and *Oregon Trail* in the early 1980s, the educational gaming or "edutainment" market has become massive (Slagle, 2004). Since then, digital products by companies such as *Leap Frog* have become best-sellers at the holidays, despite a lack of research to support their use. Video games, simulations, and those that sit in the crux between the two are already being leveraged to impact learning in many spheres ranging from adult learners to students in K-12 setting.

Cognitive research related to the use of action video games to modify visual selective attention have shown that they can be used to improve attentional capacity, especially in those that play games often (Green & Baveller, 2003). This

research focused on learner recall of items they have brief encounters with (subitizing) which found video game players were more successful with this task than non-gamers (4.9 items vs. 3.3, population effect, $p < .01$). Further, video game players also showed that they can attend to more resources and their spatial distribution within a learning environment than non-players during training exercises. Gamers were also able to note secondary phenomena in the learning environment more rapidly and more often, switching between tasks with fluidity not found in non-gamers. By use of specific games like *Tetris* and *Medal of Honor: Allied Assault*, non-gamers were also able to increase their acuity on all tests (adjusted $r^2 = .43$, $p = .13$) through practice over a relatively short period of time (10 hours).

In the business world, game-influenced simulations are in common use for training groups of learners at the post-collegiate and in-service levels (Wolfe, 1993). A study on the use of a business game-simulation by Wabush and Gosen (2001) found significant differences between pre and post-tests on nine of eleven data sets after the use of this game as an intervention in business classes. They find that simulations, especially those with game-like elements are valuable "as a learning methodology, a research tool, and as a classroom decision-making exercise that models the real world (p. 292)."

As a corollary to these findings, more research is under way to validate these findings in a number of spheres including business, academia, and the military. One large movement is under way in higher education called *Serious Games* that seeks to develop learning environments that leverage existing

games, build new games and simulations, build theory about the use of game principles in education, or simply to study the work of game designers as they work to improve public education at all levels. This work has been led through publications by James Paul Gee's (2003) work related to what children learn about literacy through play with off-the-shelf games, Clark Aldrich (2003) on the use of simulations in education, Henry Jenkins (2000) regarding the importance of video games in popular culture and in children's lives, Mark Prensky (2001) focusing on the use of computer games for learning, Constance Steinkuehler's focus on the importance of player literacy practices in games as they relate to learning in massively multiplayer online role playing games (MMORPG) such as *Lineage* and *Star Wars Galaxies* (2004), and Kurt Squire's work with *Civilization III* (2005). While efforts are currently under way to empirically study the use of video games by learners at all levels, much of the work that has been done to this point has either been through case study, anecdote, or qualitative analysis. Findings from studies of three games, learning environments with game-like qualities, and simulations with game-like qualities that have been specifically used for instruction are described in the following sections. These include **Civilization III***,* a K-12 learning game from the Education Arcade at the Massachusetts Institute of Technology (MIT) called **Supercharged,** the U.S. Army's video game **America's Army**, a game-like multi-user virtual environment from *Quest Atlantis* that most closely parallel's *Anytown*, called ***Taiga*****,** and.

2.421 Civilization III. The use of off-the-shelf video games that have a learning component has been one approach to using games to improve student

learning of subject matter. One such attempt has been Squire, Giovanetto, Devane, and Durga (2005) use of the video game Civilization III, a turn-based strategy game-simulation (RTS) that allows students to take command of a civilization that existed at some time in history. Students spend time build cities, temples, and aquifers to serve their people while interacting in the complex political systems that evolve as their own civilization interacts with others that are commanded by the computer or, in some instances, by other players. Using interviews and surveys, this group's work found that participation in game play (a.) immerses students in historical terminology and reinforces their knowledge of existing terms, (b.) improves student interest in the content of history, (c.) encourages understanding of the game itself as a form of historical simulation, and (d.) provides a scaffold for thinking about the historical concepts and content they encounter in contexts outside of the game-simulation itself, implying transfer of learning from the close context to more distal ones (Squire et al., 2005). They also noted that students were encouraged to learn the political and social aspects of history when their attempts to dominate through war were met with failure. The designers also found that modifying game play through design decisions to reduce the difficulty and complexity of play increased student engagement with the simulation. Similar to the findings regarding collaboration in learning environments noted by Linn et al (2003) and Samsonov, Pedersen, and Hill (2006), Squire et al found that students who were successfully at completing game objectives tended to work with other students and shared their experiences often. Finally, over the course of five weeks, most students advanced to the point

where they could be considered experts at strategies that benefited them most as players. While this work only includes self-reports regarding what students learned during their time, it is of note that they believed that they learned more about “maps, timelines, and historical terms (p. 40).” As a whole, what this research does show is that game-based simulations can be effective for encouraging student collaboration, increasing expertise in a skill or strategy based system, and that failure or frustration is an effective means to guide students to new strategies that may have not been apparent from the outset.

2.422 Supercharged! This game stemmed from the Education Arcade project at the Massachusetts Institute of Technology (Jenkins et al., 2003) and involved a number of game designers who came together to produce this learning game. The academic focus is on the teaching of physics concepts through immersion within a world that digitally represents abstract concepts, such as of physics that take place at the molecular level. The study looked at the use of this game-simulation that was used to support an electrostatics curriculum in middle school classrooms. The research questions specifically focused on a.) the social practices that emerge as students worked collaboratively on the game, b.) the strategies teachers used to integrate this game into their lesson, and c.) the impact of *Supercharged!* on student learning of electrostatics? The quantitative portion of the study compared an experimental classroom that used the game to help students learn about the physics concept in addition to lectures and other activities planned by the teacher and compared it with a teacher who only used the standard curriculum, activities, and lecture without the game addition.

This study found that, the experimental group significantly improved their scores versus the control group on the conceptual exam questions ($\underline{M}_{exp}$ = 5.4, $\underline{M}_{cont}$=4.7). Further, the scores of the boys appeared to result in greater improvement than did the girls scores (Squire, Barnett, Grant, & Higginbotham, 2004). In addition, a two-way analysis of variance was conducted using post-test scores as the dependent variable, with *type of intervention* and *gender* used as between-subjects variables. The results showed a significant difference between the experimental and control groups [$F(2, 89) = 4.8$, $p < 0.05$, η^2=0.59.] However, based on this data no significant effect was shown resulting from gender.

2.423 America's Army. Another attempt that bridges the use of simulation for both child and adult learning, the free, downloadable *America's Army* "first-person shooter" simulation-game has been used both to entice teenager's into joining the army by providing the simulated experience of being a soldier while it is also used to allow soldiers to be trained in a safe, virtual environment in which the impacts of their actions have consequences without the severity of real battle or the cost of outdoor war-game simulations with real guns, rubber bullets, and smoke grenades (Nieborg, 2005). The users' confidence in their actions when interacting with the simulation has a large impact on how well the user will perform the simulated actions. If the feedback they receive is constantly negative, this may impact the users' sense of self-efficacy, making them less apt to perform well in each instance of practice or interaction with the simulation, though are far more apt to be influenced by modeled behavior (Kaplan, 2003). Using regression

analysis on data generated by online players and soldiers at Fort Leavenworth, this game-simulation has been shown to be effective at imparting knowledge and skills about tactics related to the practice of fighting a battle (Schneider, Carley, & Moon, 2005). What is similar between the *America's Army* and *Anytown* is the use of text in the games that is influenced by the *Choose Your Own Adventure* book series that were commonly read by children in the 1980s. In both cases, players choose how to address problems, strategize, and react to how their decisions affect unfolding events. In addition, both the larger Quest Atlantis system and the *America's Army* system both work to instill values held by the funding organizations; in the National Science Foundation's Quest Atlantis project, these values are related to improving student science learning, while the U.S. Army's *America's Army* game has been shown by Nieborg (2005) to include values related to recruitment of new soldiers, improvement of battle strategy, and evaluation of individual soldier capacity for war exercises.

However, the *America's Army* simulation has also shown that if the feedback is continually positive, soldiers may develop an overblown idea of their abilities, leading to carelessness in interacting with the simulation and are much less susceptible to corrective feedback. For example, soldiers fighting currently in the Iraq conflict had been trained using digital simulations and had developed specific behaviors based on the feedback they received in the game (Kaplan, 2003). Namely, if they hid behind certain objects, they could jump out and kill opponents. When it came time to translate their simulated experiences into real

world experiences, the simulation had not prepared them for the idea that bullets pass through wood crates or that opponents do not react in predictable ways.

This example suggests that while games and simulations have the propensity for enhancing learning, however, much care must be taken to create an environment that truly simulates the practice activities that the learner will engage in when they complete the training. There are still many questions about whether this can be done effectively and whether face-to-face methods may remain more effective that the use of video games and simulations.

2.424 *Taiga*. The *Taiga* learning environment is used to immerse students in an unfolding story about a national park that has environmental problem that resulted in fish dying. The different viewpoints of characters who belong to the three major factions can be learned by clicking on non-player characters (NPCs) which provides learners with a dialogue with the assorted characters, illuminated the warring perspectives on the problem. Students move through the digital environment and are represented by a digital avatar as they inquire into the large, ill-structured problem of reduced numbers of fish in a local river at the behest of a concerned park ranger. These fledgling scientists are specifically asked to develop a hypothesis that explains the declines in fish numbers based on both fact and opinion revealed to them by characters and objects within the learning environment. In the pilot studies, additional activities also required students collect and analyze data to test their hypothesis and develop a revised hypothesis about the problem that is informed by the data. Students were also given the opportunity to complete voluntary Quests if they pass other “tests”

which allow them to acquire items and new game functionalities such as listening to music.

The goals of this unit include: (a) encountering new concepts such as *erosion, eutrophication, water quality,* and *system dynamics* and (b) improving student analytical skills through *graph deconstruction, hypothesis generation and revision, simulated water analysis, socio-scientific reasoning,* and *scientific inquiry*. The design of this environment has evolved through multiple iterations over a two year period that, consistent with design-based research which is a process that includes an initial curriculum design which is then tested quantitatively and qualitatively. These findings are then used to redesign the curriculum, learning environment, and learner experiences to overcome any identified deficiencies (Barab & Squire, 2004; Barab et al., In preparation; Kolodner, 2002).

The results of the first iteration showed a statistically significant increase in pre-post learning gains using standardized test items that were close to the same content as was used in the curriculum (F (1, 23) = 39.73, p < .001) (Barab, Hickey, Sadler, Heiselt, & Zuiker, 2006). The test items used here are considered "proximal" to the curriculum according to terms proposed by Hickey and Zuiker (2003) because they are close enough to the activities that learners were expected to complete to be recognizable, though the frame of reference around the item is different.

In Hickey and Zuiker's terms, distal-level items are also standardized, multiple-choice items aligned to external standards, but in this case, it is done

without regard for local curricular ties such as context or, in some cases, comparable assessment activity. A repeated measures analysis of variance on these distal items presented non-significant gains [F (1, 23) = 2.57, p = .122]. The researchers note that it is possible that the learning experiences are too situated within the local context and therefore skills and content learner there do not transfer to distal assessments.

In a second pilot, the designer-researchers gave additional opportunities for students to encounter the key underlying formalisms in their more abstracted forms to respond to this issue of lack of transference found with the first iteration (Barab, Zuiker, et al, 2006). By doing so designers helped ensure that the environmentally-supported student interactions appropriately connected with the content formalisms that were targeted for transfer. Further, students could also be assured of experiencing both contextualized and more abstracted formalisms related to the state content and skill standards. For example, the requirement that students analyze scientific diagrams that they encounter by chance in the environment was coupled with the provision of a virtual computer that included more formal, non-contextualized descriptions of what constitutes erosion and eutrophication as resources for completing the task as a means of providing this kind of experience. Beyond this provision, the designers also embedded a series of game-like interactions that forced students to decode data with help from non-player characters that offer aid upon student request. The findings from this second study revealed significant learning gains on both proximal (F (1,19) = 16.77, $p < .01$) and distal items (F (1, 19) = 9.03, $p < .01$). The suggestion of

these findings is that students were immersed in the narrative context, developed understandings about the underlying content formalisms in within the context of the *Taiga* lesson, and also began to appreciate the relationship between their own experience and how it can be related to other, distal contexts. Much of the narrative context, display of relevant information, and complexity of the problem were conveyed through characters in the 3-D space. These characters, who acted as instructors, fonts of information, and directors of activity, are known as pedagogical agents.

2.5 Pedagogical agents

According to Slater (2000), pedagogical agents are:

> "(C)omputer characters that are tied into an artificial intelligence backend. The agent is 'embodied' - meaning it has a visual representation - and can detect external stimuli such as keyboard input, mouse position, and mouse clicks. The (artificial intelligence) backend has a mood and behavior system to simulate human emotions and actions, as well as various components tied to learning. This agent has the potential to motivate, engage, involve, and adapt to the individual learner."

Recent research into the use of pedagogical agents as mentors and guides in digital learning environments has been ramping up over the course of the last decade. Baylor (2002) identifies several benefits of using pedagogical agents:

- They allow learners to take as much time as necessary
- The learner can specify their interactions with the agent
- They encourage learner reflection on their thinking processes

She notes further, that beyond these uses for students, pedagogical agents can be useful as research tools regarding instructional theory because "1) the researcher has more control over the learning environment and interactions than in a classroom setting; 2) agents are independent objects in the system, lending to more flexibility and interactivity; 3) while a computer agent can never simulate a real human instructor, agents can better operationalize the human aspect of instruction than other computer-based methods; 4) agent-based systems provide the potential to capture a large amount of rich data, both quantitative and qualitative; and 5) through designing agent-based learning environments with ***multiple*** agents, it allows for investigating the effect of ***multiple perspectives of multiple mentors***" (Baylor, 2002, p. 3-4). It is these affordances that make pedagogical agents useful in rich, problem-based learning forms of online learning environments because they help convey the complexity of the problems, allow students multiple means of accessing the information that students are to learn. Further, the large number of agents allows for student choice of interaction, allow researchers to collect data regarding student preferences of agent and delivery system, and allow for complex stories to be conveyed through the agents which student can analyze, interact with, and write about in their formative and summative assessments.

In terms of research, Baylor (2005) found that students prefer pedagogical agents that aid in *motivation* when they are similar to themselves in age and ethnicity (d > .8), a concept known as homophily, defined by Lazarsfeld and Merton (1964) as the tendency for humans to gravitate towards others with similar characteristics. Despite this preference, male motivational agents were rated more highly in terms of their knowledge of the subject (d=.55). In terms of agents used for instruction, students both preferred and learned more from African-American female agents who were presented as professors in late middle age (d=.60). Overall, students viewed pedagogical agents that appeared more realistic as being more knowledgeable, an important note for instructional designers wishing to teach through these characters.

Baylor and Kim (2005) found evidence that pedagogical agents can be tailored to serve roles of “Motivator,” “Expert,” and “Mentor.” In their study, “Motivator(s)” and “Mentor(s)” were found to be more human-like (F=7.19, p < 0.01, d=.85) as well as more useful for engaging students in tasks they were less likely to do (F=22.56, p < 0.001, d=1.76). However, “Expert(s)” and “Mentor(s) were viewed as both more credible (F=15.64, p<0.001, d=1.13) and better able to help students learn (F=2.74, p<.05, d=.55). These findings indicate that pedagogical agents with both human qualities and sufficient information to make them seem plausible as authorities on a subject are useful for engaging students with learning tasks, although Baylor and Kim also suggest that a mixture of all three may be necessary to provide students with a choice of agent with which to interact.

What is important about these pedagogical agents is that they function similarly to characters in video games, teachers in classrooms, and peers in the both online video games and classrooms, acting as tools for improvement of skills and developing knowledge. The social aspect of these agents is clearly important, with those that are most like humans being rated as highly preferred by students in the research. While these pedagogical agents are present both in classroom and online settings, this is not where the similarity between instruction and video games ends.

2.6 Instructional design versus game design principles

Another similarity between the two comes from the areas of instructional design and game design. As a result, the design of the *Anytown* environment is informed by overlapping video game and instructional design principles. The instructional design principles used to guide in the design of the digital learning environment were those proposed by Savery and Duffy's (1995) for the development of problem-based learning environments. These include:

- Anchor all learning activities to a larger task or problem; (2.) Support the learner in developing ownership for the overall problem or task; (3.) Design an authentic task; (4.) Design the task and the learning environment to reflect the complexity of the environment they should be able to function in at the end of learning; (5.) Give the learner ownership of the process used to develop a solution; (6.) Design the learning environment to support and challenge the learner's thinking;

(7.) Encourage testing ideas against alternative views and alternative contexts and; (8.) Provide opportunity for and support reflection on both the content learned and the learning process. (P.3-6)

Table 1 includes a comparison of game design principles using an example for the video game *World of Warcraft* compared with instructional design principles often used to teach in classrooms along with a sample lesson.

Table 1.
Game design and game example compared with instructional design principles

Principle	Video Games	Instruction/Teaching
Conflict/ Problem	Ex. You (the player) need to get Briarthorn plants BUT local Grit monsters try to stop you. They all will need to be defeated in order to get Briarthorn.	Ex. Gang violence at the school needs to be reduced. What are the issues? How do we reduce violence? What causes it?
Context/ Environment	Ex. Narrative context (Hexa needs you to get 10 Briarthorn plants to teach you to make a Healing Potion and learn Alchemy.)	Narrative context (In order to better understand the conflict going on at their urban school, the teacher frames the conflict in terms of the novel *The Outsiders*.)
Activities/ Tasks	Game tasks to be completed (i.e. gather 10 Briarthorn plants)	Learning tasks (i.e. read ten pages of *The Outsiders* and answer these five related questions)
Rules/ Conditions	1. Collect 10 Briarthorn 2. You must defeat *all* Grit monsters 3. *Only return* to Hexa when done 4. *Only after* obtaining plants can you learn to make the potion	1. Pages must be read in 30 minutes 2. Answer questions in complete sentences in the following 10 minutes 3. Answer questions correctly 4. Paper must be college ruled 5. Turn paper in to teacher
Goals/ Achievement	*Victory conditions* 1. Get 10 Briarthorn plants 2. Defeat all Grits 3. Return plants to Hexa 4. Learn to make potion	*Learning/performance objectives* 1. Read 10 pages from *The Outsiders* in allotted time period 2. Answer 5 questions correctly in allotted time period 3. Turn in paper to teacher
Scaffolds (Hard)	1. Environmental feedback such as visual and auditory cues (i.e. grits and plants are identifiable by rollover name, song) 2. Tutorials – computer GM provides information and feedback as player succeeds or fails at activities. 3. Character (*NPC) direction	1. Concrete directions broken into manageable chunks (i.e. 1. Read pages, 2. Answer questions, 3. Turn in to teacher) for the activity are written on the board (visual) 2. Questions on a hand out. 3. Concrete directions are announced by the teacher (audio) 4. Model of a correct question response is shown on the overhead projector 5. Clock timer is provided to let students keep track of how much time they have to

	to complete actions	complete the learning tasks.
Scaffolds (Soft)	1. In-game hints upon repeated failure (i.e. computer GM voice/text – "Try using your dagger on the Grits." 2. Peer direction (**MMORPG) – Other player – "There are more Briarthorn to the northwest."	1. Teacher answers class procedural questions as a group 2. Teacher answers individual student procedural questions 3. Teacher provides additional examples of correct answers 4. Teacher poses questions to students to prompt thinking
Assessment	Clicking on Hexa provides an assessment of whether goals have been achieved – If successful, see feedback 1 below. If unsuccessful, see feedback 2.	1. Students turn in paper for written assessment – correct answers are marked with a check mark for correct and an X for incorrect. A single incorrect answer indicates non-success. 2. Success and non-success lead to different feedback (see next).
Feedback	*2. Success* – Hexa responds - "You did a fine job of gathering the Briarthorn. Now when you have ten, you can click on your spell book to make a Healing Potion." *Game task is completed.* 3. *Failure* – Hexa responds "You still need two Briarthorn. Do not return until you have it!" Also acts as a soft directional scaffold." *Player returns to game task with new information.*	1. *Success* – Teacher marks paper with "100%" and "Good job", indicated successful completion of this learning task. 2. *Failure* – Teacher marks paper with "3 out of 5" and "Try again." *Learner returns to learning task with knowledge that these two answers are incorrect.*

**NPC* – Non-player character ** *MMORPG* – Massively multiplayer game

This table provides a comparison of those learning principles that are employed within the first several minutes of Blizzard's *World of Warcraft* alongside those that are commonly employed within a set of instructional designs that came from a lesson presented by the designer in 1999 as directed by a local Texas school district curriculum that was tailored to state standards. Each curriculum, both that provided by the non-player characters in *Warcraft* and the district include the same basic elements as a means of directing the learner to complete the task successfully such as hard scaffolds provided by worksheets ("answer the following five questions") or digital information on screen ("collect five Briarthorn"). It is these similarities between the digital and analog contexts that

allow for the development of digital learning games that have the same underlying instructional principles, scaffolds, and feedback that a student may encounter in their daily life as a student. The modification of these underlying principles to fit within a problem-based learning lens is what allowed the design of the *Anytown* learning environment to balance a need for the kind of open-endedness that is called for by problem-based learning while still providing the level of scaffolding that is needed by fourth grade students that often overwhelms teachers who attempt to design such an environment in an more traditional, face-to-face setting. The following section on learning environments presents past attempts to use these instructional design principles to develop games, simulations, and multi-user virtual environments that leverage the motivational and rapid feedback affordances of digital video games.

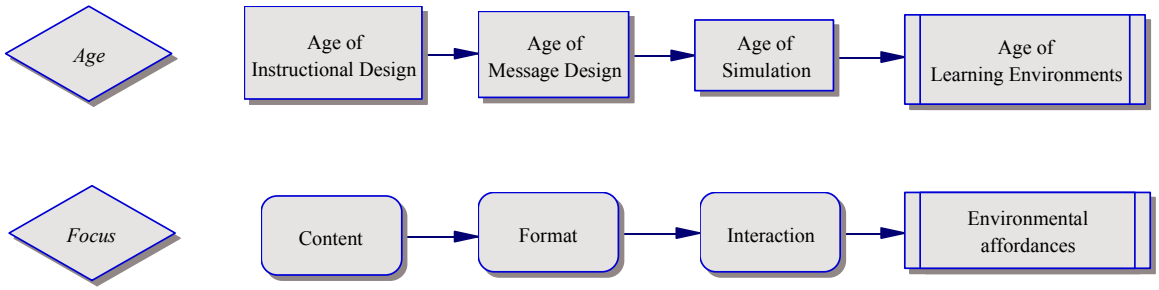
2.7 Existing Learning Environments

Several multi-user virtual environments and single-user virtual environments already exist in various forms and address a number of different academic content areas at the K-12 level. These environments use various combinations of technologies such as computers, distance learning equipment, Internet resources, or other, comparable hardware or software, in order to improve, or otherwise scaffold, student understanding. This notion is comparable to Winn's (2002) concept of an artificial learning environment or Grabinger's (1996) notion of a Rich Environment for Active Learning (REAL). Four particular learning environments are of special interest here: Quest Atlantis' *Taiga* world,

massively multiplayer online role-playing games, and Chris Dede's *River City* as they have the most in common with the learning environments studied here.

Before exploring these environments, it is important to note that theorists such as Winn (2002) believe that the field of educational technology has "moved through three 'ages'" (p. 332). The following figure details these ages and their primary focus.

Figure 1.
The four ages of educational technology



Adapted from Winn (2002), p.332

While this view has not been widely adopted throughout the field of instructional systems technology, many theorists are still moving slowly towards the idea that education should be integrating innovations such as (1.) artificial learning environments, (2.) communication tools used to foster social interaction, (3.) distributed cognition in the form of communities of practice, and (4.) integrated or "complete systems" (Winn, 2002, p. 343).

In addition, the use of integrated, digital learning environments becomes increasingly prevalent, as the availability of technology in K-12 schools grows

through state and federal grants to rural, suburban and urban schools alike. Some benefits of digital learning environments are presented in Table 2.

Table 2.

Affordances of technology-supported learning environments

General	*Problem-based learning*	*Inquiry-based learning*
Frees teacher to act as facilitator (Grabinger, 1996; Hewitt, 2004)	Allows for authentic, embedded assessments and rapid feedback (Grabinger, 1996)	Allows for customized teacher and environmental feedback to address learner needs (Grabinger, 1996)
Allows for learner-control of instruction (Winn, 2002)	Has propensity for strengthening fledgling communities resolved around common practice (Wenger, McDermott, & Snyder, 2002)	Allows for embedding of simulations to practice dangerous techniques with feedback (Winn, 2002)
Allows rapid customization to learner needs (Hannafin, 1995)	Allows for peer feedback (Hannafin, Hannafin, Hooper, Rieber, & Kini, 1996)	Allows for self-directed learning using situational role-play and team-building games (Winn, 2002)
Motivational for students (Hannafin et al., 1996; Prensky, 2001)	Allows for active learning through interaction with peers to solve authentic problems (Grabinger, 1996)	Allows access to large databases to support individual and group knowledge building (Hewitt, 2004)

It is these benefits that are predicted to allow learners in game-like learning environments to spend more time on task while providing rapid feedback to learner-directed activities in a digital environment.

2.71 Quest Atlantis' *Taiga* world. The design of the National Science Foundation-funded *Taiga* learning environment was undertaken with the goal of

engaging students in science inquiry-based learning activities that would help them better understand the abstract formalisms that underlie the chemical processes and environmental influences that occur as a result of watershed abnormalities such as erosion, farm run-off, and over-fishing. Using a design-based research perspective, the learning environment was created under the influence of specific science standards that were taken from Indiana's sixth grade Core 40 learning objectives. From these standards, a simulated national park was created with a Y-shaped river confluence that included three groups that were competing for resources in the forest and watershed: trees, fish, and farm products. While the overall goal is to encourage students to understand the chemical indicators such as pH, dissolved oxygen, and turbidity, the complimentary goal is to help students understand the complex system that is the watershed represented in the digital simulation. As students begin to understand the complexity of the problem they are asked to solved, the hope is that they will also come to understand the complexity of the competing economic, social, and political influences at play in a park where every decision a student makes has consequences. Because of the design-based nature of this project, the environment has undergone several revisions in content, language complexity, learning activities, and curricular focus as pilot studies were completed and weaknesses were identified. For example, when it was discovered that the language within the character dialogue was leading students to a single cause of the declining fish numbers in the river (namely, the loggers), the dialogue was reworked so that the cause was fuzzier and less obvious. As a

result, students could build their own evidentiary cases and come to discover the pollution contributions of all parties involved, leading them to a new, more complex view of the system itself. Once this issue was taken care of, another pilot revealed the motivational aspects of the environment were not as strong as they could be, so the environment was redesigned again to include more video-game like activities that would draw students into voluntary enrichment activities beyond what was required by the teacher. While *Taiga* is a strong example of a learning environment that is designed to have game-like activities, off-the-shelf video games have become a $12 billion dollar industry, leading one to believe that game companies understand a lot about motivating kids to interact with the content they are providing.

2.72 Massively multiplayer online role-playing games. In support of *Quest Atlantis'* approach to improving student engagement has been a small amount of qualitative research regarding foundational questions about learning through interaction with digital gaming and simulation environments themselves, often by studying the interactions of participants in massively-multiplayer online games such as *Star Wars Galaxies* (Squire & Steinkuehler, 2005; Steinkuehler, 2004) . The complexity of the digital environment, as well as the intensity of communication use to solve problems and meet objectives, in video games such as Blizzard's *World of WarCraft* and NCSoft's *Lineage* series, provide a rich environment for qualitative inquiry, using such methods as computer-mediated discourse analyses, interviews with players, and observer participation. Questions such as why, when, and how learning is taking place in a digital

gaming environment, the depth of cognition engaged in by learners, the social nature of learning, and player motivation for learning have implications for the design of future technology-supported learning environments.

2.73 River City. The River City project at Harvard University focuses on the use of Multi-User Virtual Environment Experiential Simulators to aid student learning. The goal of the project is to allow students to explore imaginary locales working with peers to answer scientific questions, similar to the goal of Quest Atlantis' *Taiga* world. Results of the pilot study showed increases in student interest in class tasks for all students.

The project employs a guided, collaborative learning-by-doing approach to instruction. The setting allows students to time travel virtually with the task of solving mysteries in late 1800s America. The curriculum provides a multi-user digital world with a city with a river running through it, different forms of land that impact local water, industries, and other institutions that play a part. Students explore the town and gather data to answer related to larger mysteries.

Several findings resulted from the pilot study. One finding was that the multi-user virtual environment suggested that it had the most positive effects for students with high perceptions of their own thoughtfulness of inquiry, scoring higher on the posttest and had higher content pre-test scores. Another outcome involved students' perceptions of their teacher's role in the classroom. By the end of the study, students in the experimental group perceived their teachers as pushing them for less for understanding than when they began. In addition, their skills in reading, writing, collaboration, and computer literacy were enhanced.

Subtest averages for students' perceptions of academic efficacy showed significant differences between the comparison and treatment groups ($t=3.36$, $p < .05$). It is also important to note that while six of seven students in the treatment group increased their content knowledge as shown by the post test, only two out of five of the comparison group students increased their knowledge significantly. These findings correlate well with the findings of Quest Atlantis' *Taiga* unit, which had some clear ties between a multi-user virtual environment's motivational aspects and increases in student learning over time. One concern regarding that the River City group expressed about virtual environment embedded curricula is the amount of required reading and writing involved in such an environment. The group's qualitative results also suggest that additional teacher professional development would make such environments more effective.

The findings of these four game-simulations lead a designer to be optimistic about using the visual, motivational, and immersive properties of this form of digital instruction. Further, because they are learning environments that can be programmed to be open-ended in a way that fits well with the tenets of problem-based learning, they appear to have a high propensity for meeting the needs of designing the form of rich learning environment that problem-based learning requires. However, there are issues related to the use of games and simulations that have been identified over the years that make their use in K-12 schools problematic.

2.8 Limitations to games and simulations in K-12

While important because of the promise of student interactivity, autonomy, motivation, and modeling potentials (Prensky, 2001; Winn, 2002), the limitations of games and simulations as platforms for K-12 learning must be explored. However, research regarding the educational value of console and computer games and simulations is still uncertain and has yet to face extensive, systematic research and serious questions remain (Bowers, 2000). At what point does their use begin to interfere with the larger educational, affective, and disciplinary goals of the K-12 schools? Are there harmful side effects to their use in the classroom to attention span, level of independent thought, or motivation to learn without the extrinsic reinforcement of the game or simulation? Are the instructional goals and affordances of a game at cross-purposes with those in the state curriculum? Can games be severely detrimental as shown when a man in South Korea died after playing video games for 86 hours straight (Press, 2002)? Additional questions related to the use of technology-rich learning environments such as games and simulations are presented in Table 3.

Table 3.
Questions related to the limits of technology-supported learning environments

Question	*Primary stakeholders impacted*
What do changes in our conception of a learning environment mean for the preparation of teachers?	Teachers, post-secondary institutions
When does the use of technology-rich learning environments begin to do more harm than good?	Students, teachers, parents, schools
What organizational structures in a K-12 setting represent the greatest challenge to introducing new kinds of learning environments?	Instructional designers, teachers, theorists
Once a limitation is identified, how do we choose and implement a systemic change process that can overcome this obstacle?	Theorists, researchers, instructional designers

Further research in this vein may result in findings that support the development of engaging educational games and simulations. It is also likely to generate guidelines for the appropriate use of games and simulations in or as learning environments. Without such research, a number of products with dangerous content may make their way into classroom use, resulting in reduced student learning, disciplinary problems, or other unforeseen consequences.

2.9 Summary

In summary, the literature related to current approaches to K-12 writing shows movement towards the use of interdisciplinary topics as students engage in step writing processes to prepare them to write both for standardized achievement tests and for their future work requirements that involve writing in nearly every professional area. Social constructivist learning environments such as those found in problem-based learning methodologies has shown several strengths and deficiencies when implemented in both face-to-face settings and those that are technology rich when employed in a variety of disciplines. The findings from research related to learning environments that include the use of student writing as a means of assessment have included benefits to students' critical thinking, organizational, and general problem solving skills. However, limitations include the amount of time it takes students to complete problem-based learning lessons, the difficulty in designing appropriate materials for these environments, lack of student on-task time, and the amount of time the teacher spends redirecting students to learning tasks. Designs have evolved over time to include cognitive tools, embedded scaffolds, and new teacher approaches to improving student learning in problem-based learning environments through feedback and individualized cognitive challenges. Further, despite problems such as "game addiction," student off-task behaviors, and fears of the impact of violent games on children, modern games and simulations appear to hold the promise of providing motivation, visual learning cues, opportunities for learner self-direction, and depth of experience to inform the design of a digital learning environment

that would allow students to work on a series of ill-structured problems or authentic tasks that should allow for writing practice and improvement. The literature in support of the use of technology to improve student writing has shown that it can improve student grammar use, attitudes towards writing, and knowledge of writing processes and the characteristics of good writing.

The goal of this treatment and study is to determine whether student writing can be improved by linking intrinsically motivating game tasks to less motivating writing tasks. While the literature indicates that improvements in many content areas can be correlated with increased student attention to the tasks at hand, increased ability to self-regulate learning, and improvements in acquisition of completion strategies, there has not been research related to the use of a technology-rich, game influenced learning environment for the improvement of writing. This begs the question, “how does one approach designing such a learning environment?”

Chapter Three, Design Methodology, outlines the instructional and game design methods that were used to develop the treatment environment. It also examines the use of new forms of embedded scaffold such as pedagogical agents, linking them to the theory that influenced the design decisions that resulted in the creation of *Anytown*. The Design Methodology Chapter includes the following sections (1.) Introduction, (2.) Instructional scaffolding and guidance, (3.) Environmental interaction and learning activities, (4.) Comparison curriculum, (5.) Writing practice, and (6.) Summary.

CHAPTER THREE: DESIGN METHODOLOGY

3.1 Introduction

The design of the *Anytown* learning environment was a complex process with five months of paper and pencil prototyping followed by an additional nine months of digital development punctuated by additional redesign as need arose. The first half of the original design was mainly sketched out on paper from November 2004 through February of 2005 by this researcher a colleague. A prototype was developed within the *Quest Atlantis* world code-named *Language Arts* from January through March of 2005 with the help of another doctoral candidate also working for *Quest Atlantis*. This three dimensional layout of the learning environment included the creation and embedding of buildings, characters, and other necessary objects such as trees, walls, streets, signs, animals, and cars. With much of the layout complete, the instructional design was implemented by creating hundreds of dialogue pages that specify how objects and characters communicate with students within the learning environment. Within these dialogue pages, html links allowed users to ask questions of characters, pick up objects, read through stories, or enter locked doors, contingent upon earning collecting other key objects. In order for these pages to appear appropriately depending on who and what students have already interacted with, which objects they have received, and at what stage in their experience they have reached, access conditions were also designed to ensure appropriate responses to student interactions. The learning environment was also seeded with learning tasks called “Quests” in the language of *Quest*

Atlantis. The original prototype included eight activities: an initial orientation task, three tasks centered on writing descriptive stories, two tasks centered on solving mysteries, and two tasks intended to engage students in metacognitive activities comparing the imaginary town with the student's own.

Once the prototype was completed, a pilot study was done to determine whether the environment as designed was tenable for the dissertation study. Problems were identified through student and teacher feedback in interviews, informal discussions, teacher-led activities, in-space chat, and audio recordings of student interactions. As a result of this feedback, the design entered its next iteration, which included revision to fix problems of unclear dialogue, access conditions that did not work, and expansion of the learning environment to include many more learning activities. The new design included over 2,000 dialogue pages with which students could interact, over 150 access conditions that controlled these interactions, and 26 possible learning tasks. The learning tasks include four creative writing tasks, six descriptive or compare and contrast writing tasks, four metacognitive reflection tasks, seven pre-writing tasks, four mysteries to solve, and a slightly altered initial orientation task.

In order to better explain the design of the learning environment, this chapter includes sections on (1.) Instructional scaffolding and guidance (2.) Environmental interaction and learning activities, (3.) Designed frustration points, (4.) Comparison curriculum, and (5.) Summary.

3.2 Instructional scaffolding and guidance

In the instance of *Anytown*, instructional scaffolding (Brush & Saye, 2001) to support the larger thematic, interdisciplinary unit (Shanahan, 1997) in the digital environment is primarily delivered in one of three ways: (1.) student interaction with primary instructional characters, (2.) student interaction with secondary support characters, (3.) student interaction with peers within the digital or lab environment or (3.) interaction with environmental features such as signs, object clues, and other sorts of visual cues such as library books, burning buildings, and graffiti sprayed plaques. However, the primary means of scaffolding comes from their interaction with characters and the ability to ask the fictional characters specific questions related to their current tasks, whether they are related to the steps required in writing a descriptive essay, or understanding the meaning of clues the students found in the 3-D environment.

This means by which students gain information contrasts with more traditional, face-to-face learning environments in which students receive much of their context for learning from the teacher or textbooks, the content also from the teacher, and learning tasks are set for students by the teacher. The following table provides a comparison of the learning in a more traditional learning environment versus the digital environment designed for this study.

Table 4.
Comparison of Anytown *delivery and assessment mechanisms versus other instructional methods*

	Behaviorist	**Collaborative**	***Anytown***
Provider of context	Teacher through lecture or within text book readings	Teacher through lecture or within text book readings	System provides through: 1. character dialogue 2. graphic elements 3. objects
Provider of content	Teacher within lecture, learning tasks, or text book readings	Teacher within lecture, learning tasks, or text book readings	System provides through: 1. character dialogue 2. graphic elements 3. objects
Provider of learning activities	Teacher through lecture, work sheet or within text book	Teacher through lecture, work sheet or within text book	System provides these within pedagogical agent dialogue
Assessor of learning	Teacher	Teacher and peers	Teacher, peers, and/or system depending on task
Student roles	Complete assigned tasks	Complete assigned tasks in cooperation with peers	Choose tasks, work with peers, interact with system, complete tasks singly or with peers

3.21 Learning goals

The primary standards stemming from the state of Indiana's Core 40 that are addressed by the *Anytown* multi-user virtual environment and the comparison class are:

Writing Objectives

4.4.2 – (1) Select a focus (topic), organizational structure, and point of view based on purpose, audience, length, and format requirements for a piece of writing.

4.4.3 – (2) Write informational pieces with multiple paragraphs that:

A. provide and introductory paragraph.
B. establish and support a central idea with a topic sentence at or near the beginning of the first paragraph.
C. include supporting paragraphs with simple facts, details, and explanations.
D. present important ideas or events in sequence or in chronological order.
E. provide details and transitions to link paragraphs.
F. concludes with a paragraph that summarizes the points.

Writing Application

4.5.3 – (3) Write informational reports that:

A. ask a central question about an issue or situation
B. include facts and details for focus
C. use more than one source of information, including speakers, books, newspapers, media sources, and online information.

Reading Comprehension

4.2.1 – (1) Use the organization of informational text to strengthen comprehension.

4.2.2 – (2) Use appropriate strategies when reading for different purposes

Within the *Anytown* learning environment, the writing objectives and application standards are mainly addressed through student responses to written responses

to Quests in *Anytown* that are focused on descriptive, informational reports that are contextualized as news stories written for Jim Tuttle, editor of the ***Anytown News***. Students receive feedback on the structure of their writing from their teacher who takes on the role of newspaper editor. Numerous resources such as pedagogical agents who act as interviewees, archived newspaper stories, access to clue trails, and visual information are conveyed to the students so that they can increase the number of details in their writing even as they move through the six steps of the writing process detailed to them through Pre-writing Quests which are offered by Bethany Rhubarb, another young reporter and pedagogical agent. Students encounter several "experiential modes" (Appelman, 2005) as they work through the Quest activities that lead them to their writing tasks. Based on Appleman's taxonomy, the affordances of the environment specifically engage students in (a.) different levels of *virtuality*, which is expected to contribute to the degree to which they perceive their interactions to be meaningful; (b.) multiple *physical structures* that increase student intake of visual, auditory, and spatial information like image clues for solving puzzles; (c.) *spatial boundaries* that contribute to the sensation of moving in a physical place and interacting within set, fictional boundaries; and (d.) *time boundaries* that limit student time in the space, but contribute to a sense of urgency to complete learning tasks in *Anytown*. The time boundaries in *Anytown* provide a framework for expected completion times, but are artificially set due to the observation period used for the study. However, students will be able to continue their work beyond the end of

the data collection and will not be limited in their writing based on time otherwise, in keeping with the tenets of problem-based learning.

Appelman (2005) provides a taxonomy for further contextualizing the affordances of the *Anytown* learning environment versus those found in the comparison classroom environment. Table Y presents a comparison of the "Learning Environment Attributes" found in the comparison classroom versus those present within the *Anytown* treatment classroom.

Table 5.
Learning environment attributes in the two conditions from Appelman's Taxonomy

***Anytown* Environment Attributes**		**Comparison Environment Attributes**	
Virtuality	Environment presents elements of real towns to scale; some fantastic elements	*Virtuality*	None except when within *Quest Atlantis* lab time; actual classroom
Background and physical structures	Includes standard elements of small towns such as business buildings, houses, trees, and schools	*Background and physical structures*	Students work in classroom or lab with desks, black boards, paper, pencils, and markers
Spatial boundaries	Virtual limits are placed on where students may work or play	*Spatial boundaries*	Students are limited to the classroom for learning activities
Time boundaries	Students are limited by class period or time at home	*Time boundaries*	Students are limited by class period or time at home

Table 6.
Learning perceptions within the environment in the two conditions from Appelman's Taxonomy

Learning Perceptions within the *Anytown* environment		**Learning Perceptions within the comparison environment**	
Interaction	Students may interact using digital Chat, Telegrams, or e-mail at will	*Interaction*	Students may interact through speech when permitted by the teacher
Sensory immersion	Students are immersed through visual and auditory senses	*Sensory immersion*	Students are immersed through all five senses depending on the activity
Mobility	Students may move through the environment at will and enter other digital learning environments	*Mobility*	Students are limited in movement by teacher restrictions; most work is done seated at desks
Apperception of time	Student sense of the flow of time stems from their interaction within the system activities	*Apperception of time*	Student sense of flow of time stems from preset limits on activity times set by the teacher

In terms of the reading comprehension goals, the dialogue texts of the various characters, objects, and archival materials in the space force students to read for multiple purposes such as identifying relevant information, developing context for their writing, entertainment, observing modeled writing behaviors and structures, and investigation. As such, students must, sometimes rapidly, switch between reading purposes as they work through the myriad Quests. Due to the fact that the necessary information required to complete more than 80 percent of the

Quests is embedded within the texts, students must read or they will not succeed at either the voluntary or mandatory activities that make up the experience of *Anytown.* Requiring students to engage in reading to allow success also increases the amount of sustained silent reading that students engage in over the course of their day, although they can self-regulate breaks in reading over time by engaging with the three dimensional interaction, writing, or exploration parts of the space. Student success at Quests may act as an indicator of student sustained silent reading, which has been difficult to ensure in classroom silent reading periods (Marshall, 2002).

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3.22 Fictional characters as pedagogical agents and learning scaffolds

While there are myriad ways for students to improve their writing in *Anytown,* the fictional characters that make the town an interactive place are the most important. As mentioned in Chapter Two, these characters act as pedagogical agents who guide in several ways. Based on the findings of Baylor and Kim in Chapter Two, the *Anytown* learning environment uses pedagogical agents to:

- Scaffold student understandings of procedure, location, and world,
- Entertain and provide the narrative through stories, puzzles, dialogue,
- Direct students to new tasks, games, and information, and

- Help build a student's embodied empathy for the complex system that is *Anytown* (Gee, 2004).

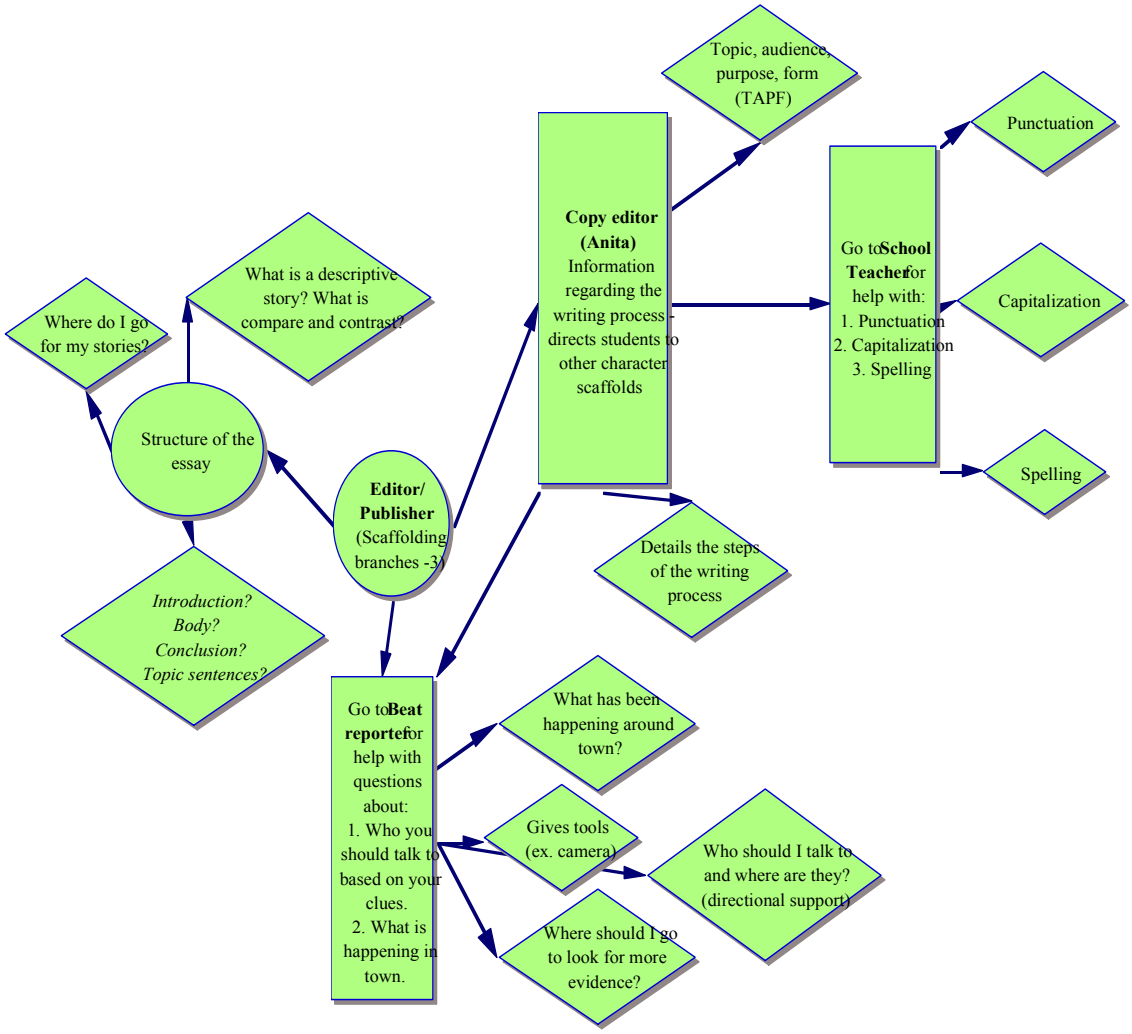
The interaction with the instructional characters comes in the form of branching dialogue. For example, students speak with Jim, the newspaper editor, for the first time and are introduced to their first descriptive Writing Quest. Several options for asking Jim questions are provided to students that they can select. This takes them to a new page that includes Jim's answer. If there are further questions related to the topic that are appropriate for the student to ask now, these appear below Jim's answer. In addition, a question option that allows students to return to the previous set of questions is also included.

Further, when students return to Jim after having spoken to him for the first time, Jim will speak to them as though they have already met, however, the same question options will remain open. If the student has already visited another character and received one of the environmental tools such as the camera, the option to ask Jim about that tool has been removed. If the student has completed a particular task such as their first writing assignment, Jim's dialogue will change again, prompting the learner to begin the next quest, while maintaining the option for students to ask questions related to his primary instructional purpose.

3.221 Primary instructional agents. These characters function in roles similar to both Baylor and Kim's (2005) "mentor" and "expert" pedagogical agents. As such, they provide students with direction about their writing tasks,

provide additional help regarding the solving of problems, answer questions related to navigation and the logistics of getting around town. In order to keep the number of characters that provide instructional scaffolding in the digital environment manageable, the larger meta-narrative of “a small town in trouble” informed which characters would aid learners. The journalism metaphor that drives the primary Writing Quests sets up the first instructional scaffolds with which students will interact. These include the editor-in-Chief, Jim Tuttle; the Copy Editor Anita Gupta; and Wendell Pallisades, the friendly city desk reporter who guides the learner through the task, writing process, basic interviewing skills, and the goals of descriptive writing. These characters also provide specific instructional support regarding the parts of a story (essay), suggest optional learning activities, and convey information about the other town inhabitants with which students will interact during the first unit or in later ones. Further, the Copy Editor directs students to Armand Rousseau, the Librarian, for help with research in the space, and Irene Morningstar, the School Teacher, for scaffolding regarding basic grammar rules. The roles of the Editor-in-Chief (Jim), Copy Editor (Anita), Beat Reporter (Wendell), and the School Teacher are detailed in Figure 1. Armand is not included as his primary instructional role does not begin until Unit II, which is not pertinent to this discussion.

Figure 2.
Primary instructional scaffolding characters and roles



The comparison teacher, by distinction, is the sole provider of students learning activities in the comparison classroom. She acts in all roles, providing scaffolding, modeling appropriate behaviors, and giving advice regarding both the writing process and grammar. In addition, she provides direct feedback on student writing and acts to direct students to resources to improve their writing.

3.222 Instructional support agents. Similar to Baylor and Kim's (2005) conception of a "motivating" pedagogical agent, these *Anytown* characters provide information, opinions, and/or evidence to students in the same way that a teacher would through verbal lecture, worksheets, or texts. Rather than providing direct instruction regarding writing, these characters engage in dialogue with students to enrich the narrative, provide multiple perspectives, and direct students towards clues when they struggle or successfully follow the trail of clues. For example, Sarah Means, an agent with almost no role in the first two Mystery and Writing Quests, provides a valuable and necessary perspective of the problem focus of the second set of Quests, gives clues regarding puzzles, directs learners to other agents with relevant information, and acts as a resource for information. A second character, Tony Wyoming, contrasts with Sarah by providing an opposing viewpoint while serving many of the same purposes of direction regarding the reopening of the old mine. It is through these characters that students engage with the narrative, explore alternate depictions of the town's history, and encounter the political and economic struggles of a small town.

By contrast, in the comparison classroom, the teacher provides directions as to what the students are to do with the information they gather through taking notes on their readings, experiences as they participate in the group writing process, or within the feedback she provides on their individual writing assignments. In some instances, the teacher contextualizes student directions and activities within the narrative context of school or within the context of the story they are writing. In the comparison curriculum, peers may also act to give a

student alternative opinions, viewpoints, and perceptual details which can then be used to guide their writing. If there is to be an entertaining facet to the learning activities, it is her responsibility to provide it.

3.3 Environmental interaction and learning activities

The underlying digital environment learning objectives included the following:

a. The learner will become familiar with the affordances of the digital environment (visual, auditory, spatial, informational)
b. The learner will begin to explore the digital environment as part of game play
c. The learner will identify standard features of the digital environment that are consistent and can be reliably used versus those that are temporary scaffolding which may be removed as they advance in ability
d. The learner will use the digital environment to explore reading objectives
e. The learner will use the digital environment to gain resources to support their writing objectives

3.31 Example

The first experience that students have in the environment is an exploration of the *Anytown* world, creating their own map as a personal scaffold

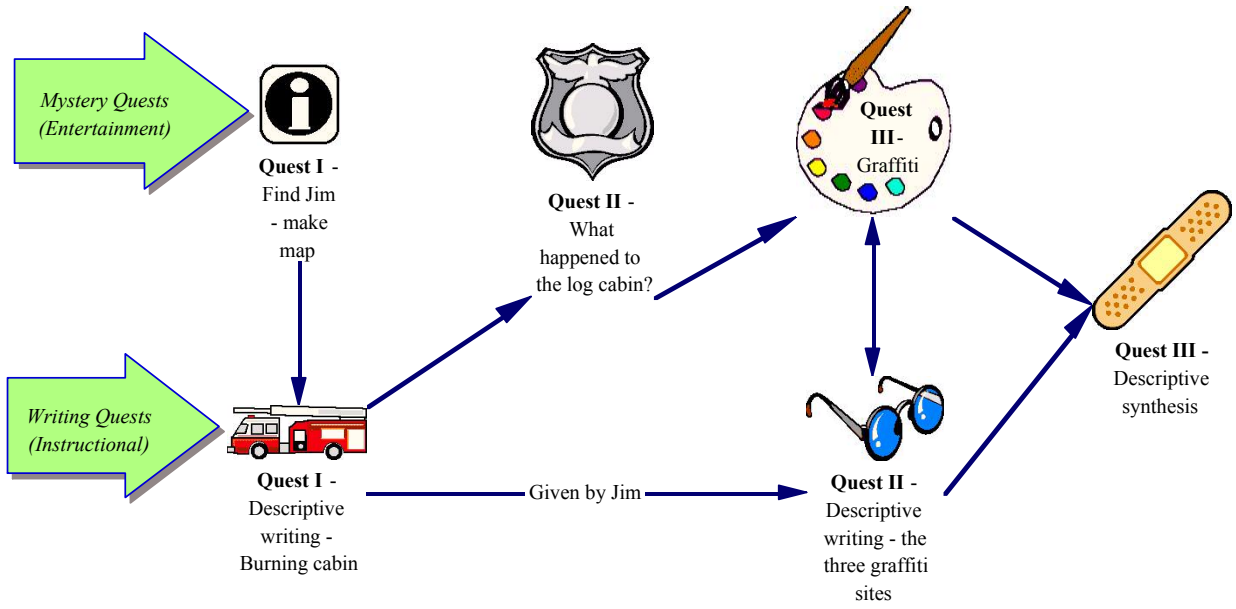
for later investigation and interaction with characters. Figure 2 presents an image of the Main Street area where students begin their time in *Anytown*. It includes the kinds of locations that students could expect to find in many small towns across the United States such as a general store, a small newspaper, town landmarks, and a gas station. Students are expected to speak to the numerous characters, interact with various objects, explore the strange places in the space, and determine their favorite and least favorite places in the space. As they interact with characters and explore, new options for Quest activity arise through their dialogue with the various pedagogical agents.

Figure 3.
Anytown's *Main Street in the Quest Atlantis system.*

3.32 Optional writing and exploration activities

Several exploratory and optional writing opportunities also exist in the *Anytown* environment. These parallel the purely instructional or metacognitive activities that have been designed into the digital space. Some of these activities include the exploration of the richly developed environment, discovery of secret locations, investigation of mysteries, context-specific ghost stories, and the accumulation of tools that allow students to engage in play across other worlds within *Quest Atlantis*. While many of the locations serve dual roles by embedding instructional and entertainment affordances within them, how students choose to proceed remains their own responsibility. Figure 4 presents an example of how the entertainment and instructional Quests parallel one another.

Figure 4.
Anytown Language Arts Unit linkage between Instructional and Mystery Quests.



3.33 Instructional frustration points

Coming from a need to engender cognitive conflict in the learner as noted by Jonassen (1999, 2002) in his constructivist learning environments, designed instructional frustration points are a means of aiding in the prompting of problem-based learning in a digital learning environment. These moments have been engineered into the learning environment with the purpose of (a.) generating cognitive conflict in the learner, (b.) engendering interdependence upon peers, (c.) engendering dependence upon the system affordances, and (d.) weaning students from their dependence upon teacher-directed instructions and direction. The frustration points generally come in the form of Jigsaw-like instances in which one student discovers a piece of information that is necessary to the success of the whole group (Aronson, 2000). Without the pieces that each student has put together, the whole task results in failure. One such instance occurs when students must pick up the gas can to complete the first Mystery Quest involving the Burning Cabin.

In the Mystery Quest, students are asked by the Sheriff to discover who set the historic cabin on fire while he waits for the fire department from a larger town to help put out the blaze. Students find a series of clues including a foot print that leads them to the general store and the clue that all the kids in town where the shoes that match it; a matchbook with the name of the nearby hardware store on it which they retrieve from the kids; and finally, a clue from the hardware store owner that leads them to a gas can which is half buried in the ground behind the Old Windmill. Through their interactions with all these

characters, they also receive information that leads them to believe that a particular child committed the crime. However, before a student can retrieve the gas can, they must speak with the parents of the child in order to link the can to the young man, Herbert.

If a student simply skips ahead to take the gas can without speaking to the parents, they encounter a frustration point in which they cannot remove it. Not only does this scaffold the idea that there is a certain order in which evidence must be collected for it to make sense, it discourages communication that may be construed as "cheating." In every game, the concept of cheating exists. However, depending upon the designers intent, the concept of "gaming the system" within reasonable bounds is acceptable. This may come in the form of constructing shortcuts to overcome opponents such as single key-presses that allow for multiple sequences of actions. For example, in *World of Warcraft*, the option exists to bind multiple actions to a single function key (i.e. F1, F2, etc.). Pressing F1 would then result in a "jump-run sideways-strafe with gun-send pet to attack" sequence that is especially effective in player-versus-player combat.

However, in *Anytown*, there is no reward for skipping ahead to the end; in fact, if they do so, the student is stymied and must speak to friends through system chat, e-mail, and telegram in order to discover what they have done incorrectly. This experience enforces the idea that it is okay and even encouraged to aid peers; however, outright "cheating" results in unwanted experiences. Further, it may result in failure to have one's Quest accepted

because the player never gathered all the information that was required of them in order to write their informational report for the Sheriff.

These designed frustration points encourage student reliance on the system by making it difficult to complete the game-like tasks in the space without the aid of others. The fact that students in the lab who have the information that an individual needs are often quite distant and it is inappropriate to shout across the room, results in students discovering and making use of the technological affordances of the learning environment. These affordances allow them to send universally viewable messages (i.e. chat) or individual-only read messages (i.e. telegrams, e-mail). In addition, much of the information that students require is also found if they speak to the appropriate pedagogical agent who can direct them to the correct answer or clue. Further, by giving students these options for information gathering, the system gradually helps to replace the teacher's role as direct giver of answers, directions, or procedure. The hope is that this will free the teacher to spend more time giving additional feedback on student writing or working with students who require additional time in order to improve their writing. This freedom is expected to come from the reduction in time spent answering the same or similar questions about "What am I supposed to do?" or "How do I get the gas can?"

If the teacher has been trained well prior to an implementation, they would also view it as their task to redirect students to the system (soft scaffold), especially early in the instructional sequence when students are still overly-reliant on her for directions and help. In this instance, it is the system and peers who act

as teacher and provider of direction and information, not the classroom teacher. Thus, the teacher can engage more actively in their role as facilitator, informal and formal evaluator of student knowledge construct, and challenger of improperly constructed knowledge. This role can be engaged through the system by using the feedback process (formal) or through questioning students as she facilitates learning in the room, evaluating their understanding and challenging them as difficulties are discovered.

3.4 Comparison class and curriculum

Prior to their recruitment for this study, the comparison class was already engaged with the main worlds of Quest Atlantis, having completed multiple Quests over the course of semester leading up to the November *Anytown* implementation. As a result, the teacher and members of the class had worked with the designer on questions related to the Quest Atlantis novel *Archfall* during earlier class periods prior to this research study, so they had a previous relationship. Because they were an existing Quest Atlantis class, the teacher chose to continue taking her class to the lab during the course of the research study to take part in non-*Anytown* related Quests as was normal for that class.

The writing curriculum used in the comparison classroom was developed entirely by the classroom teacher that was observed. She made no modifications to the content she would teach over the course of the treatment in an attempt to conform to the specific curriculum of *Anytown*. Since she was already prepared to teach a four week lesson related to descriptive writing which she calls “sense

writing", which is the focus of her first semester, students were engaged in two to three hours of writing work per week. Sense writing involved the use of the traditional five senses: smell, taste, touch, hearing, and sight; however, the teacher also includes a sixth which she calls "feeling." *Interactive Writing*, *Literature*, and *Readers and Writers Workshop* were the titles of the time periods during which the comparison teacher engaged students in writing tasks.

Because the teacher's existing curriculum which she designed was already in place and was related directly to the form of writing that both environments were intended to allow students practice, this prevented the researcher from forcing an artificial curriculum into place that could be manipulated to fit with the way the researcher and designer views a "traditional" writing curriculum. Interviews were conducted with the comparison teacher during which time she explained how she planned to teach her descriptive writing unit that culminated with the creation of a publishable piece of descriptive writing at the end of a unit cycle. Appendix D provides additional description of the self-reported curricular activities (both mandatory and voluntary) that the teacher used during the data collection period.

3.5 Writing practice

The benefits for writing practice are expected to come from the increased writing practice that students will engage in as part of an intrinsic need to learn the outcome of the story that drives the writing in *Anytown*. Tuzun's (2004)

research argues that the use of a multi-user virtual environment has the following thirteen benefits for motivating student learning:

1. Allows student identity presentation to others
2. Increases opportunities for learner social relations
3. Allows playing activities with peers
4. Improves willingness to learn academic content
5. Leads to increased student achievement
6. Provides students with both intrinsic and extrinsic rewards
7. Provides an immersive context different from school
8. Engages students in a fantasy narrative
9. Allows uniqueness of student learning experience
10. Encourages student creativity in writing and developing solutions
11. Allows students to engage with their natural curiosity in a safe place
12. Provides students with control and ownership over their learning, and
13. Gives learners a context of support from peers and adults for learning

These motivational aspects of the learning environment itself are part of what is expected to improve student writing in the space. However, additional motivating elements have been embedded in the space beyond those present in the multi-user virtual environment that Tuzun observed. For example, as students complete writing tasks, new game tasks and pieces of the narrative unfold, which allows the students to piece together additional parts of the meta-mystery that is

the scaffold upon which each of the sub-narratives rest. The more Quests that students complete, the more they are rewarded for their perseverance on the game tasks and the writing; more clues are revealed, additional narratives intersect, and characters begin to open up as they provide additional information. This unfolding of story is part of what drives learner motivation in other inquiry learning environments like *River City* (Dede, 2006; Dede, Ketelhut, & Ruess, 2006), Quest Atlantis' *Taiga* (Barab et al., In preparation), *Whyville* (Foley, Jones, & McPhee-Baker, 2002). Like writing done related to science inquiry, the writing practice *Anytown* focuses on the use of social studies, science, and health, and mathematics content knowledge that is revealed through the emerging story as data they can use to explore, analyze, and interpret complex societal issues (Driver, Newton, & Osborne, 2000; Ryder, 2001; Zeidler, Sadler, Simmons, & Howes, 2005).

As in these science inquiry environments, students in *Anytown* are channeled to investigative activities that give them opportunities for discovery, reading followed by analysis of written, mathematical, and science content, and connections to real world work roles involving writing and science that they can aspire to such as a journalist which research by Linn, Clark, and Slotta (2003) have found can improve student understanding of the relationship between the work they are doing in the learning environment and future work for an adult career. The writing that students complete is modeled for them by the pedagogical agents, as was found effective by Baylor and Kim (2005), the written artifacts embedded in the space as hard scaffolds, a technique employed by

Brush and Saye (2003), and through written artifacts left by other students who have engaged in *Anytown* activities. This is in opposition to the comparison curriculum in which writing activities are provided only by the teacher and models of correctly written pieces are also given by the instructor. Further, the writing activities, clues, and non-human objects in the space include embedded hard scaffolds to help students through more difficult game and writing tasks which have been found by Brush and Saye (2001, 2003) and Linn, et al (2003) to be required as an aid for students when they encounter largely unstructured, open-ended activities like written response. These come in the form of character advice, instructional references on grammar, spelling, punctuation, and the writing process, as well as those that are embedded within the task language itself that acts as a guide for appropriate content and structure. In the comparison classroom, scaffolding is provided almost entirely by the teacher, although peers are allowed to give help and information to peers if they have received permission to do so by the teacher.

3.6 Summary

In summary, the design of the multi-user learning environment had been informed by social constructivist learning environment principles as well as game design principles resulting from analysis of several video games. The game-like learning environment, while limited by the *Active Worlds* and *Quest Atlantis* system, were designed and developed to balance the tension of ensuring that the learner has sufficient instructional and task scaffolding, while concurrently

engaging the student with frustrations that build interdependence with peers and the instructional system of *Anytown.*

The goal of this design was to free up the teacher to engage in fewer repetitive teaching behaviors such as giving directions regarding the task. In order to complete this, characters that functioned as pedagogical agents within the learning environment were structured to help reduce the teacher's burden while still including instruction and an avenue for the teacher to provide adequate feedback to the learner. At the same time the design was intended to engage students in engaging learning activities that they would volunteer to complete without teacher mandate. This was done through the revision of the design by including additional game-like activities in the form of Mystery Quests.

Chapter Four, Research Methodology, outlines the research methodology employed to determine the answers to the quantitative and qualitative questions outlined in Chapter One. The Research Methodology Chapter includes the following sections (1.) Introduction, (2.) Philosophy of inquiry, (3.) Research design, (4.) Participants and Setting, (5.) Conditions, (6.) Instrumentation, (7.) Procedure, (8.) Data Collection (9.) Data Analysis Procedures, (10.) Limitations of the Methods, and (11.) Summary.

CHAPTER FOUR: RESEARCH METHODOLOGY

4.1 Introduction

This study examined the *Anytown* multi-user virtual environment in a naturalistic, classroom context. Because such an environment includes many confounding variables that may have influenced the controlled variables, and that the researcher of this study was both designer of Quest Atlantis and an implementer of the project, this study employed mixed methods that included both quantitative and qualitative methods. Due to the relative infancy of the use of game-like structures and multi-user learning environments in education, the addition of qualitative methods to the quantitative was intended to allow the researcher to identify emergent tensions that result from the use of such an. Of particular interest were in-space struggles which interfere with or enable student learning in these contexts, teacher instructional behaviors that might interfere with the design intentions, and research methods that show special promise or result in tensions between researchers and student or teacher. By generating quantitative and qualitative findings, this study hopes to build support for the use of such learning environments as a supporting tool for improving student learning while explaining the specific issues that influenced the outcomes of the study. Specific quantitative research questions included:

1) Were there significant differences between the treatment and comparison teachers on time on the task of answering directional and procedural questions?

2) Were there significant differences between the treatment and comparison classes in terms of the number of voluntary writing activities completed, and

3) Were there significant differences between the treatment and comparison classes in terms of their standardized achievement scores from the beginning of the treatment to the end?

The qualitative focus of this study was to describe the differences between the manners in which learning unfolded in the *Anytown* multi-user virtual environment treatment classroom versus the comparison classroom.

4.2 Philosophy of inquiry

What is real or true? How do we know what is real from what only exists in the mind? These questions must be answered if we are to understand what can be known through inquiry. Before illustrating any experience, the ontological ("what is") and epistemological ("what can be known or how we come to know it") assumptions underlying the research must be made clear (Bernstein, 1983). The methods by which we seek to reach any truth must be consistent within the ontological and epistemological view upon which the search for truth has been undertaken. The researcher's belief about what exists and how one comes to know it inform any research findings or conclusions that stem from the methods used to seek truth.

The idea of positivism has been the basis of scientific inquiry since the time of Descartes (Hollis, 1994) and purports that there is a reality beyond our own minds (“ontology”) and that we may achieve know ledge of this reality through our senses (“epistemology”). Using empiricist methods based upon the senses (such as using the scientific method,) a researcher can make claims about the world, an objective truth, or an observed phenomenon. From this experience of truth, the researcher can then make claims about the nature of reality without slipping into relativism in which the findings are only relevant to a particular observed occurrence or overly laden with subjective statements that are personal to the researcher (Bernstein, 1976, 1983; Robson, 2002).

However, alternate views also exist about the nature of reality and what can be known as presented by Denzin and Lincoln (2003), which claim that either there is no objective reality to be known or that while there is an objective reality, our senses and the scientific method are unable to provide us with sufficient information to provide us with an accurate picture of reality. These views fall within the relativist perspective that holds that there is no reality but that which we make for ourselves individually. The contextualist perspective that argues that reality is socially constructed and agreed upon by groups of people (Bernstein, 1976, 1983; Hollis, 1994). As a researcher and designer, I believe that the contextualist perspective guides my curricular designs and research methods, although it is tempered by the reality of a society that still largely embraces a positivist perspective along with its need learning assessments that show numbers that are believed to correspond to observable learning gains in

students. However, I believe that these perspectives can be balanced and that contextualist influenced instruction and assessment can also result in positivist-measured learning gains.

A mixed methodology of quantitative and qualitative research is appropriate for the following reasons: 1.) the first three research questions focus on items that can be counted and therefore known such as the amount of time spent by a teacher answering specifically formulated questions or how many times a particular form of activity are completed by students during a set period of time, 2.) these questions provide the answer to whether or not the quantities reached significance but not why or why not, 3.) claims about the differences between the classrooms focus on the qualities that make them different which identify areas for future research, making qualitative inquiry an appropriate method for further interpreting the quantitative findings. As this is a relatively new field, the qualitative findings will be useful for guiding future research and design because they provide context for the tensions and experiences by which the quantitative results were generated.

This chapter includes sections on (1.) Research Design, (2.) Participants and Setting, (3.) Conditions, (4.) Instrumentation, (5.) Procedure, (6.) Data Collection (7.) Data Analysis Procedures, (8.) Limitations of the Methods, and (9.) Summary.

4.3 Research design

This research study employed a quasi-experimental, pretest-posttest comparison design to measure the effect of a curriculum-based, 3-D learning environment on student standardized writing achievement. It is quasi-experimental because students were randomly assigned by the school to be in one class or the other class to two classes which were randomly assigned to the treatment or comparison group. The pre and post test measures were counter-balanced by splitting the two classes and randomly assigning students to one of two prompts. Random assignment was completed by drawing names from a hat and assigning students to a pre or post test prompt. Whichever prompt a student did not complete for the pretest, he or she competed as a posttest. Each pre and post test was a standards-based writing prompt selected from released prompts from the California Achievement Program and New Jersey Assessment of Skills and Knowledge, which were aligned to the targeted content standards.

The independent variable in this design is the type of instruction (*Anytown* Language Arts Unit or Reading Curricular Unit) and the dependent variable is student achievement on a post-test writing activity taken from a released state standardized examination as well as their submitted work (close assessment). The validity and reliability already validated to be used for standardized tests and were appropriate for the age group by either the state of California or New Jersey and had been used for standardized testing in those states.

4.4 Participants and Setting

4.41 Setting

There were two settings used for research in this study. The first was the school itself and the second was the technology-supported learning environment in which the students engage with the learning, entertainment, and metacognitive activities. The elementary school will be located in a small Midwestern city near a large, land-grant research university.

4.42 Participants

The participants are be 44 students in two 4th grade classrooms, split evenly between two teachers who commonly use face-to-face problem-based learning environments in their instructional methods. These students were quasi-randomly selected as they were recently randomly selected by the school's computer system for assignment to each classroom.

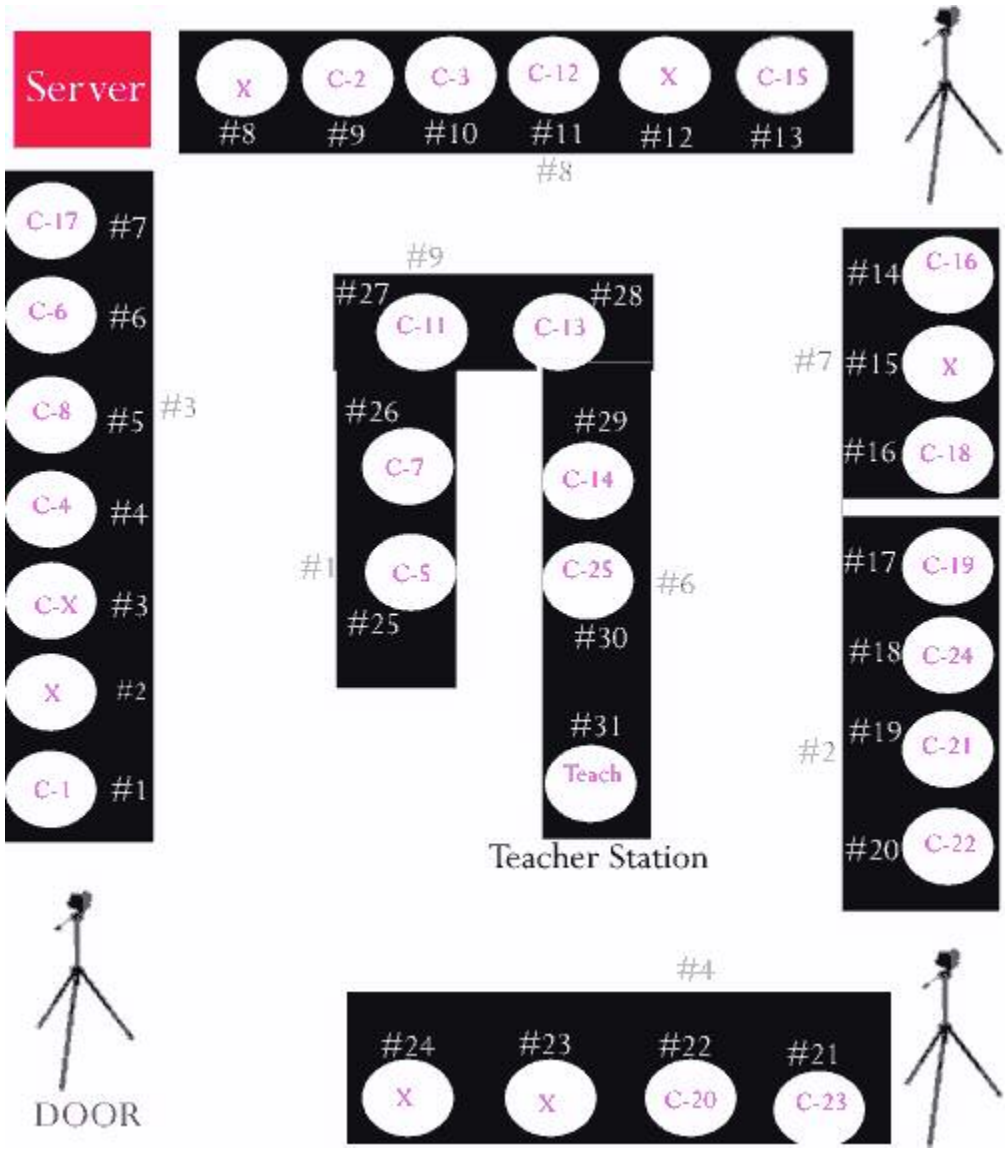
4.5 Conditions

4.51 Primary Treatment Condition

The treatment was student completion of a language arts and reading unit that exists completely within the designed multi-user virtual environment known as *Anytown*. Within this unit, students completed problem-based writing activities embedded within the *Anytown* setting. The environment was customized to include specific learning activities related to practicing descriptive writing, engaging in problem-solving and reflecting upon their own personal experiences.

The teacher in the treatment condition was recruited for several reasons. While she has been part of *Quest Atlantis* for the past two years, she has not been an active one. During pre-recruitment discussion, she noted that she is largely uncomfortable with technology and that her classes had not been in the learning environment prior to the treatment. Her lack of experience with both technology and with *Quest Atlantis*, within which *Anytown* is housed, made her an excellent teacher for this condition because she and her class would not be entering the treatment with pre-set expectations about what they were to do and how to act as an instructor in such an environment. This would allow the treatment to unfold as it would for the majority of teachers who would use a video-game influenced multi-user virtual environment for the first time. The treatment class itself would be starting at the base tutorial stage learning how to navigate in the *Quest Atlantis* environment, use objects, begin to immerse themselves in the narrative, and approach *Anytown* without having spent a lot of time exploring the environment and testing the system prior to their participation in the treatment. Figure 6 shows the layout of the lab during the treatment.

Figure 5.
Layout of the treatment computer lab



The treatment itself, the *Anytown* multi-user virtual environment was created using the Active Worlds browser that is the underlying digital system for the *Quest Atlantis* grant project. While other towns elsewhere in *Quest Atlantis* are fantastic, otherworldly realms in which the architecture defies physics, employs “teleports” that move students rapidly from place to place, or simply

have no analog on Earth, the design of the *Anytown* environment is intended to create a small town feeling in which the locations, people, and other objects would be mostly familiar to the majority of participating students. The design followed this plan in order to set student learning in an environment for which they already have some background knowledge. This idea also helped to match the "modeling reality characteristic" from this designer's definition of game which helps to situate the learner in a modeled space that is not radically different from their own experience of a town. This was expected to allow students to readily recognize the affordances of particular locations such as the general store, the school, and the library as many have similar locations in their own real-world contexts.

Given that these are not twenty-five-year old medical students who may be more readily expected to solve their own problems with little guidance, much more instructional direction in the form of textual and visual scaffolds were embedded in the *Anytown* unit. These came from the dialogue of characters in the space, three dimensional signs, interactive environmental features of the space, and from developmental nature of the learning tasks themselves as described in Chapter Four.

The writing, mystery, and metacognitive reflection tasks in the *Anytown* learning environment increased in difficulty and complexity over time as is often found in high quality classroom instruction. This was expected to allow the learner the opportunity to gain competency with developmentally appropriate writing, critical thinking, and cognitive-reflective practices prior to moving to the next set

of tasks. Further, the feedback students received from the teacher in the form of recommendations for revision prior to the acceptance of a piece of writing was expected to act as a scaffold and gate-keeping method.

Contingent on the provision of adequate hard scaffolds in the form of in-game tutors and resources (Baylor, 1999, 2005; Baylor & Kim, 2005), it was believed that providing increased student control over of the exploration of learning environment and their own writing products would improve student willingness to engage in voluntary writing practice while improving reading skills. This was expected to be further reinforced when combined with teacher soft scaffolds in the form of verbal guidance and an immersive, authentic context, and authentic tasks linked to future work and learning goals that has been correlated with increased learning in other face-to-face learning environments (Ge & Land, 2003; Hedberg, Brown, & Arrighi, 1998).

4.52 Comparison Classroom

This teacher was asked to be the comparison teacher for several reasons. The first reason is that, based on pre-recruitment discussions with her as she helped her students use *Quest Atlantis*, her teaching methods are based in large part on the problem-based learning approach proposed by Savery and Duffy (1995), making her face-to-face approach to instruction somewhat comparable with the approach taken in the *Anytown* environment. Further, in contrast with the experience of the teacher asked to lead the treatment condition, the comparison teacher reported and showed evidence in past interactions with the researcher

that she has much higher levels of expertise related to teaching with innovating technologies. This expertise was more likely to act as a confounding factor in any interpretation as to whether the learning environment would be responsible for improvements in student learning found during the study. In addition, the teacher reported in pre-recruitment talk that she already taught a unit related to descriptive writing during the semester that the study would take place related to description using the senses and therefore there would be no need to impose an artificial curriculum on the comparison teacher. A final important factor was that both the teacher and students in the comparison condition had already used *Quest Atlantis* more than half a dozen times during that semester, so there would be little to report in terms of student learning challenges related to using an innovative technological curriculum because many of these would have been mitigated during those initial training session. Without observation of these challenges, it would be likely that the researcher would fail to see inherent problems in the design because students may have already developed adaptations that permitted them to succeed where a less experienced class would have been met with failure.

The comparison classroom teacher provided the writing curriculum to which the *Anytown* Language arts unit was to be contrasted. Rather than try to create a “traditional” curriculum and in order to maintain high validity in terms of referring to the comparison curriculum as authentic, the comparison teacher used her existing descriptive writing curriculum and taught writing the way that she normally does over the course of the data collection period. As noted in Chapter

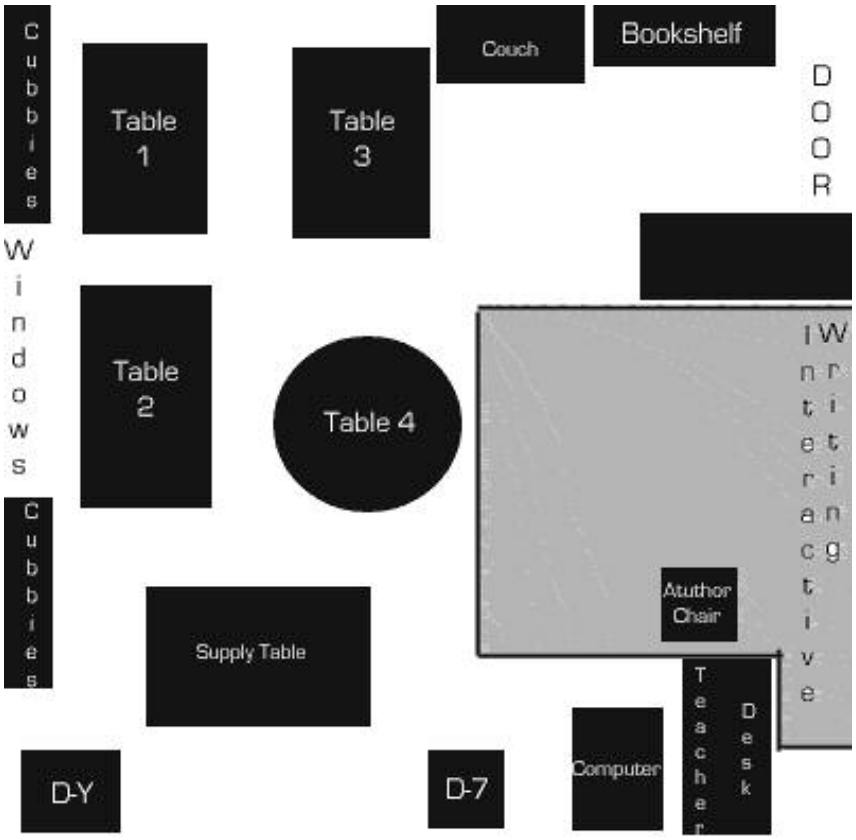
Four, the establishment of the teacher's existing curriculum prior to the implementation was an attempt to prevent the researcher from forcing an artificial curriculum on the comparison teacher. This would be problematic, because it may be viewed as "traditional" by the researcher/designer, but may be completely off-base from how the teacher views a modern "traditional" curriculum, reducing the validity of the curriculum and the findings of this study.

In terms of her own curriculum development, the teacher was apprised by the researcher of the standards that would be addressed by the *Anytown* curriculum and what assessment measures would be used to compare the performances of her students with the performances of those students in the comparison group. The teacher also developed a series of voluntary writing activities that would parallel those that were offered in *Anytown*. Students were able to complete these activities if they chose, but they were not required to do so, similar to the approach taken with the voluntary Mystery and Reflection Quests present in *Anytown*. As noted in Chapter Four, Appendix D provides a listing of the curricular activities that she offered or mandated during the study.

The voluntary activities in both the comparison and treatment classes qualify as "free choice activities" in which students may choose to do or not depending on personal preference (Nevius, 1982). These are in opposition to directed activities, called mandatory activities in the *Anytown* curriculum, which are required by the teacher or the system. It is student participation in these game-infused voluntary activities that acts as a measure of whether or not students are motivated by them. The number completed and the amount of time

that they spent working on these activities is an indicator of their level of engagement (Sorensen & Maehr, 1976). In the case of this study, it is student motivation to complete these voluntary activities while engagement will be the focus of future studies. In order to keep these activities free or voluntary, the teacher in the comparison classroom introduced the activities as options for extra practice as she ordinarily did in her class. The free-choice activities are tied thematically to the mandatory writing work that students were assigned by the teacher to complete either alone, in dyads, or in larger groups. Figure 7 shows the layout of the comparison classroom.

Figure 6.
Layout of the comparison classroom



4.6 Instrumentation

4.61 Activity-oriented assessment (Close measures)

These are the writing products that students produced as they progress through the *Anytown* unit which are submitted through the online system. These documents were analyzed to determine if students made incremental improvements in their writing based on feedback over time. They included mandatory Writing Quests and three forms of optional writing practice Quests:

investigative Mystery Quests, metacognitive Reflection Quests, and Creative writing Quests.

The three required *Writing Quests* included in the descriptive writing portion of the *Anytown* Language Arts world were intended to allow the teacher to gauge student achievement on a progressive scale. The initial introduction Quest "Welcome to *Anytown*" allows the teacher to establish a baseline in terms of the level of descriptive writing they are currently able to achieve. Successive Quests were evaluated by the teacher in terms of progress between Quests. Teacher assessment rubrics and direction asked them to examine the level of improvement in student detail, elaboration, and extension from their first Quest to their last.

Within the *Mystery Quest submissions*, teachers were encouraged to look at the improvement of a student's writing from the Burning Cabin Quest to the Graffiti Quest rather than judge solely on a single standard or against other students' work. Further, as these Quests were intended to help students to narrate their experiences and use evidence to support their mystery solution, the level of detail with which they describe their experiences, the clues, and support their solution were all be important pieces of the assessment.

The *Reflective Metacognitive Quests* asked students to think deeply about their experiences in *Anytown* and engage in different kinds of writing more similar to reflective journaling. Some of these Quests asked students to do writing in which they compare their home town to *Anytown* and identify what is missing or what they wish were there. As teachers assessed these Quests, they were asked

to look at the depth of student reflection and how well they defended their answers. *Creative Writing Quests* allowed students to practice writing poems, short stories, legends, or creating art objects to accompanying a creative writing piece.

The work produced by students in the comparison classroom was largely generated in groups through the Interactive Writing and Readers and Writers Workshops. Students shared their work through peer review, group sharing, and written submission to the teacher. Much student writing work was done in multi-colored markers on large blank sheets of paper that the teacher had pinned to the wall in the Interactive Writing area. Students wrote sentences and paragraphs on these sheets, editing them with specifically colored markers that indicated spelling and grammar problems. For further description, see the description of the comparison classroom in Chapter Six of this dissertation. While they were present in the classroom, researchers were also given access to student work as it was generated and then again prior to its return to students. Further, Quests completed by the comparison students while in Quest Atlantis were reviewed and assessed on the same rubric that was applied to student work in the treatment condition.

4.611 Rubrics. A rubric was developed for each Quest and each Quest was evaluated by multiple raters to produce a mean score for each. Due to the large number of *Anytown* Quests (28), the rubric used to grade these is included in Appendix I.

4.62 Curriculum-oriented Assessment (Proximal measures)

Student writing achievement changes were measured by a total of two pre- and post-treatment writing activities. Namely, students in both the comparison and experimental groups responded to one of two randomly assigned writing prompts prior to engaging in the *Anytown* unit or the existing curricular activities. The pre-test prompt acted as a base-line for where student writing skills and knowledge of the traits of good writing stand prior to treatment. One week following the completion of the unit, students responded to the writing prompt that they did not use as a pre-test and it served as a post-test. Each was evaluated on a rubric tailored for each prompt by multiple raters trained to evaluate student language arts and reading work. Using the resulting ratings, pre- and post-test mean scores for both classes and individual students were created. These prompts can be found in Appendix B.

4.621 Rubrics. New Jersey ASK assessment rubrics specific to each prompt were used to determine whether there is an improvement in student writing from the beginning of the unit to the end, with each Quest as a stage marker. An example of these prompts is included in Appendix J.

4.63 Standards-oriented Assessment (Distal measures)

As with the curriculum-oriented measures, student writing achievement changes were measured by a pre- and a post-treatment writing response activity. In this instance, the prompts were not closely matched to the type of descriptive writing completed by students during the *Anytown* treatment to qualify them as

distal measures. Namely, students in both the comparison and experimental groups responded to the one of two randomly assigned standards-oriented writing prompts prior to engaging in the *Anytown* unit or the existing curricular activities. One of the pre-test prompts acted as a base-line for where student writing skills and knowledge of the traits of good writing stood prior to treatment. One week following the completion of the unit, students responded to the writing prompt that they did not use as a pre-test and it will function as a post-test. Each was evaluated on a rubric tailored for the prompt by multiple raters trained to evaluate student language arts and reading work. Using the ratings, pre- and post-test mean scores for both classes and individual students were created. These prompts can be found in Appendix B. The scores will be presented in the Results chapter.

4.631 Rubrics. California standards rubrics specific to each prompt were be used to determine whether there is an improvement in student writing from the beginning of the unit to the end, with each Quest as a stage marker. Multiple raters trained in evaluating writing were used to assess scores based on these rubrics for the prompts. A copy of the prompt may be found in Appendix I.

4.7 Procedure

First, students in both classes were randomly assigned to either distal prompt by drawing student names from a hat. This was repeated for the proximal prompt. Following this assignment, both classes wrote in response to the prompt they were assigned as a pre-test that the researcher will administer. Next, both

groups began their writing process. For the treatment group, this meant that they began visiting the computer lab and engaging with the *Anytown* environment. For the comparison group, they began their pre-planned writing unit as described in Appendix D and in the Results chapter. Students in the comparison group continued through their normal writing process until they completed a published piece at the end of the data collection period. However, the comparison students were also provided with poster boards and typed teacher directions that gave them directions for doing additional voluntary writing practice which were as similar as possible to those that students in the treatment group had available to them in *Anytown*. Students in the treatment group completed *Anytown* activities which directed them to create a small number of published pieces related to descriptive writing. At the end of the data collection period, each group completed the writing prompt that they did not receive (distal and proximal) during the pre-test as a post-test measure in order to ensure the counter-balancing. This was also administered by the researcher. Once all prompts were collected, analysis began. All writing prompts, both proximal and distal, are available in Appendix B.

4.8 Data collection

4.81 Comparison measures

As discussed above, the primary comparison measures are the in-class writing activities and the student standardized writing activities. These measures are intended to measure the difference between the writing practice and

achievement between the comparison and experimental groups, as well as the difference in time spent by the teacher answering basic procedural and directional questions posed by students.

Additionally, the voluntary writing practices of these students were examined as an indicator of student motivation to engage in writing. This was measured by tallying the number of non-required writing Quests completed in the experimental group versus the number of optional writing assignments completed by students in the comparison group during the same time period. Many of these voluntary activities were available to both classes in digital and paper or poster forms and acted as free-choice activities which have been found to indicate that they act as motivators for student participation in learning (Nevius, 1982; Sorensen & Maehr, 1976). In the comparison classroom, these voluntary activities consisted mainly of optional writing prompts provided by the teacher that students were encouraged to respond to as a means of improving their descriptive writing. Voluntary writing activities in the treatment class consisted of optional Quests related to descriptive writing in the form of solving mysteries or metacognitive reflection activities in which visual or physical elements of the virtual town are compared with a student's own town. In both instances, students were also provided with opportunities to engage in creative writing tasks such as developing poems, short stories, myths, and legends. In both conditions, the activities did not come from a single place, but arose throughout the learner's experiences in their learning environments.

The voluntary writing Quests are also important because a survey of research from the 1950s to the 1990s conducted by Krashen (Krashen, 1991) indicates that the total amount of student writing practice is correlated with improvements in overall student writing quality over time. Therefore, the amount of time that students are willing to spend engaged in voluntary writing practice in addition to their required writing practice should correlate with general improvements in student writing. Combined with a motivation to practice writing unprompted by an authority figure and increased feedback from the teacher on the specifics of their writing such as grammar and spelling, students should see marked gains in their writing achievement as assessed by standardized scores on graded prompt responses.

4.9 Observation measures

For the purposes of this study, qualitative research is defined as that which "seeks answers to questions that stress how (sic) social experience is created and given meaning" (Denzin & Lincoln, 2003, p. 13). Also, for this research study, a case study is defined as "a phenomenon of some sort occurring in a bounded context" (Miles & Huberman, (1994), p.25). Jonassen and Hernandez-Serrano describe the use of case based reasoning as "entail(ing) the elicitation, analysis, and inclusion of stories as a primary form of instructional support" (2002, p. 65).

Qualitative methods tend to look at qualities, characteristics, and attitudes inherent in a system. The use of observations and interviews as primary methods

of data collection allows qualitative researchers to make sense of a situation or of what happened in a system prior to an intervention, and what is happening since that intervention (Denzin & Lincoln, 2003; Gall, Borg, & Gall, 1996). This examination of the system may take place as a formative review, or as the intervention occurs, or as a summative review of the interactions, benefits, and detriments stemming from the implementation of an intervention. All field notes, interviews, and a selection of audio and video recordings were transcribed and printed out. Collectively, observation measures totaled 241 pages.

4.91 Field notes

These notes were taken by at least three observers trained in qualitative methods over the course of the collection period and focused on student interaction with the embedded scaffolds, willingness to complete tasks that included nested goals and face-to-face discussions related to the narrative context or the explicit rules of the learning environment. During laboratory and classroom instruction periods, researchers observed the teachers in both the comparison and experimental group and recorded instances of teacher procedural or directional question answering behaviors in their field notes. These field notes have been used to generate initial hypotheses about student learning and writing practice in both conditions. These hypotheses were verified using triangulation in which interviews were also used as member checks. In addition, audio and video segments were used to confirm what was observed and

recorded in the field notes. The field note coding scheme that was generated by five of the observers and was used is listed in Table 4.

Table 7.
Field note coding scheme.

Text Color	*Code*
Light blue	Peer help (ph)
Dark blue	Voluntary activity (Quests, outside school work) (va)
Red	Frustration point, problem, or question (fp)
Light green	Informal assessment
Pink	Hypothesis (nascent or otherwise, includes claims) (h)
Light Gray - (25%)	Clarifying question (cq)
Yellow	Teacher redirect to system (tr)
Violet	Other tension (ot)

( ) = text tag

This scheme was developed by the group of researchers who completed the *Anytown* observations. It began with a large number of possible codes identified by each member and each was then folded into larger categories that were agreed upon by the group. Each is related to student discourse.

4.92 Informal and semi-structured interviews

Semi-structured and informal interviews were conducted with the comparison and treatment teachers during the data collection period as events occurred that warranted interview as well as at the conclusion of the data collection. While the questions that were asked informally may have been unpredictable, the semi-structured interview protocols for pre- and post-treatment are located in Appendix E. They have been used as a means of gathering data

about student and teacher learning and teaching experiences and to member check codes and hypotheses generated by using other data.

In addition, these same semi-structured and informal interviews were also conducted with students during the course of the period and were conducted as need arose with a small number of students at the conclusion of data collection to gain summative data. The semi-structured interview protocol that was used is located in Appendix F.

4.93 Audio and video recording

MP3 audio recordings of different groups of students as they work through *Anytown* and the comparison group were collected throughout the data collection period and have been transcribed. Video was collected throughout the period to capture student interaction outside the digital environment and during face-to-face, teacher-led activities supporting *Anytown* as well as in the instances of typical comparison teacher-led writing activities.

4.10.1 Data analysis

Several means of analysis were used, depending on the data collection methods employed. The quantitative data were analyzed using analysis of covariance procedures in which the dependent variable was student writing improvement as measured by the posttest essays, and the covariate was student writing achievement, as measured by the pretest essay. The ninety-five percent confidence level ($p < .05$) was be used as the criterion level for determining

statistical significance. The criterion for determining educational significance was be one-third of a standard deviation ($\Delta = 0.33$). Analysis also focused on both student writing activities and the pre- and post-test writing prompts that were completed during the four week period.

Qualitative data was analyzed using grounded theory in order to identify emerging themes to support or contextualize the quantitative findings. These procedures include the coding of repeated ideas and the collection of these topics into broader themes. Once these themes were identified, they were classified into relevant categories for later interpretation and use in supporting the findings of the researchers. Specific methods of analysis for the interviews and observations are described below.

4.10.11 Interview and observation analysis

Transcription of taped interviews and teacher speech acts committed during the course of the implementation were conducted by the interviewer in the interests of accuracy and completeness. Each transcript was typed verbatim from interview recordings and used for coding and analysis. The number of researchers was limited to one writing and coding the transcripts for the purpose of establishing a relevant coding scheme and generating useful themes for explaining the results. These codes and themes were verified by outside raters to determine the validity of each. This analysis reflects procedures recommended Denzin and Lincoln (2003), Gall et al, (1996) and Carspecken (1996).

Handwritten notes from the observations were typed and included for consideration as themes were drawn from the interviews. These observations serve to triangulate the findings. Triangulation, a strategy for verifying the internal validity of the documents, was conducted by correlating the observations with participant interviews and the examination of received documents (Gall et al., 1996). Themes generated by the researchers were brought to the participants for member checks and discussion. This collaboration allowed the interviewees and participants to verify that the themes are accurate and allow a consensus to emerge related to the findings and implications. In addition, the logic related to the generalizability of the findings generated by this case based research endeavor is considered to be generated through reader/user generalizability in which the reader is expected to determine the applicability of the research within their own context or situation as suggested by Cronbach (1975) and Wilson (1979).

Interviews were conducted prior to implementation in order to establish the pre-treatment view of instruction. These were done with the comparison and treatment teachers, as well as with the instructional designer of the multi-user virtual environment. By establishing such data, more valid claims are able to be made during the analysis phase.

4.10.2 Summary

This mixed methods study that focused on the *Anytown* game-based multi-user virtual environment employed both quantitative and qualitative research methods in order to collect the raw data. Quantitative analysis was then conducted using SPSS to determine statistical significance of the findings through the use of t-tests for the first two research questions and repeated measures ANOVA for the question related to proximal and distal achievement. Using a mixture of the constant-comparison method, computer-mediated discourse analysis, and critical ethnographic methods, assertions were produced about discourse, teacher training, student interactions, and tensions arising from power relationships within the treatment class. Both an empiricist and a contextualist ontological perspective were used by the researcher to develop the methods employed as a means of asserting underlying truths related to the study. This study examined the use of the *Anytown* multi-user virtual environment by focusing on both the teachers and students in the treatment and comparison classes who participated in the study to identify differences between the experiences of students engaged in a more traditional, non-digital writing curriculum versus those students who engaged with the designed learning environment. Those claims presented in the following two chapters focused on the quantitative and qualitative findings are grounded in the data collected for this study. They were also validated by the use of multiple data collectors, coders, member checks, and multiple data sources.

CHAPTER FIVE: QUANTITATIVE RESULTS

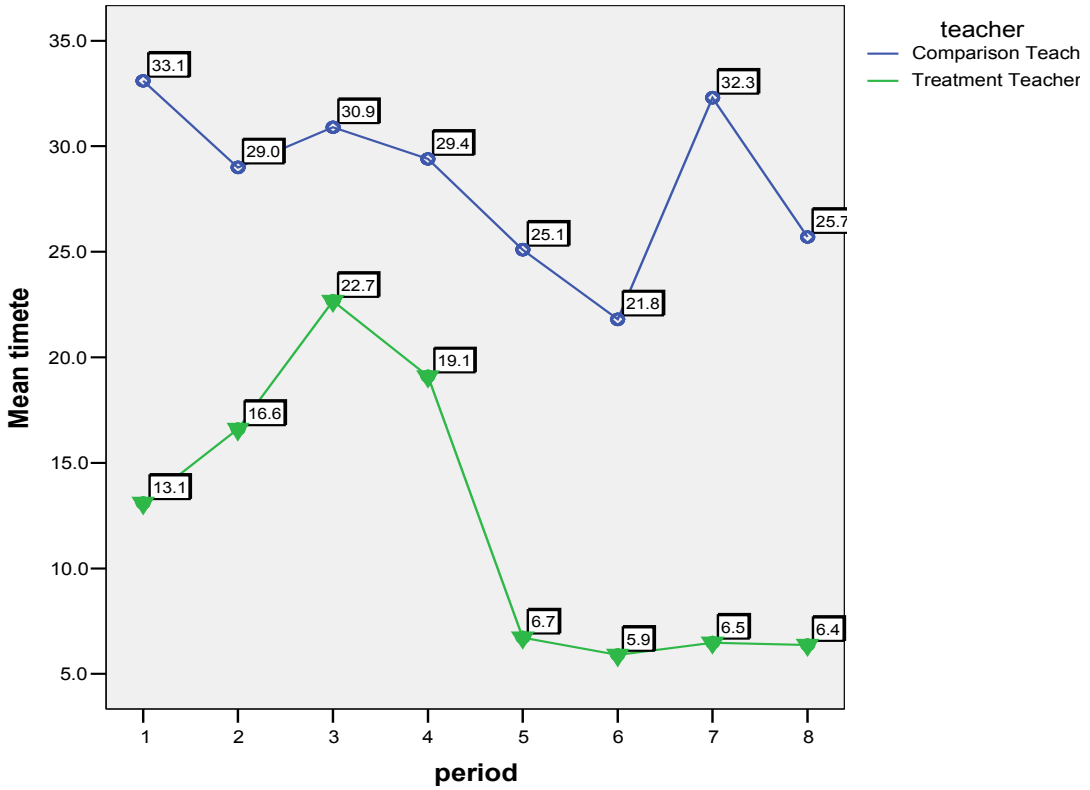
In this chapter, the quantitative findings of the study are presented. The quantitative findings presented here represent the results of analysis conducted on three separate hypotheses. These hypotheses were that 1.) the teacher time spent answering directional questions would be reduced significantly in the treatment condition, 2.) the amount of voluntary student writing activity would be greater in the treatment condition, and 3.) the standardized achievement of students would be higher in the treatment condition. The results for each hypothesis are presented in the following sections.

5.1 Hypothesis One – Teacher time on directional questions

This data used to test this hypothesis was identified by matching the field notes produced by four different researchers with audio recordings and transcripts of those recordings. The individual lines of these transcripts were then copied into Excel spreadsheets and each line that corresponded to student questions about directions or procedure for completing the task were identified by color-coding them. All other forms of discourse were also similarly coded using text color or highlight color to discriminate various student and teacher behaviors. Each line has a time-stamp and the amount of time spent by the teacher for each student-teacher interaction was totaled. After the entire transcript was encoded in this way, the total number of seconds spent asking or answering these types of questions was recorded. The number of seconds divided by 60 was used to produce the total number of minutes spent by the teacher.

For this question, a paired-sample t-test was conducted on the teacher time spent answering scores to see if the mean for Teacher C was significantly different from the mean for Teacher D. With the alpha set at .05, the paired-C-sample t-test showed that there are significant differences ($t(15) = 5.947$, $p = .043$) between treatment ($M = 12.118$, $SD = 6.6951$) and comparison teachers ($M = 28.413$, $SD = 3.9033$). The following chart presents the mean time spent providing direction about the task over the course of the eight periods of the treatment by teacher.

Figure 7.
Time spent by teacher on directional questions



Note: **Mean timete** is presented in minutes.

The above graph shows differences between the amount of time spent by each teacher answering questions about task directions or procedures for completion of the task. The amount of time spent by the treatment teacher shows that on the first four days of the implementation she spent nearly time on directional or procedural prompts, but this dropped significantly over time.

The amount of time spent by the treatment teacher shows that on the first two days of implementation, she spent nearly the same amount of time answering directional or procedural questions about the nature of the student

tasks. However, by day four, the teacher time spent answering such questions is much reduced. Further, in both instances, the comparison teacher spends more time answering such questions within each hour of instruction.

5.2 Hypothesis Two – Voluntary writing activity

This hypothesis was tested by collecting the voluntary writing assignments that were produced by students in both the treatment and comparison classes. A voluntary assignment is defined here as any writing activity that is presented by the system or teacher as an option, but is not mandated by the teacher (or system) as part of the student's daily work. Further, the work is not graded.

In this study, students in the treatment group worked on or completed thirty required writing activities. In addition, they also worked on or completed twenty-six voluntary writing activities. The findings do not include any voluntary writing activities from the comparison class because they completed none. In addition to the four voluntary activities provided by the researcher that parallel the *Anytown* creative writing Quests, the comparison teacher also provided several additional opportunities for students to write voluntarily. These included descriptive, compare and contrast, or creative pieces related to the main writing trajectory of the class. That trajectory involved writing sensory descriptive pieces. The students attempted neither the teacher nor researcher provided writing opportunities.

For this question, a paired-sample t-test was conducted on the teacher number of voluntary writing activities completed to see if the mean for the

treatment class was significantly different from the mean for the comparison c. With the alpha set at .05, the paired-sample t-test showed that there are significant differences (t (40) = -16.410, p =.006 between treatment (M = 1.0870, SD = .288 and comparison classes (M = .000, SD = .000).

5.3 Hypothesis Three – Student achievement scores

The achievement scores for hypothesis three are broken up into three sections. The sections related to the types of achievement scores depending on the relative similarity of the achievement task to the learning tasks which comprise the treatment. The three levels, as described by Hickey and Pellegrino (2005), are close, proximal, and distal. Close level assessment is comprised of assessment tasks that include the same content and expected skill performance, but are not the exact same activities that students engaged in as part of the treatment. Proximal level assessment involves assessment of performance in a different context and with different content than existed in the primary learning activities and established curriculum. Distal level assessment is commonly focused on student use of learned skills in new or substantially different contexts or new domains (i.e. social studies instead of science) (Hickey & Pellegrino, 2005; Hickey & Schafer, In press; Hickey, Zuiker, Michael, Schafer, & Taasobshirazi, Under review).

5.31 Close level scores

Close level achievement scores were produced by collecting the Quest writing prompts that were completed by the students over the course of their time in *Anytown*. Scores were produced by three teachers who acted as graders for iterations of each Quest. Iterations were produced by students in response to treatment teacher feedback. Close level scores were only produced for the treatment class as the comparison class did not complete *Anytown* Quests.

For this question, a paired-sample t-test was conducted comparing the scores of students on the mandatory Quests with scores on the voluntary Quests. This was done to determine whether the mean for the mandatory scores was significantly different from the mean for the voluntary Quest scores. With the alpha set at .05, the paired-sample t-test showed that there were no significant differences ($t(24) = -9.505$, $p = .666$) between the scores on mandatory Quests ($M = 1.67$, $SD = .752$) and voluntary Quests ($M = 2.73$, $SD = .518$).

5.32 Proximal level scores

Proximal achievement scores on the standardized writing prompts were measured using rubrics that were tailored to each prompt by either the state of New Jersey or state of California prompt, depending on which state had validated the instrument and used it for a standardized assessment of student writing. Three graders, all teachers trained in the grading of writing prompts, used rubrics to independently grade the pre and post-test prompts. The scores were on a six point scale to evaluate whether students could identify and use the

characteristics of good writing. One is lowest possible score, six was the highest. Inter-rater reliability was developed by providing the same normed rubric to all three graders who talked through the grades under the lead of the most experienced teacher to get 100% agreement.

For this question, a repeated-measures analysis of variance was conducted comparing the pre and posttest scores for each class with the pre and posttest scores for the treatment group with those of the comparison group to determine whether significant differences existed.

Table 8.
Proximal pre and posttest means and standard deviations

Teacher	Mean	Standard Deviation	Number
D-Pretest	1.86	.56	19
C-Pretest	2.16	.53	23
Total	2.02	.56	42
D-Posttest	1.79	.56	19
C-Posttest	2.49	.68	23
Total	2.18	.72	42

With the alpha set at .05, the repeated-measures ANOVA with a Bonferroni adjustment showed that the scores on the proximal posttest differed significantly (F (1, 40) = 4.32.) The following table presents the proximal data:

Table 9.
Proximal level repeated measures analysis of variance results

Source of Variation	**SS**	**V**	**MS**	***F***	***P***
Between Subjects					
Comparison teacher (T1)	179.25	1	179.25	725.25	.000
Treatment Teacher (T2)	2.62	1	2.62	10.59	.002
Within Subjects					
Factor1 (F1)	.36	1	.36	1.84	.183
F1 * teacher	.85	1	.85	4.32	.044
Error (F1)	7.84	40	.20		

Note: *Factor1 = Mean Pretest (PRD) and Mean Posttest (POD)*

5.33 Distal level scores

Distal level achievement scores on the standardized writing prompts were measured using rubrics that were tailored to each prompt by either the state of California or state of New Jersey and were validated and used by these states. These prompts were graded on a four point scale, with four being highest and one being the lowest score. The same three grades who graded the proximal prompts also graded these distal prompts. As with the proximal scores, inter-rater reliability was developed by providing the same normed rubric to all three graders who talked through the grades under the lead of the most experienced teacher to get 100% agreement.

For this question, a repeated-measures analysis of variance was conducted comparing the first Quest iteration scores with the last iteration score

scores to determine whether the mean for the final iteration scores was significantly different from the mean for the initial Quest scores.

Table 10.
Distal pre and posttest means and standard deviations

Teacher	Mean	Standard Deviation	Number
D-Pretest	2.32	.50	19
C-Pretest	2.36	.61	23
Total	2.34	.56	42
D-Posttest	2.05	.54	19
C-Posttest	2.17	.56	23
Total	2.12	.55	42

With the alpha set at .05, the one-way repeated-measures analysis of variance showed that the scores on the distal posttest did not differ significantly (F (1, 40) = 6.77, $p < .05$) by teacher. The following chart reports the relevant distal data.

Table 11.
Distal level repeated measures ANOVA results.

Source of Variation	**SS**	**V**	**MS**	***F***	***P***
Between Subjects					
Comparison teacher (T1)	206.26	1	206.26	891.2	.000
Treatment Teacher (T2)	.073	1	.073	.32	.577
Within Subjects					
Factor1 (F1)	1.06	1	1.06	6.77	.013
F1 * teacher	.029	1	.029	.186	.669
Error (F1)	6.28	40	.16		

Note: *Factor1 = Mean Pretest (PRD) and Mean Posttest (POD)*

It is of note that the close and proximal level scores show improvement over time the distal level scores show a reversing trend, especially in the comparison group. While the comparison group's average post test scores were lower than their pretest scores, when a t-test was run on both the treatment and comparison group scores, the comparison group ($t(19) = -2.13$, $p = .46$ showed a decrease that reaches significance. However, the treatment group's ($t(18) = -1.57$, $p = .52$ decrease does not reach significance.

CHAPTER 6: QUALITATIVE ANALYSIS

The qualitative data comes from several sources so that triangulation can be ensured. The primary sources of this data come from both the researcher field notes and audio recordings gathered during the implementation period. In addition, this data was triangulated using video data from digital video recorders and a digital computer recorder called Camtasia™. Peer debriefing and member checks were also used to help confirm the qualitative descriptions of the two classes that are presented here and the conclusions reached resulting from analysis of this data.

The first section describes the categories of analysis used to frame the qualitative experience described here and those findings associated with it. This is followed by a description of the differences between the classrooms resulting from this analysis. Finally, a rich description of both classrooms is detailed, period by period in order to provide the reader with the ability to draw their own conclusions regarding the learning experiences of both classes and their comparability as suggested by Denzin and Lincoln (2003).

6.1 Categories of Analysis

The analysis of the data involved coding the field notes and transcripts of 20 periods of instruction. This included ten periods of instruction in the comparison classroom and ten periods in the treatment condition. Using the critical ethnographic methods, I coded the field notes and transcripts line by line. Another researcher on the team then reviewed the codes to check for validity. Those codes upon which there was no agreement were dismissed while those upon there were agreement remained. Once these codes were established, they were then folded into larger categories. The generation of codes followed Denzin and Lincoln's (2003) methods of descriptive analysis for the development of grounded theory. In a few particular instances, Carspecken's (1996) critical ethnographic analysis used on selected passages to address specific power relationships. The coding and categorization of codes was accomplished using a combination of Microsoft Word and Microsoft Excel. A sample of this power analysis may be found in Appendix I.

A selection of three full class periods of transcripts and/or field notes was coded for each class involved in the study. This represents seven hours and thirty two minutes of text and field notes related to the sixteen hours of observation. 1,982 lines of text were coded which included 23,968 words and 111,371 characters. The codes that emerged surrounded instructional issues related to the teacher, students, directions, researcher interactions, and power relationships among all participants. These were represented by in 22 codes that

addressed the interactions of participants, researchers, and system. A description of the codes used to produce these results is presented in Table 10.

Table 12.
Coding scheme for teacher and student speech acts within transcripts/field notes

Indicating marker	**Coded Meaning**	**Treatment** *Number of lines/ (Percentage)*	**Comparison** *Number of lines/ (Percentage)*
Black text	Non-relevant speech act		
Light blue text	Directional question asking	343 (33.6%)	537 (55.8%)
Sea green text	Technical problems	104 (10%)	7 (.7%)
Plum text	Within system directions	81 (8%)	2 (.2%)
Gray text	Clarifying question	222 (22%)	101 (11%)
Dark red text	Interface help	97 (10%)	4 (.4%)
Orange text	Rule-setting	203 (20%)	104 (11%)
Dark yellow text	Student or teacher frustration	71 (7%)	182 (19%)
Blue-gray text	School system tension	32 (3%)	29 (3%)
Red text	Direct teaching	337 (33%)	491 (51%
Lavender text	Student information offered	51 (5%)	149 (15%)
Tan text	Empathy expression	23 (2%)	12 (1%)
Turquoise text	Grammar question/instruction	141 (14%)	412 (43%)
Rose text	Teacher informational statement	281 (28%)	291 (30%)
Lime text	Teacher informal assessment of work	318 (31%)	212 (22%)
Medium blue highlight	Teacher check for understanding	189 (19%)	229 (29%)
Red highlight	Typical interchange	62 (6%)	67 (7%)
Bright green highlight	Whole class direction	147 (14%)	287 (28%)
Pink highlight	Teacher/researcher discussion	77 (8%)	0 (0%)
Light blue highlight	Peer help	37 (4%)	117 (12%)

Yellow highlight	Teacher redirect to system	492 (48%)	13 (1%)
Gray highlight	Teacher redirect from off-task	312 (31%)	368 (38%)

*Reported percent is the number of lines as a percent of total lines coded.

The category **"**directional/procedural question**"** contained codes pertaining to questions by student answers or teacher responses to questions about how to complete the learning task within *Anytown*. These were mainly administrative questions and had little to do with instruction because they generally involved repetition of directions for completion of tasks that are provided within the learning environment. 1,339 total lines were categorized as representative of this category for both classes. This was by far the largest category as it was the most common form of help asked for by students and given by teachers. This category included codes centered on directions for action outside the learning environment, within the environment, permission-asking behaviors, and the correct procedures for task completion.

In the comparison classroom, teacher responses to procedural and directional questions tended to focus on how they were to engage in instructional activities such as "Interactive Writing." This was a complex activity that involved most students in the class as they worked together to produce a rough draft of a descriptive story based on the oral telling by an individual student. During this process, students move through the writing process as a group, editing for spelling, punctuation, vocabulary words, sense-making, and identifying the parts of speech by color coding individual words as nouns, verbs, adjectives, and adverbs. Students asked questions such as, "What am I supposed to circle?"

“What am I supposed to do?” and “Where am I supposed to go?” frequently during this time. In other instances such as individual student writing periods, students asked about the procedures related to completing steps in the writing process, which activities they were supposed to complete, and asked for directions that the teacher had already given verbally, often when the teacher expressed her disappointment that they were not working.

The following is a typical exchange between teacher and student related to the task in the treatment classroom:

FS9: Mrs. _____, I have a question.

FS9: (whispered) I don’t know what to do.

Teacher: Did you read it? Do you know what you have to do?

Note that the student question is asking specifically for directions as to what she is supposed to do to complete the task. While the task is clearly laid out before the student on-screen, she wants the teacher to tell it to her as she does in the classroom. However, in this instance, the teacher resists providing this information to the student and instead prompts her to find it on her own. Further, she asks the student to explain what the task is in her own words, a form of discourse that Webb, Nemer, Kerstin, Ing, and Forrest (2004) have found is correlated with improvements in student learning.

This interchange brings up another important category mainly found in the treatment class that included codes concerning “teacher redirect(ion) to system” in response to student directional or procedural questions that were clearly

answered by the system in dialogue pages or chat. For example, the following interchange continued from the student directional question:

FS9: (whispered) Yeah.

Teacher: Okay, go over it one more time.

FS9: (Reads Quest in a whisper)

Teacher: Okay, but what are you going to do? What are you going to do up here?

Teacher: Start up here and then see what you're doing down here.

Teacher: Yes.

FS9: I'm supposed to find Jim Tuttle and walk around and make a map?

Teacher: (Nods head) Okay.

In this instance, the student had requested not just clarification of the directions, but to be told what to do. The teacher redirects her to read what the dialogue page within the *Anytown* system asks her to do which results in the student spending time reading. Once the student finishes reading, the teacher elicits a response from the student, asking her to repeat the directions to her. While the student is able to produce the directions, the question in her statement indicates that she is still unsure and not used to receiving directions from someone other than the teacher. These codes were often generated in response to student refusal to read the dialogue pages such as in the treatment class example in the last paragraph despite having been informed repeatedly that reading the in-game directions would provide them with the procedures required to complete Quest tasks. As the teacher worked to wean students from her own direction, these codes were found less often across the transcripts and field notes, especially

falling on the last four days. Based on observations of the non-lab treatment classroom, it was clear that the norm for moving from task to task throughout a class period was for the teacher to ring a bell, students turn to the teacher, and she provides them with directions as to their task which may help explain the heavy reliance of students on the teacher for directions and need for a lot of teacher redirection to the system over the course of the first several days. By contrast, the comparison teacher only redirected students to the system when they were in the computer lab where there was a system for students to use.

The category that included "technical problems" included codes related to computer difficulties, questions, and teacher or researcher responses to these difficulties and problems. These codes were far more prevalent in the early transcripts and video than in the last four periods and were almost non-existent in the comparison classroom. Some of these problems stemmed from inherent technical failures of the learning environment such as failure to allow a student into the world, while others were problems specific to a computer such as when C-25's machine would only type in capital letters. Other problems occurred when similar system problems arose such as in the following interchange:

FS2: I'm stuck in the water.

Teacher: I'm so sorry. How did you get there?

MS3: Hit the plus sign to move up.

Teacher: Okay, are you out now? Okay?

FS3: Uh huh.

In this instance, the student experiences a technical problem in which they fall into the water and cannot move. While the teacher is unable to help, she makes an attempt to understand the problem and its underlying cause. Fortunately for FS2, a nearby student who has either previously experienced the problem or knows the physics and interface controls at a higher level is able to intervene and help her get out of the water. The teacher verifies that the technical problem has been overcome before moving to help other students.

The category "within system directions" also involved the technical system, but in this instance referred to directions given by the *Anytown* or *Quest Atlantis* environments rather than by a human. This category included codes related to Tutorial directions, Quest directions, and procedure for completion presented by the system which occurred mainly in the treatment classroom, but occasionally in the comparison classroom when students used *Quest Atlantis*. For example, in the following interchange, a student has difficulty following the within system directions she has read as part of her task:

FS3: Why can't I get through this door?

Teacher: Did you already click on this?

FS3: Yeah.

Teacher: There you are. Now you can get through the door. Yeah, go ahead and go through the door.

Teacher: Yeah, you can go through, you're just not showing you.

Teacher: See, you advance the arrow key and you can go through.

The student had difficulty following the system direction which tells her that she should go through a particular door as part of his Quest activity. When she is unable to do so, the teacher provides additional directions and help in using the system properly to achieve the goal. Codes in this category mainly took place during the first four periods as students learned to follow the system directions and use the interface. In this instance, the student had ignored the within system direction to use only the first-person perspective option which would permit her to have an appropriate viewpoint to complete the task.

The category "clarifying question" focused on codes related to teacher or student asking for clarifying information about a bid for help, confusing information offered, or reiteration of a bid for help that was unclear. For example,

> **Teacher:** Did you have a question?
>
> **FS7:** Yeah, I just clicked on that guy and he said something and I don't really know what it meant. Is it just another Quest…or does it have something to do with mine?
>
> **Teacher:** That's a mystery. That's a good question.

In this instance, the student was given information, but required clarifying information in order to interpret its importance. The teacher has no answer, but is now notified of the possible problem. In other instances, the teacher can provide clarification regarding what a character means, what a student should do, or where they might go to receive additional information. Similar clarifying questions were often asked in the comparison classroom as students sought to understand the limits of their assignments.

The category “interface help” focused on questions about the *Quest Atlantis* or Microsoft *Windows XP* technical interfaces that resulted in confusion about how to ensure that the system responded in the manner the student wished. For example, students often encountered difficulty with the *Quest Atlantis* interface because clicking in the right-hand window means that the student cannot move their avatar in the left-hand screen until they click in that left-hand screen again.

FS3: The place that you are supposed to click is…

Teacher: That’s third person. Go ahead.

FS3: Do I click third person?

Teacher: Yeah, uh huh. Then you can see you.

In this instance, the student is asking specifically about how to appropriately use the *Quest Atlantis* interface within Windows XP in order to see her character in third person. This provided the student with a view from behind the character that is similar to the views found in many video games and was the preferred view for most students. However, especially in the early days of the implementation, students struggled with using the interface to move back and forth between first and third person as the system directed them when necessary for a Quest which resulted in higher instances of this code during that time.

Another important category that arose throughout the implementation was “rule-setting” or the negotiation of what students were allowed or not allowed to do. The rules applied to codes such as “Which Quests am I allowed to do?” “Am I

allowed to submit my Quest" and "How am I allowed to use the chat?" For example:

> **FS5:** Can we say 'hi' in the chat?
>
> **Teacher:** No, we don't say 'hi' in the chat. But if you have a question to ask someone…or need help with directions, help with a clue….
>
> **FS5:** But…
>
> **Teacher.:** You're chatting to someone, its home on e-mail. But if you're talking about Quest Atlantis, then that's an appropriate use of that space.

In this instance, the student wanted to know the teacher's rules for using a newly discovered affordance of the system that allows the student to communicate at will in the *Anytown*. The teacher set a rule, which is not one that is a system-wide rule ordinarily, that limits students to using the communication tools for school-work only. This was a rule that the teacher continued to reinforce with the whole class throughout the data collection period by monitoring student online chat, student face-to-face verbal chat, and then reprimanded students who did not follow her rule. However, once the rules were set by period six, the number of codes related to this category dropped off precipitously.

In another instance of rule-setting and negotiation, student C-13 asked, "Can we sell the objects in the mine for money?" He had discovered a problem with the rock collection limitation. While it was fixed earlier in the period, he had already collected many rocks. He had been gathering as many as he could for about ten minutes and doing nothing else while he explored the Mine earlier in the period. This student's behavior was clearly off-task from the Quest that had been assigned by the teacher and system, but like the testing behavior of C-4

mentioned earlier, his could also be viewed positively through Gee's lens. In this instance, the student was learning one of the "grammar's of the game" (Gee, 2003) which was that these rocks are available because they have some value, whether he knew what that value was. If something has value, then having as many of that item as possible could have been positive in the future. As he asked the teacher, C-13 predicted that he could have sold them for money, called "Cols" in QA; however, he might have also earned social capital with friends by giving them away, or transformed the rocks in some way that would have made them even more valuable. His acquisition activity appeared related to acquiring future power, whether in relation to the system or to peers. The old adage that "money is power" appears clearly at work in C-13's question as he works to accumulate power in the form of Quest Atlantis cash. Despite this possible power-hungry motive, by exploring this exploit, C-13 also began to understand the structures of the system in a meaningful way that, according to Gee, could have helped him eventually develop an "embodied empathy" (Gee, 2004) for it while he also acquired experiences that could be described in detail as he completed required learning tasks.

In the comparison class, the teacher sometimes had to remind students of the established classroom rules, but there was little negotiation in terms of adjusting them. The rules had been established early on in the semester and were often violated and then consequences were provided by the teacher along with a reminder of each rule. Due to the off-task behaviors of several students, there were several days during which these rules had to be reinforced often.

Consequences included moving students to individual desks away from the rest of the group, individual reprimands, and exclusion from some group activities.

The category “student or teacher frustration” involves instances in which the teacher or student became frustrated with the task, the system, the technology being used, a peer, or himself/herself.

FS6: It still doesn’t want to play it for me. Can I go to a different world?

Teacher: It’s just your computer then, hon.

Teacher: We’ve tried two sets…see how it won’t…

FS6: Yeah.

Teacher: …stay up in there. I’m sorry.

FS6: Try glue?

Teacher: (Laughs) Yeah, that might work.

The non-functioning headphones were important for students to be able to complete the Tutorial Quest by watching and listening to the “Legend of Atlantis” video. By this point, the teacher has tried more than one set of headphones and because the child’s computer will not accept the headset connector, she and the teacher have reached a frustration point with the technology. The technology and task frustrations tended to be the most commonly coded in the treatment class. By contrast, in the comparison class, students were much more apt to become frustrated with peers who were off-task, distracting them from their own, or were intentionally antagonizing them.

The category “school system tension” involved instances in which existing requirements of the school day such as sending a student to the speech teacher, announcements from the overhead speaker, parental intrusions, or school holidays. For example, on day two of the study, the speech teacher walked into the computer lab to ask why one of the students had not come to speech on during the previous class period as was customary. This question began a fifteen minute interchange between the treatment teacher and the speech pathologist as they attempted to work around the restrictions of the school day and still fall within the parameters of the law. In the comparison class, this happened less often because there were no instances of aberrant class periods in the computer lab that were out of the ordinary. However, in both classes, learning activities had to be shuffled to other days because of a district student holiday that fell during the data collection period.

The “direct teacher questioning” category involved codes in which the teacher asked questions as part of their general teaching strategy for improving writing, helping students overcome their frustrations, or helping students improve their use of the system. These codes were more prevalent towards the end of the implementation as they gradually replaced the “directional/procedural” question codes which dropped off as students relied more on the system for their answers to those questions. The following is an example from the treatment teacher:

> **Teacher:** What did you find?
>
> **MS4:** Well, I click on it some place over and it said to go find Sarah was over by the river. So I decided to head to the mountains to get their and I got lost.

Teacher: How did you find your way back?

MS4: I managed…I managed to come out on the side of the mountain.

The teacher asks questions to elicit a response from a student who has not been actively been pursuing his Quest task and has instead spent a lot of time exploring areas that were meant to be closed to him until he had completed a series of tasks. The teacher, by questioning him here, is attempting to get him involved in describing his experience as a means of leveraging that into using the details to complete a writing task. She shows interest in his experiences and works to have him identify relevant details that can be used to write his descriptive essay. MS4 later used this discussion as he wrote about his explorations in his Quest response:

> I liked this eccentric building that I was in. I can describe it for you. It looked like some kind of really old building. It had some stairs. I went down and I came to a tunnel, and there were red lights on the wall.

In the comparison class, the teacher often asked students to answer her direct questions related to the topic under discussion, but it often appeared to be the same students who were repeatedly asked or volunteered to answer. In this instance, those who volunteered were the six that completed the reading entire book and tended to be the highest achievers. Was this small volunteer population symptomatic of a larger problem in that many of the other students rarely finish reading or other assignments and are often off-task? Is the difficulty level of the

material too high for the majority of the students? Do they need more time than they have been given or more oversight to reduce off-task behavior? Does the class noise interfere with student reading? Do parents support reading at home? The answers to these questions may help the teacher revise her instruction to engage more students regularly with the reading and writing tasks.

Another category, "student information offered" often prompted those codes found in the "direct teacher questioning category." For example, student frustration at not being able to pick up the gas can resulted in information being offered by two different students to the teacher:

> **MS25:** That sheriff guy, he will not take my gasoline can. I like. . . I like. .
>
> **Teacher:** He will, but you're going to have to ask somebody how. Maybe ask Lauren.
>
> **MS25:** I have it and I pressed on him.
>
> **Cummings:** …But he won't take the gasoline can.
>
> **FS14:** it will let me get the gasoline can.
>
> **Teacher:** it is a very, very difficult thing to do. Ask somebody how to pick up.

In this instance, MS25 is asking for help and expressing his frustration as he also offers information about his particular experience. FS14 interjects with her more positive experience, indicating that the task can be completed. However, neither the teacher nor FS14 offer MS25 any help, only information and in the last instance of teacher speech, empathy with his plight.

This information often elicited codes found in the "empathy expression" category in which the teacher informed the student that she understood their

problem of concern, but did not offer other help. Most of these expressions were simple and fairly short such as in the following interchange in the treatment class:

> **MS3:** I cannot figure this out.
>
> **Teacher:** Oh, it's hard, but it's fun. You don't have to figure it out today. The best thing to do is just get some clues.

These empathy expressions often followed student frustrations with the system, technical problems, or specific tasks. In this instance, MS3 was struggling with completing a Mystery Quest. While the teacher did not offer to help him with anything specific, she did offer her understanding about the difficulty of the task based on her experiences with other students who had similar problems. These empathy expressions occurred more often in the treatment than the comparison class, likely because the tasks set for comparison students were those that were already familiar and few had technical components that could result in problems.

Codes falling into the "teacher informational statement" category mainly involved unsolicited information about on and off-topic issues arising from discourse with students. Some of these statements provided additional information about the topic under discussion while others were only tangentially related such as when the treatment teacher described her experience as a child playing with mercury in the following interchange:

> **Teacher:** Mercury has a lot of special properties. One thing is that it is really heavy.
>
> **MS13:** Another thing is that if you…if you work with it can give you diseases…
>
> **Teacher:** It can damage your veins. Yep.

Teacher: the one thing that it is, it is a really heavy. And it is poisonous.

MS13: It is liquid metal.

Teacher: one thing that is scary is what I was a kid we split with the mercury from thermometers. (laughs) It came out of the ball and a bunch of little ones.

This category often was often accompanied "teacher informal assessment" in which the both teachers used informal examinations of student work that was in-progress as a means of ensuring quality. As part of her social interaction with the students, the treatment teacher also often provided additional information related to something that the student wrote about as a means of connecting it to her own life experiences. In the following interaction, the teacher reviews the work of a student who appears to have been off-task for most of the period:

Teacher: What did you find out?

MS13: Well, I read through the Quest…and…there's something strange in the mountains…I saw a bunch of strange things…

Teacher: For example?

MS13: For example…I saw…let's see…how there are like bits of stone, and a whole pale stone area.

Teacher: Interesting. Like sidewalk-type things?

MS13: Yeah, they're just like, small pieces of them. Very small slices.

The teacher asks questions about his experiences as a means to ensure that he is collecting details that he can use for his writing. She asks for examples of what he had seen as he explored as a means of informally assessing whether or not

he is collecting information relevant to his writing task. When he does not provide sufficient explanation, she probes more deeply:

> **Teacher:** What else?
>
> **MS13:** Like…um…a tree… but it was made out of metal.
>
> **Teacher:** That's something you don't find on a mountain every day.
>
> **MS13:** No.
>
> **Teacher:** You should write those things down in your notebook so you have them.

When she was satisfied that he has gleaned sufficient details from his explorations, she concludes by reminding him of her earlier direction to take notes that he can use to improve his written product. Through her assessment, she was able to determine the level of student interaction in the environment, whether he had the information he needed to do his quest, and also reminded him that despite the fact that he is working in the digital environment, she is still observing and monitoring him.

The category "teacher check for understanding" differed from "teacher informal assessment" because it often focused on whether students understood the directions or procedures given by herself or the learning environment rather than whether the work was of sufficient quality. For example:

> **Teacher:** Just look at your original Quest to see what you are supposed to do. What does your original Quest tell you to do?
>
> FS3: To find Turtle…Jim Tuttle…
>
> **Teacher:** And what else?

FS3: That…the uh…to uh…to roam and get a map?

Teacher: Mmmm hmmm!

In this interchange, the teacher is simply asking for information that indicates whether or not the student understands her task. This kind of short interaction allowed the teacher to verify that a student could continue with their work individually without spending additional time ensuring that their understandings of the content or writing skills were correct. It was fairly common to see this kind of interchange on the first few days of the implementation though the teacher moved more toward assessing student understanding over the course of the last three.

Codes within the "whole class teacher direction" category tended to occur less often as students became acclimated to the learning environment. This form of direction occurred often during the first two periods as the teacher established norms and rules for use of the environment. Once these had taken hold, these codes tended to appear most often at only the beginning or end of the period as the teacher either reminded students of their learning goals, directed them to log off the computers, or prepare to begin a new activity such as preparing to go home. For example, the teacher in the treatment class gave the following direction:

> **Teacher:** If your Quest is in the middle of the screen, press the little minus sign and it will minimize it and send it to the bottom of the screen.

The direction to the whole class is intended to reduce her need to repeat it to each individual student as many are having the same problem. Throughout the

first four periods, this was very common as the teacher addressed issues related to use of the system, provided rules for student behavior, or attempted to convey general tips that would improve student time on task. However, these directions could also create other problems such as when the treatment teacher restricted students from working on voluntary Quests. On day three, she announced to the class that they could only work on the mandatory Writing Quests and further had to have her visual review of each of their Quest responses before they could move to their next. Because students had been restricted by the teacher from working on these Quests, they internalized the rule that they could work only on Quests that were listed as mandatory on the back of their Reporter's Notebook and had to have her review before working on anything else which became difficult to break later when these rules were lifted. It was also problematic, because it would broke the role-play illusion established because certain feedback was to be provided by characters in the town.

This was an example of the teacher exerting her power over students as a means of indirectly taking control back from the open system. Open-ended learning systems can be unsettling for teachers, because they deliver control of content and activity back to the students which makes it difficult to monitor the myriad directions of student progress, creates problems in discriminating on-task from off-task behavior, and managing the classroom (Jonassen, 1999; Jonassen & Hernandez-Serrano, 2002; Oliver & Hannafin, 2001). This perceived power imbalance between teacher and system will result in the teacher retrieving acting

in ways to retrieve there power by exertion of control over student activity through the establishment of rules that bypass those embedded within the system.

Interactions coded as “teacher/researcher discussion” occurred with some frequency often coming in the form of interviews that lasted anywhere from two minutes during Period Two to fifteen minutes during Period Eight. This indicates that the teacher had much more time once students had begun to rely on the system for instruction to take part in such discussions, refine or check student understandings, or provide immediate feedback to students. The following is the first series of interchanges between teacher and researcher that began a ten minute-long discussion:

> **Researcher:** So what you think is responsible for their improvement? What do you think it is? What you think is going on?
>
> **Teacher:** Well, it is interesting…
>
> **Teacher:** …and I think it is interactive.
>
> **Researcher:** Okay.
>
> **Teacher:** Instead of the. . . Distance part. And, it is obviously interesting.

The increase in time that the teacher had for teacher/researcher interactions may have also been because codes within the category “peer help” increased dramatically beginning on Day Five, which possibly relieved the teacher from that duty.

Codes within the category “peer help” involved instances in which a student directed another student in such a way as to aid in overcoming an obstacle, answered a direct question, or suggested possible solutions to a

frustration. For example, rather than rely on the teacher for directions, two students provide help to another in the following interchange when he reaches a stopping point:

MS8: What do you do?

MS9: It just said “Go upstairs and it will take you to another world.”

FS9: Come on!

The second student provides help in the form of directions for the first student in terms of where they are supposed to go to complete the task and move to the next. The third student acts as a pull to move the other two students forward within the Quest activity. These forms of help occurred regularly throughout the observation period and came both in the face-to-face setting in the lab in the form of verbal input, but during the last few days also began to occur within the chat as well when students began to struggle with picking up the gas can clue which was one of the designed frustration points. At that point, students provided examples of the procedure that they followed to get the gas can that had been successful coordinated taking individual students to locations that they struggled to find.

The category “teacher redirect from off-task” included fewer codes in the treatment class than in the comparison classroom over time. The two main students who required redirection to the task were those with disabilities such as autism and attention deficit hyperactivity disorder. However, the teacher reported that both students exhibited superior time-on-task with the *Anytown* activities when compared with normal classroom assignments. Further, in an interview,

she reported that the quality of the work both produced was greater than any she had received to that date.

"Grammar question" codes occurred most often when the teacher had restricted the students to only submit after she had reviewed their work. Once the teacher redirected them to use the system or other tools like dictionaries to answer these questions, the number of codes dropped off precipitously after Period Four. In both the comparison and treatment classes, there were numerous reviews of student work to verify that students were using correct grammar, but students rarely volunteered to ask questions about spelling, punctuation, or vocabulary use.

The last category "typical interchange" was infrequently coded as it was meant to provide examples of interchanges that were common within the learning or teaching experience of all participants. All other codes provided here overlapped with this category as it was intended to be inclusive of all other categories as a means of identifying typical student experience resulting from the treatment or comparison curriculum. For example, a typical interchange related to student difficulty in dealing with the frustration point surrounding the use of the camera looked like this:

> **FS10:** Still, no one will answer me about how to take a picture.
>
> **Teacher:** Did you try some different ways? Did you ask some people who were around the camera?
>
> **FS10:** Ummmm…
>
> **Teacher:** Try that, see if you can ask some people who are round to the camera and then try some different ways, but you can't hurt anything...

FS10: Like, what do you mean, ask some people?

Teacher: Anybody who was around there, see if you can click on anybody and ask something. See what happens when you click on the camera. See if it went someplace else.

The reason that this sequence is coded as typical is because it is representative of fifteen other conversations between the teacher and students with questions about how to approach the problem. The teacher provides several options, as she did in her interactions with other students. She clarifies the student's questions in response to her directions and asks probing questions to see if the student worked to overcome her own problem.

CHAPTER 7: QUALITATIVE FINDINGS

7.1 Introduction

As a result of analyzing all available forms of data collected during the implementation, several differences existed between the two classrooms. In order to achieve triangulation of qualitative findings, multiple forms of data were used to generate these differences. These sources included analysis of audio transcripts, video, field notes, interviews, and computer-mediated discourse for both classes when available. These findings were then provided to another researcher involved in the data collection as a means of peer review. Follow-up interviews were also conducted with teachers and students as a means of participant member checking and verification of findings. What follows are five assertions stemming from the analysis of the thick record which is a combination of the multi-level analyses of transcripts of interviews, audio and video recordings, and online discourse, multiple observer reports, and researcher reflections completed at the end of each period.

7.2 Assertions

7.21 Student time-on-task

One of the affordances of using computers that has been reported by Glazewski et al, (2004), Brush and Saye (2003), and Goldberg et al, (2003) is that students remain on-task longer when using the computer than when engaged in more traditional forms of classroom instruction. Based on a review of the video, audio, and field notes for both classes, this finding was upheld as the treatment class worked on task-related activities longer and more often than students did in the comparison classroom. The teacher in the comparison classroom spent much more time redirecting students to work on their task than did the treatment teacher. This may have been a function of teacher style and previous student relationship with their teacher. Based on analysis of interactions between students and teacher in the comparison class, it is likely that this was because most of the power in that classroom was concentrated in the hands of the teacher who provided learning tasks that often did not engage the students. Students appeared to feel powerless to direct their own learning to more motivating tasks, so engaged in transgressive behaviors, seeking to take back power by what means were available to them. These behaviors included off-task talking or whispering to peers, drawing unrelated pictures, kicking their feet, throwing objects, talking to the researcher, asking irrelevant questions, and putting their heads on their desks. There were a few students, however they were in the minority, who remained engaged with their learning tasks throughout each period they were observed. It is of note that these were the highest

achieving students in the class, were strong writers, and had been assigned to read books above their grade level by the teacher. Upon review of their interactions with the teacher and peers, their power in the classroom appeared connected to a positive rapport with the teacher, motivation stemming from achievement, and conforming to the teacher declared norms. These students also were not invited to take part in or resisted transgressive behaviors engaged in by the large majority of students in the class.

It is also of note were many opportunities for off-task behavior in the treatment class and several students excelled at this. For example, students told the teacher, peers, and researchers that they were intrigued by the Dark Lakes and Raintree Manse areas of *Anytown*. They revealed that this was because of their unique appearances, the fact that they are out of place in the town, and because there are things in place to keep them out. These locations took a few students away from their main task fairly often. These were all boys, with most of this off-task behavior centered on students C-20, C-11, C-4, and C-X. This behavior most often took place in locations that are important to later Quests, but had no relevance to those that the boys were working on at the time. Their wish to engage in activities not yet open to them pulled them off-task as they attempted to exert their own power over the system.

For one student, C-4, this resulted in off-task behavior in which he attempted to “game the system” by bumping into walls as he sought to enter the walled off area of the mine that serves as an entrance to the Dark Lakes area. This behavior resulted in little activity related to the completion of his mandatory

writing activities, but gave him a sense of power over the system when he was able to overcome the obstacle and discover the new place. This off-task behavior also caused some friction between himself and the teacher when she attempted to exert her power over him through multiple attempts at redirection. These attempts began as gentle prodding, but over time became more explicit redirects that the child attempted to divert through ignoring her questions and reasserting his own queries about the purpose of the Dark Lakes area. It was only when she asked to see the extent of his work on his assigned Quest that her power and the system's were reasserted, resulting the student working on his assignment.

7.22 Student choice of activities

As identified by Jonassen (1999, 2002), one of the important pieces and affordances of problem-based learning environments is that they allow student choice and control over their own learning. Choice and control over their own learning are a form of power which enables students to act within the learning environment and feel a sense of ownership of their learning process (Barab, Warren, & Ingram-Goble, 2006). Because of the different approaches taken to empower students in the two learning environments, the comparison and treatment classes varied substantially in the amount and kinds of student choice of activity that were allowed. For example, the first day in *Anytown* was largely designed to empower students to explore and tell each other where things that they thought were cool were located. They also engaged with the system for the first time as they talked to pedagogical agents and independently identified

Quests that each would like to do in the future. In addition, there was a lot of student face-to-face sharing as they helped each other learn where they were supposed to go to complete the first Quests. This contrasted with the comparison class in which student activities were predetermined and choice was limited. The teacher was the primary arbiter of where students were allowed to go and whether dyad, triad, or group work was allowed to achieve the task. However, most tasks were individual work unless they were teacher led.

7.23 Face-to-face discussion vs. chat

Students appeared to prefer face-to-face discussion to in-space chat in the treatment class and the comparison class. Most students whispered quietly when they did speak face-to-face in the treatment class, but it was by far the most common mode of communication. While the treatment teacher pointed to the chat window and told them how to use it, the comparison teacher modeled the use of computer chat several times for students and forced them to respond to her to show that they could use it. This appeared to allow students to become proficient with the discourse tool more quickly than in the treatment classroom.

By the last three periods of the treatment lab time, student use of computer mediated chat increased dramatically as the teacher reinforced its use and students discovered that it functioned as an information seeking tool for completing the first Mystery Quest. Socialization through face-to-face chat was banned by the treatment teacher, which likely reduced its overall use as well. During the last three periods, students engaged in 657 instances of chat, e-mail, or telegrams, which within the system, are all treated as the same form of

communication. This was opposed to three instances of chat in the previous five periods.

However, this increase was contradicted by the end of the last period, face-to-face chat had risen substantially again. Once more than an hour passes, it is possible that students hit an exhaustion point and can no longer effectively use a means of communication that is difficult or new to them such as QA chat or mail. They may revert to face-to-face once they hit an exhaustion point with a new technology.

The research team that supported the dissertation study data collection also analyzed the computer mediated communication (CMC) that occurred during the collection period only for the treatment condition. The analysis took place using five raters, including one faculty member and the PI of this study. Each person independently generated codes and rated instances of chat to produce the following eight categories and numbers of instances:

Table 13.
Computer-mediated discourse analysis categories

On-task?	Question?	Answer?	Social?	Task logistics	Interface logistics	Other logistics	Playful?
477* (77%)	259* (39%)	332* (50%)	272* (41%)	388* (59%)	40* (6%)	219* (33%)	37* (6%)

* Out of 657 total utterances
NOTE: These percentages are rounded.

These categories are non-exclusive because these categories are on different orders of magnitude. For example, on-task behaviors could be question, answers, or neither. They may also be related to task logistics, interface,

logistics, or other, however, they would not be playful unless such an utterance also included information or queries related to the task. To develop these codes, the researchers met face-to-face and talked through all of the lines of student chat until the raters reached 100% agreement on each utterance. If a particular researcher had specific information that informed the classification of an utterance into a category, discussion and interpretation took place. If utterances could not be classified into an existing genre, a new classification was agreed upon.

The category “on task” captured instances in which students were communicating in ways that appeared to be related to completing the chosen or assigned task within the 3-D learning environment. The 477 instances, representing 77% of all speech acts, compares with 180 instances (27%) of off-task behaviors that involved socializing, experimenting with the system, or accidental submissions. The prevalence of on-task behaviors follows with the researcher reports in the field notes that student behavior in the treatment class was largely productive towards completion of learning goals.

The category “question” focused on whether or not utterances were intended to be question asking behaviors for the purpose of a student getting help with their learning tasks. While the number of questions is fewer than the number of question answering utterances, closer inspection of the transcripts revealed that students often answered questions in separate submissions or multiple students answered the same question. This helps explain the larger number of answers than questions asked. Questions could be general and non-

directed to individuals, or specified to a particular user that a student believed had an answer they required to complete their task.

The “answer” category focused largely on any instances in which students appeared to be answering questions that were asked either in the digital or face-to-face environments. These answers could be on-task or off and often overlapped with other categories such as task, interface, or other logistics. Some answers were as short as two characters when a student responded to a question with, “No.”

The “social” category included behaviors that were often off task. These included greetings, coordination of social behaviors, and other forms of similar “off-task” behavior. The category tended to be a catch-all for off-task behaviors which explains why nearly one-half of all utterances were categorized this way.

The “task-logistics” category captured utterances related to student discourse on or about the Quest tasks. Here, logistics are defined as coordinating or directional behaviors intended to allow completion of a task. In this instance, this form of logistics captured discourse around coordination of action in support of solving the Quest, determining the location of objects, locations, finding characters necessary to the solution, or overcoming a designed frustration point embedded within the Quest task such as retrieving the gas can for the Mystery Quest.

“Interface-logistics” covered that discourse in which students asked for or provided directions regarding how to use the Quest Atlantis interface or the *Anytown* learning environment that was not related to completing the Quest task.

While this had some of the fewest instances (6% of all CMC), this form of communication augmented the face-to-face classroom discourse that was prevalent throughout the implementation. Such discourse tended to occur most often among students with fewer computer skills who were also struggling to complete the tasks.

"Other-logistics" dealt with logistical and directional behaviors that did not fall into the first two categories. This meant that they captured instances of student's coordinating off-task behaviors with directions like "Chase me." They also capture student's coordinating in-space behaviors for the purpose of viewing interesting locations that were not part of the task. This form of behavior captured 217 instances of computer-mediated communication or 33% of all communication, making it fairly common within the categories.

The category "playful" involved instances in which students were engaged in play behaviors, teasing, joking, or other behaviors not intended to be taken seriously as part of completing the task. Based on the 37 instances representing only 6% of all discourse, students appeared to mainly use the chat and other in-space communications affordances for more serious work.

Further analysis of these categories is ongoing with the group to determine whether the findings reach significance and will be reported elsewhere as they are not directly related to the research questions for this study. However, because they help explain student use of the learning environment for communication, they are included here in order to help provide a clearer picture of the student experience within *Anytown*.

7.24 Quest frustration points

As noted in Chapter Three, these points were intentionally set into the design of the learning environment to compliment the larger, ill-structured problem that was posed to students. They were intended to force student reliance on the system and on peers in order to solve the problem and complete the Quest. At several points, students expressed their frustration with collecting the Gas Can clue which was required to complete the Burning Cabin Mystery Quest. This frustration came out in the chat during which more than half the responses were either requests for help with getting the gas can or responses to these requests. The following was a typical interchange:

> **Student C-7**: Can you help me with picking up the Gasoline tank?
>
> **Student C-22**: pick it up by clicking on it
>
> **Student C-7:** How do you pick it up?
>
> **Student C-7:** The Gasoline tank?
>
> **Student C-23:** i dont know try aging (sic)

This frustration point surrounding gaining the gas can item generated more discussion than all other discourse within the computer mediated discourse. The gas can is the final item that student must retrieve before the final evidentiary sequence opens up and students can complete the first Mystery Quest's game section. Therefore, the frustrating object acts as a gate keeping mechanism to prevent students who have not collected sufficient evidence to write their Quest from continuing further. Listening to student audio during the last four periods,

their face-to-face discourse also revolved around reducing their frustration and solving this problem that each student encountered. The designed frustration point appeared to function in the way that the designer intended, forcing students to rely on each other and the system for information to reduce their frustration and solve the problem.

The teacher also acted in a way similar to the designed frustration point, by redirecting students to each other to the system affordances and peers in order to solve the problem. For example:

> **Teacher**: Did you ask me something?
>
> **Student C-4**: Yes. I wanted to know how to pick things up, but now I just want to know how to pick up the gas can. How you get the gas can out, but somebody already answered it. What do we have to do first?
>
> **Teacher**: Ask C-25 or ask C-22.

In this instance, the teacher specifically directs the student who is frustrated at not being able to pick it up. Rather than directing the student to the correct answer, she intentionally redirects the student to his peers with little fanfare. In this way, she does not reassert her power over the student in the learning context and instead empowers him to solve his own problem through peer negotiation, which is a key feature of problem-based learning environments (Jonassen, 1999). Had the teacher reclaimed her power to direct student learning behavior, she would have likely stymied the affordances of the learning environment as had happened on previous days or reinforced his existing dependence on her as arbiter of information.

7.3 Emergent tensions

In addition to the differences between the classrooms, several tensions also emerge primarily in the treatment classroom that were not regularly found in the comparison classroom except during computer lab times, and then, far less frequently. These tensions appeared to emerge as a result of the unique form of instruction, the substantially changed roles of teacher and student, and the game-like nature of the learning environment. Each is discussed in further detail below.

7.31 Teacher vs. system

The most pressing and challenging tension that emerged was within the dichotomy of the teacher and system power relationship. This tension resulted in a power imbalance between the teacher and system in which the teacher worked to regain power from the system from the beginning of the study through the insertion of rules that redirected students to the teacher for permission to submit work. Further, these rules had the unintended consequence of the teacher taking away student control over their learning task, and removing choice in activity at several times during the course of the treatment. Specifically, this tension emerged when the teacher restricted all students writing activity to only Writing Quests, when she required students to raise their hands for teacher approval prior to submission of all writing activities, and when she restricted student communication within the computer lab.

This tension arose when the teacher's need to be involved in the instructional process conflicted with the need for the system to function as it was designed. For example, the best example of this issue came during Period Five when the teacher inserted the requirement that she had to visually review any student Quest submissions in the lab prior to student submission. This subversion of the system caused many students to sit with their hands raised, unable to work. Some waited for five, ten, and in some instances, thirty minutes.

Later in the same period, the teacher set a rule that students were not allowed to work on any other Quests until their Welcome to *Anytown* Quest had been submitted. By doing so, this defeated one of the major purposes of the system, which was to reduce the amount of time she was required to spend on this form of teaching behavior. Between these two rules, the system was essentially stymied.

If the teacher felt that the system was not providing adequate instruction (e.g. refining ideas, re-teaching, clarifying, responding to questions, defining vocabulary), she engaged in teaching behaviors that were at odds with the design intent of the system such as those that were teacher-centered, behaviorist-style teaching vs. inquiry learning design. When this occurred, the teacher introduced instructional elements that could have resulted in what Brown (1992) refers to as a "lethal mutation." While these behaviors were not allowed to reach a point of lethality in terms of subverting the design to the point where the research questions could not be addressed, it clearly created a mutation of the self- and system-directed learning experience that *Anytown* was designed to

deliver. It is important to note that this was not an isolated incident and this same form of mutation occurred with both the teachers in the pilot and the dissertation study. This was problematic, because the teachers often spent valuable lab time doing teaching in the classroom and lab what was already being covered by the system and it also stymied attempts built into the system to wean students off the teacher's directions so that they could be more self directed as is called for by problem-based learning (Barrows, 1986; Jonassen, 1999; Jonassen & Hernandez-Serrano, 2002; Savery & Duffy, 1995).

The challenge was resolved when, between days five and six, the primary investigator, with the permission of the committee, spoke with the teacher. During this conversation, the teacher's purpose and the system's purpose were repeated and she was told that she could move at her own pace rather than at one that would allow for the completion of all mandatory Quests. She agreed that for the remainder of the implementation that these restrictions and a third which prevented students from working on voluntary Quests would be lifted.

Another tension emerged when the teacher roles were revealed as facilitator, evaluator (through the system), and challenger of poorly constructed knowledge constructs. By the fifth day, students received the majority of their instruction and scaffolding from the system and had begun to rely on it. This left the teacher with the three roles identified, which are not as common as the roles of classroom disciplinarian, provider of direct instruction, and repeater of directions during her daily life. However, after several periods in which there were no student-asked questions for ten or more minutes at a time, the teacher began

to provide feedback using the QA system. In doing so, she began to work with specific students who showed need for writing improvement. In some instances, the teacher was able to spend ten to fifteen minutes per student on improving their writing. For example, in one instance, she provided extensive verbal feedback to a student on his writing:

> **Teacher:** Now, why is what you wrote important? How will it make our world and the Atlantian world of better place? How can you it make the Atlantian world a better place?
>
> You need to make it so it anyone outside of here could understand what is going on. Specifically, then address why you think it helps the Atlantians. What do you mean by 'what's going on?'

In this instance, the teacher is able to give instruction based on the students written submission not only by explicitly pointing out what is missing from his writing, but also by asking probing questions that help lead the child to improving their own writing. Questions like, "What do you mean by 'what's going on?' act in the way that problem-based learning theory supports, as a challenger of a poorly constructed idea of writing. In this instance, the child's meaning is unclear upon first reading, so she works to redirect his thinking to the audience for his writing, rather than allowing him to continue to write as though others have a privileged view into the inner workings of his mind.

During the last two periods, the treatment teacher was more comfortable with her new role. By giving hints or directing students to ask peers for help, she dealt with the video game problem of how to help the player/learner past a frustration point. Does one give a nudge or an explicit walk-through? This is part

of the scaffolding of a problem-based learning-problem as well. How explicit must the answer be without doing the work for the student? The teacher did this well by not giving into their impatience and instead either forced students to work together or referred them back to the system scaffolds.

7.32 Class rules vs. system rules

The discussion around what students were not allowed to do in terms of Quests was a major topic of tension in the classroom throughout several entire periods. These rules are a fundamental part of any game (Salen & Zimmerman, 2004); however, they are also a fundamental part of classroom management (Etscheidt, Stainback, & Stainback, 1984). The establishment of rules in a classroom is necessary to learning in a classroom because they establish umbrella norms for behavior, provide expectations of consequences for violations, and guide student interactions with teacher and peers. However, in the case of *Anytown*, a completely new set of rules governing student behavior in the virtual learning environment were introduced that in many ways contradicted the rules of the face-to-face classroom, resulting in a fundamental tension between those that, based on teacher style, were more explicit and controlling in terms of the *classroom* and those that permitted system and learner control in *Anytown*. With the teacher holding power in this instance, the rules of the classroom, such as “student’s must raise their hand before speaking,” “students can work on only activities as directed to by the teacher,” and “the teacher is arbiter of knowledge,” were destined to trump those related “student’s are free to choose their learning

activities," "student-student interchanges are encouraged," and "the system acts as gate keeper for student action."

For example, talk regarding rules about *game rules*, specifically what is and is not allowed within the system was less frequent than talk about *teacher rules* in which students discussed often up until the last two periods. Based on analysis of teacher-student interactions in the non-lab classroom, this was likely because the treatment teacher holds most of the power in the face-to-face classroom and students remain silent, raising their hands for permission to speak, and speaking only when spoken to by the teacher. The existing rule structure established by the teacher from the beginning of the year conflicted substantially with the rule structure built into the *Anytown* system and with the tenets of problem-based learning which mandate few rules governing student behavior, noisy collaborative work, and student control and choice over their learning activities (Jonassen, 1999).

There were four major forms of interchange between a.) teacher and students as announcement, b.) student and students, and c.) researcher and students. The initial announcement regarding what students were allowed to work on came from the treatment teacher:

> **C-7:** Can we work on the Quest for Larry?
>
> **Teacher:** Actually, we're actually working on this Quest in here. There are Mystery Quests that you can work on at home.

The primary investigator provided clarification of the task to the teacher at the beginning of the fifth period:

> **Primary Investigator**: and if they're done with their revisions and got to accept they can work on whatever other Quest want to do: Mystery Quests, Reflection Quests, or Writing Quests.

Later in that same period, the teacher, researcher, and student were all involved in clarifying the rules about what they were allowed to do:

> **FS #3:** I just resubmitted my Quest, because I only had one word that I misspelled and I changed it. And what should I do, should I just go explore?
>
> **Teacher:** (To researcher) After they finish their Quest, what should they do?
>
> **Teacher:** They can go on, go on to another one?
>
> **FS #3:** But she (the treatment teacher) hasn't checked it though. I just submitted it.
>
> **Researcher:** That is okay, you can work on one of the others. You can work on the Mystery, Writing, or Reflection Quests.

This tension emerged with several different groups and had to be addressed by the primary investigator in a discussion with the treatment teacher. Once the directions were clarified for her again, the last four periods allowed for much more student choice of activity and revealed a preference for taking part in voluntary Quests at a much higher rate than the mandatory Quests. This may have been because of the interactive, game-like nature of some of these voluntary Quests, or simply a preference for the topic around which the Quest

was situated. Based on the amount of face-to-face and computer mediated chat that was revealed on during the last four periods, it is also likely that the social nature of the problem-solving engaged students in the tasks more than was evident in the Writing Quest.

7.33 Off-task behaviors resulting from the design

Early on in the implementation, students C-20 and C-23 exhibited common off-task behaviors that resulted from escaping the physical boundaries of the instructional space. In this instance, they had entered the "Nowhere" area that lies outside of *Anytown*. They ran around outside the town, but did no exploration that linked to the task requirements. When asked how he escaped the boundaries, C-20 said that he used the JUMP feature to get there. This is a limitation of the system itself that could possibly be addressed in future revisions of the environment. Such off-task behavior has been noted in studies of similar learning environments like River City (Dede, 2006; Dede et al., 2006) and Quest Atlantis' *Taiga* (Barab & Duffy, 2000; Barab & Jackson, 2006; Barab, Thomas, Dodge, Carteaux, & Tuzun, 2005; Barab, Warren, & Ingram-Goble, In preparation; Barab et al., Under development) and is a feature of play as students begin to understand a new learning environment.

Later on, after completing the "Welcome to *Anytown* Quest," C-20 was walking on top of the digital corn fields rather than working on a Quest. He became trapped in a rectangular patch that he could not escape from easily. He then told C-23 to come and find him. This appeared to be an instance in which C-

20 was trying to get C-23 off-task and he succeeded for a few minutes. However, C-23 soon returned to the Mystery Quest, possibly because the rules of that particular mini-game were clearer and more interesting than the improvised hide-and-seek game provided by C-20.

7.34 Realistic dialogue vs. past student experience

An additional tension appeared because of the design of the dialogue for certain characters. The designer's intention was to create a simulation-game, which meant that the dialogue needed to be in keeping with how people act in a real town, especially when a reporter is snooping around a place of business or a home. Therefore, some of the characters were rude or non-responsive until the student had proven themselves or the character had some information or role to play in the narrative that is the story of *Anytown.*

This resulted in frustration for some students when characters were repeatedly non-responsive. For example, the teacher made the following observation: "That's interesting how what kids think many of the characters are rude…(laughs)." Later on, in a discussion with one of the researchers she noted:

> **Teacher:** She was talking about one of the characters…. It's like they actually think they're humans…
>
> **Researcher:** They kind of do…
>
> **Teacher:** When I told them…because a couple of them haven't responded…there's always a human that behaves like these characters…
>
> **Teacher:** And in the classroom what they mostly talk about when we talk about the last lab, was what frustrated them most were rude characters.

Researcher: They don't like that…

Teacher: Well, they're not accustomed to that…

This also came about in dialogue between teacher and two students:

104:47 – **C-20:** Then, I don't know. Try talking to her again.

104:49 – **C-24:** She says she is busy.

104:52 – **Teacher:** Oh, that's the one that everybody thinks is rude, huh?

By viewing the pedagogical agents as human-like, the instruction and interactions became more meaningful to students and therefore improved the chances that students would understand the underlying rules of the learning environment. This is in keeping with findings from a study by Baylor and Kim (2005) that showed that learners tended to empathize with agents who are the most human in appearance and reactions to student actions. Further, students humanized characters who rambled or provided inordinately long informational passages less than those that generated realistic discourse that could be followed by the student, which is also in keeping with their findings. It appears that this humanization may be occurring as a result of the framing of the dialogue in which the actions or discourse of the pedagogical agent can readily be understood as realistic based on the learner's own experiences.

7.35 Reading vs. being told

One of the largest issues with the system going into the implementation was the amount of text that students would be required to read in order to receive

their tasks and solve the problems set forth in *Anytown.* For the first three days, students asked the teacher repeatedly what they were supposed to do and many refused to read the dialogue pages on the right hand screen. The teacher studiously refused to answer their questions during that time and throughout the implementation, constantly redirecting the students to the learning environment asking questions like, “What did he tell you to do?” and “Read that and tell me what it says to do.”

The following is a typical interaction:

FS4: I don’t know what that person is saying.

Teacher: Read it again. (pause) There.

Teacher: What’s he asking you to do?

FS4: He says I need to do two things before I…

Teacher: What two things?

FS4: The first thing is to ask Anita downstairs…

Teacher: Anita, okay…and then…

FS4: …Ask about the writing process…

While the teacher did not abandon a student to struggle alone, she appeared to be trying to help foster more dependence by the student on the system. When the student did not understand, rather than give the answer, she directed her to reread the directions and repeat them back to her to check for understanding. This did not let the child off the hook in terms of reading or coming to her own understanding of the directions and may have been a sufficiently unpleasant

interchange to discourage her from trying to get directions from the teacher when they are clearly on the screen in front of her on the next task.

This is a problem that has occurred in other studies that require extensive reading (Azevedo, Cromley, Winters, & Moos, 2004; Barab et al., 2005; Barab et al., Under development; Brush & Saye, 2003; Dede, 2006; Dede et al., 2006) like *Anytown* which functions as a modified 3-D web browser, necessitating that much of the information and learning experience be conveyed through text. This necessity results from the lack of interactivity that such browsers allow because they are not based on video game engines; therefore, they act primarily as web pages. If too much text is presented or it is slightly above the learner's reading level as advocated by Vygotsky (1978), it is understandable that students would reach exhaustion points more rapidly and ask for help from the more learned expert in the form of the teacher.

7.36 Student disabilities vs. the system

In the treatment class, one student was partly deaf and usually wore hearing aids that receive broadcasts from a microphone and box that the teacher wears. While this did not appear to cause any problems for her in during the implementation, her progress was not as rapid as other students. Further, the teacher spent a much larger percentage of her time helping answer directional and procedural questions for this student. The student also did not spend as much time in face-to-face chat with other students, which may have led to her slower progress, because she was not privy to the same information as the

others. However, once she discovered the in-space chat, it became her primary means of communication and an important information seeking tool as she worked to solve the first Mystery.

Another student was autistic and became intently focused on very specific activities in the learning environment such as running in “Nowhere,” playing games with a peer, and taking part in other off-task behaviors. The teacher spent more time on certain days simply redirecting him to the tasks than she did with other students. However, the teacher revealed that the writing he completed during the implementation was substantially greater and of better quality than any other that she had received this year. Working with a peer appeared to substantially increase the amount of time that he spent on task as the peer redirected him to the task without aid of the teacher on many occasions.

As noted in Chapter Two, these findings are consistent with several studies of student writing, reading, and science work that is scaffolded using computers and software programs (Cunningham et al., 2002; Englert et al., 2004; Fink-Chorzempa et al., 2003; Goldberg et al., 2003; Graham & Harris, 2000). Students with reading and writing disorders required more time to complete assignments than there non-challenged peers. Based on the findings of the aforementioned studies, the benefits to using the technology affordances of computers and this learning environment likely resulted because they allowed special needs students the ability to: (1.) visually organize their writing, (2.) self-pace their work, (3.) receive additional and extensive feedback from the teacher because she had the time to give as is consistent with hypothesis one of this

study, (4.) receive feedback on their writing from peers, and (5.) use the additional, non-digital writing aids like the Reporter's Notebook, dictionaries, and thesauri that were provided by the teacher or researcher.

7.37 Research requirements vs. the lab

The classroom was cramped as there were four researchers in the room on any given day. This was in addition to a parent aide, the teacher, and between twenty-three and twenty-six students. On some days, there was also a computer and math aide from the local university, which brought the total number to thirty-three people in the room on the most crowded day. There were also three cameras and eight audio recorders, which made the space even more cramped. Researchers and instructors often had to brush past one another as we observed different parts of the room.

While students did not often appear bothered by this issue initially, the researchers noted the problem in debriefing meetings afterward. In addition, the teacher told the researcher, just prior to the third period, that her students had said that there were too many people in the room. This issue may have arisen because the room was quite small compared to a normal classroom at that school or compared with the computer lab at a nearby elementary school in which we also conduct research. It may have also been that we simply had too many researchers given the size of the room.

7.4 Summary

In conclusion, the findings of this study were generated using two separate methodologies: quantitative and qualitative. The quantitative findings revealed significant differences between the comparison and the treatment groups in terms of teacher time spent answering procedural and directional questions as opposed to engaging in teaching refining behaviors. In addition, there were significant differences between the classes in terms of the number of voluntary writing activities with the treatment class completing more than twenty-five. There were also significant gains on the proximal writing prompts in which the writing required was similar to that the students completed during the implementation. While there were no significant differences between the classes in terms of distal achievement on the standardized prompts, the comparison class showed significant decreases in achievement between the pre and post tests while the treatment classroom showed decreases that were not considered significant. The final chapter, implications, will discuss what these findings mean and how they should affect the future course of research in this vein.

CHAPTER EIGHT: IMPLICATIONS

8.1 Introduction

Now that the quantitative findings, qualitative differences between the classes, and a description of the periods of observation have been reported, it is important to discuss implications that are revealed by this study. By examining and exploring these implications, this researcher intends to examine emergent tensions revealed by the study, while building on the existing literature that was discussed in chapter two of this research report.

The quantitative research questions were centered on a hybrid problem-based learning-game system's usefulness in a.) reducing teacher time spent answering directional and procedural questions, b.) increasing the amount of voluntary writing practice engaged in by students, and c.) improving student writing scores on state standardized writing prompts. The qualitative question mainly focused on describing the main differences between the comparison and treatment classes. As a result, the implications addressed in this chapter are: Multi-user virtual environments and writing; Researching digital learning environments; Teacher Training and Learning Environments; and Design Elements Supporting a Game-Like Learning Environment. Following these, the final section overviews recommended next steps within this line of research. Within this section, the limitations of this study and recommendations for future research beyond *Anytown* will also be presented. While the recommendations presented here are intended for the researchers in the field, they are also intended as part of this researcher's evolving research agenda.

8.2 Multi-user virtual environments and writing

Based on the findings of this study, it appears reasonable to claim that, given a similar classroom, multi-user virtual environments may be used as a means of allowing students to practice descriptive writing in place of more traditional paper and pencil practice in the classroom. This is because findings were correlated with increased, free-choice writing practice in which students voluntarily chose to take part in writing in the treatment class at a ratio of 26:0 versus the comparison class. Writing practice is noted by Krashen (1991) to be vital to improving student writing not just in descriptive or informational writing, but in their general writing skills based on several studies beginning as far back as the early 1970s. Further, with the focus on standards and meeting student standardized achievement, the use of this digital environment was correlated with improvements in student writing in just seven periods while there were no significant gains in the comparison classroom. While the distal gains that would indicate improvements on an actual standardized test did not materialize in this month long study, there is the strong possibility that if the environment were used over a longer period, these gains could be manifest and future research may address this question. Finally, the significant increase in time that the teacher was shown to have available in the treatment group should free the teacher to engage in teaching behaviors rather than spending time repeating directions, reinforcing procedure, or on other administrative tasks. These teaching behaviors may include providing improved and specific feedback on student writing, giving encouragement, praising student work, empathizing with student struggles,

modeling writing, asking cognitively challenging questions, providing soft scaffolds to struggling writers and readers, and providing tools and resources to students as they seek to become better writers.

8.3 Researching digital learning environments

Another important finding is related to the difficulty of studying student and teacher used of multi-user and single user digital learning environments. As researchers, we believe it to be important to collect as much data as possible when a research opportunity affords itself. However, given the nature of computer labs in which there are often thirty to forty computers, twenty or more students, the teacher, teacher aides, and errant administrators, there is then a challenge when it comes to research. While the environment itself collects some data, we also often want qualitative data such as student interactions with peers, teachers, and computer systems which we need to capture for future analysis using multiple video cameras, audio recorders, and human observers who take field notes.

In the instance of a multi-user virtual environment such as *Anytown*, we then have crowded as many as forty people in a room along with a lot of equipment when the room was designed to hold only thirty comfortably. At times during the research of *Anytown*, there was a researcher for every three students in the treatment group which made the participants uncomfortable and they expressed there concern to both the teacher and primary investigator. With the participants unable to act naturally, the observed behaviors of students and

teacher tended to be stilted and students were acting as though they were constantly aware that they were being observed and were trying to make a good impression.

The only means to alleviate the circumstance at that point was to reduce the number of researchers in the room, work to make the video and audio recorders less conspicuous, and consider alternative means of data collection. For example, once students began to use the communication affordances of the system such as chat, telegrams and e-mail, the face-to-face discussion in the classroom largely ground to a halt. At that point, much of the action was taking place in the digital space as students worked together to solve problems there. As a result, a computer program called Camtasia™ was used to digitally capture student movement within the environment to determine who was working together, where they were spending their time, and which Quests they were struggling with at a given time. Two researchers used their avatars in the digital environment to observe students and record what they saw. One of the researches, unaware that he had chosen a female avatar, caused confusion and off-task behaviors in several students as they tried to determine why a boy was walking around *Anytown,* but was dressed as a girl. Student discovery of the chat feature led many students to be less active in the virtual space because much of their interaction with peers was taking place only in the chat which reduced the effectiveness of the Camtasia™ video capture as a data collection tool. As a result, the digital video often resulted in long periods where students did not move; at this point, the chat data became much more valuable.

What all of this indicates is that researching any form of virtual learning environment is difficult under the best circumstances. However, it is important to use an approach that (a.) minimizes the number of observers in the learning environment and their impact on the participants; (b.) ensures capture of data as students shift their modes of communication such as the use of audio and video recording equipment, software to capture within digital environment interactions, and logs to capture typed communication; and (c.) that the observers chosen comport with the social norms of the group under study so that they do not unintentionally create cognitive conflict in the learners that is off-task and unsupportive of the learning objectives. Researchers must be prepared to shift their modes of observation fluidly if their data collection is to be fruitful.

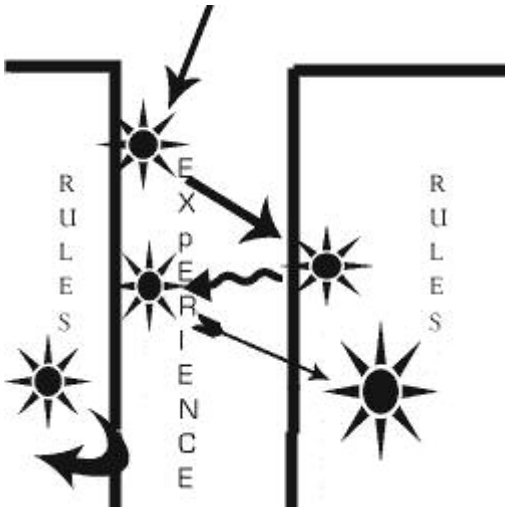
8.4 Teacher training and learning environments

Digital learning environments, especially those with game-like elements, are expected to be alien to many teachers. This may be because the “game-ness” of the environment and the allowance of play are very different from what is normally allowed under existing classroom strategies. Based experience as teacher and trainer of teachers with technology, play and video games were viewed by both teachers and administrators as off-task behaviors to be corrected and discouraged. The idea of play as a form of learning was still a very new concept or was largely ignored in the texts we were provided with in graduate school at that time.

8.41 Play

As a result of this study, past experiences as a teacher, observations of successful teachers while serving as an administrator, and other research conducted with Quest Atlantis (Barab et al., Under development), I hypothesize that play is the most fundamental form of human activity and means of learning. Play allows for the mind's exploration of the rules and consequences of engaging with or breaking them. In some instances, this play is subtle, with the learner testing their finger against the blade of the rule and discovering it is unpleasant. In others, they throw themselves into the crevasse bodily, learning the rules as they slam into them, bouncing from rock face to rock face. This is in keeping with theories of play espoused by Vygotsky in which children at play encounter a number of rules which make up a game that, according to Barab and Jackson (2006), they submit freely to as part of the act of play.

Figure 8.
Conception of play as interaction between experience and internal rules



NOTE:  *= moments of play or interplay*

Testing actions often take place as learners measure the reaction of the environment in relation to the strength of our actions. For instance, from a positivist perspective, we might wish to test the solidness of a single tree in the forest and compare it with the same quality of other trees. To do so, we play a game of action and reaction, using our senses. Perhaps we press fingers and hands against the surface of the bark to identify a rule such as that one cannot pass one's own physical form through the tree's physical form. However, there are more parts than the bark and to fully understand this concept of solidness, we might then explore the parts of the tree and compare them with the parts of our own bodies.

Since we already know the rule related to the bark, we may press our fingers against the leaves or needles or run a finger along bare trunk. We are able to describe the sensation of the wood against our fingers as smooth and generate the rule that the trunk under bark is smooth as a result of our play. The physical feeling of each component that makes up the tree may generate the rule that trees have parts.

In as much as play is a form of exploration, the fingers may then explore a fir needle on the tree by running along the length of its smooth side, then settling up the point, resulting in a stabbing pain or bloodied finger. This then generates a new rule for behavior that prohibits touching the point or the player/learner will suffer these newly learned consequences. At this point, four rules have been generated and learned through the interplay between sense (touch) and tree: 1.) trees are solid and cannot be passed through, 2.) trees have different parts, 3.) the wood underlying the bark of a tree is smooth, and 4.) the end of the component called needle is sharp and may cause pain if the end is touched, though the sides are smooth, like the trunk.

These rules can then be used to govern the learner's future behaviors and may be refined, added to, or discarded as other senses are enlisted into play such as scent, sight, and sound. It is during the incorporation of new rules into the learner's existing rule set when learning from play occurs. This experience of play also takes place in between the rules as the learner discovers or refines the boundaries of their rule set, such as when the player discovers that a fir needle is

smooth except when they play within this rule and discover that the point has a different rule because it is sharp. Therefore, the sharp end should be avoided.

This conception of play overlaps and incorporates other conceptions of play from the philosophers Plato (1955), Wittgenstein (1968), Derrida (1997) and Vygotsky (1978) in which play is a function of the mind's exploration of the world, itself, and interactions with other humans. However, it reconceptualizes play as a means of exploration and understanding rather than a light pastime in which the experience may be wasteful of genuine learning experiences. This is in an attempt to reframe all learning activities as a form of play that produces experiences and rules that can act as referents for future actions. Training teachers to understand that play is an acceptable form of learning is important if game-based curricula are going to be consented to in place of more traditional forms of face-to-face instruction.

As noted at the beginning of this section, when it comes to teachers, this conception is problematic, because most view play as off-task behavior to be corrected. This creates issues for acclimating teachers to the notion that play is part of a student's learning process. As a result, teachers must be trained to recognize when play is productive and when it is not.

8.42 Teacher training

The emergent conflict between a teacher's need for control and the need for the learning environment to function as designed means that more intensive training is required for teachers prior to the implementation of such a game-like

environment. In the instance of *Anytown*, a six page manual was provided to the teacher that outlined the environment, the activities, and the teacher role. In addition, an hour was spent in face-to-face training with the researcher in the week preceding the implementation. However, this was not enough and the problems described in the Findings chapter in which the teacher asserted her control over students by preventing voluntary activities and requiring teacher review of all quests before submission stymied the design intentions of the researcher.

Thus, I suggest that a more expansive teacher manual would be helpful. This is in keeping with the results of Dede's work (2006, 2006) which recommended that additional teacher professional development would make the River City multi-user virtual environment more effective. It should provide additional details about what the teacher might expect in terms of student cognitive challenge, the student-centered design of the environment, and what kinds of teaching behaviors would defeat the purposes of the system. Further, rather than an hour of teacher in-service, three hours of training should be required in the weeks preceding the implementation. During this time, the teacher "walks through" the activities with the researcher (acting as an instructor model) and becomes thoroughly familiar with what challenges await for students, when and where instruction take place, and what the teacher's role will be

With this form of innovation, teacher training and preparation are far more important than with instructional strategies that are more similar to the teacher's own experience. Without this training, the system will not function and the

teacher will subvert it based on their own perceptions of teaching and learning. With this training, the teacher should better understand their own role, the role of the system, the role of students, and, hopefully, the intention of the designer.

8.5 Design elements related to a game-like learning environment

As described by Salen and Zimmerman (2004), there are several major design elements that are required for a game: (a) *a rule-based interactive system*, (b) *a quantifiable outcome characteristic, and (c) artificial conflict and play characteristics*. They may also include *modeling reality characteristic*. While each of these elements was present in the *Anytown* multi-user virtual environment, their presence was not enough to make it an educational game. Further, they were not specific enough to guide the design of a learning environment that could be considered a game or even game-like. Additional elements were required. As a result of the design of the *Anytown* environment, I propose that the following set of elements must be present in an educational learning environment or game: 1.) conflict or problem, 2.) realistic context, 3.) rules or conditions for play, 4.) tasks, 5.) criteria for achievement, 6.) instruction by pedagogical agent, 7.) hard scaffolds, 8.) means of providing soft scaffolds, 9.) means of assessment, 10.) means of feedback, and 10.) designed frustration points.

While this is a far more complex set of criteria than were laid out by Salen and Zimmerman based on their meta-analysis, these also provide far more direction to designers in terms of those elements that are present in many games

and in this multi-user virtual environment in particular. Many of these elements, such as instruction using pedagogical agents, have already shown their effectiveness in non-game settings (Baylor 2004, 2005). The two primary additions to this list of design elements that stem from this research are the inclusion of hard scaffolds, the means for teacher or peer provision of soft scaffolds, and designed frustration points.

8.51 Scaffolds

Scaffolds in this context largely refer to aid or instruction that is provided by embedded system responses as pedagogical agents (hard), or by human agents such as the teacher or students (soft). This conception both overlaps and differs somewhat from the conception of Brush & Saye (2001), if only because pedagogical agents were not discussed in their article. Most video games include some form of scaffolding game play such as tutorials, in-game hints, and reduced difficulty if the player fails at a task repeatedly. Others include chat spaces for sharing tips with human players. This is similar to the peer help that has been shown to be effective in classroom settings (Kling & Courtright, 2004; Steinkuehler, 2004; University & Maas, 2003).

As noted by Baylor and Kim (2005, 2005) and as supported by this study, systems may be designed that embed scaffolds effectively within pedagogical agents. These pedagogical agents have been shown to be most effective at facilitating learning when they are perceived as learners as being most human-

like. Further research in this vein, especially with younger learners may help benefit future instructional designs that leverage such intelligent agents.

8.52 Designed frustration point

For many people, learning is a painful and uncomfortable process similar to breaking a bone and feeling it knit itself back together over time. It often centers on some point of frustration, some moment during which we do not understand a concept or our flawed conception is shattered for us by some outside agent. Constructivists often refer to this as cognitive conflict (Duffy & Cunningham, 1996; Jonassen, 1999; Jonassen & Hernandez-Serrano, 2002). However, it may not be the conflict itself that results in learning, but instead the successful resolution of that conflict is what results in learning. The designed frustration point is the means to engender cognitive conflict in the learner, however, learning only takes place when the student overcomes the frustration and can use the strategy again in a similar situation.

Producing cognitive conflict in a learner is not usually a difficult task. However, designing an event or a situation in which the learner becomes frustrated to the point of acquiring or generating a new understanding that the instructional designer intends can be much more difficult. It is easy to overly discourage the student, which results in only frustration and no learning. This is why it is important to include designed frustration points during the course of a lesson or embedded within a learning environment must be present for learning to occur while at the same time providing embedded scaffolds to help students

overcome their difficulties. If a frustration point is designed, tested, and refined until learners can interact with it meaningfully and usefully to produce a new or superior understanding that readily makes use of the engendered cognitive conflict, then it will be much more useful that a random instance of conflict that the instructor did not prepare adequately for prior to its incidence. An example of such a frustration point comes when one student discovers the fictional “Raintree Manse,” which is locked and linked to a mystery Quest. The following is the interchange between student and teacher:

FS12: Are we are allowed to go inside the house?

Teacher: Can you?

FS12: No, it is locked.

Teacher: How do you and unlock it?

FS12: You have to find the key.

Teacher: How you find the key?

FS12: I'm searching for clues. But I don't know...

Teacher: You can ask for help.

Note that the teacher guides the student to try to use strategies to answer her own questions rather than giving a yes or no answer that would solve the child’s problem, but would also forge further dependency of student on teacher and fail to teach the learner a valid strategy for problem solving. This approach is an excellent means of redirecting students to try to reduce their own frustration or

cognitive conflict. The student later asked nearby students and in the chat for help in solving the problem. This had the threefold effect of redirecting her to the system for help and rule-setting, redirecting her to peers for help, and making her (the student) responsible for overcoming the frustration instead of the teacher.

Further, these frustration points can and do have more uses that simply overcoming cognitive conflict and generating new knowledge structures. *Anytown* indicates that these frustration points can become rallying points around which learners can choose to work together to overcome the problem, resulting in increased collaboration. By coming together, students become interdependent on one another for information, developing shared knowledge structures, and developing larger understandings of the why and how questions related to the way something functions and how to overcome it.

Another use of these structures is to help wean students from over-reliance on teacher direction and help. This will improve student-centered learning by encouraging them to trust and understand other systems that provide information, such as the *Anytown* environment where they solve puzzles and mysteries that lead to exciting writing topics, the Internet where they can conduct research or even something as simple as an online dictionary where they can seek definitions. Further, when a learning environment is rich with communications tools such as e-mail, chat, and telegrams as *Quest Atlantis* is, student trust of the system may lead to improvements in computer skills, typing skills, and non-verbal communication, which is especially valuable in public

schools and classrooms that value quiet, but still want student learning to involve sharing and interaction.

In addition, frustration points centered on visual puzzles, such as the number of fish swimming at a certain point in a river, or audio cues, such as a plane starting to stall, can help to leverage what games and simulations are good at; namely, they provide a dynamic place to learn in which the environment and objects within it change based on learner actions, much the way they do in the real world. The benefit of the designed frustration point is that it compliments and overlaps what simulations do well; it minimizes possible injury to the learner, while still providing an active, challenging learning experience less likely to just result in frustration (Cubitt, 2001; Ellington, Gordon, & Fowlie, 1998). Careful design and consideration of when and where student frustration occurs can allow both systems, through embedded scaffolds, and instructors, through soft scaffolds, to buffer this difficulty and help ensure the correct learning experience for each learner without making it overly onerous on the teacher. It also allows practice, interdependence on peers and learning systems, and struggle with ill-structured and difficult problems, while still providing adequate scaffolds for when the learner stumbles or falls.

Supporting all this learning, refining the design, and assessing the progress is the teacher, without whom the design would remain a stagnant moment, either too difficult or too simple. For example, the treatment teacher helped a student think through the problem when he discovered one of the

designed frustration points in the Mine:

> **MS11:** How do you get past this thingy?
>
> **Teacher:** What is that thingy?
>
> **MS11:** Um…I think it's a barrier of some sort, but I…but when I click on it, it just says…it didn't say much…
>
> **Teacher:** There…pull it over more so you can read it…you just need to be able to read it…okay.
>
> **MS11: (reading):** 'The strange machine does not seem to fit in *Anytown* at all. Maybe some Atlantian technology has found its way here. You do not have anything with you that seem helpful. There is this area, too.
>
> **MS11 (reading):** 'This area of the mines has been blocked off with large pieces of wood, rocks and other pieces of debris.'
>
> **Teacher:** You've got some pieces of debris there. You'll have to pull it off.
>
> **MS11:** So, is there any way I can get past this…debris? Oh, wait I think I might have….

The teacher's presence and redirection spurred the student's reading and he discovered that he could solve his own problem. There was not much scaffolding involved here, but without it, the learner may not have found his way through for several more days. It is important that I make clear that it is not my intention to try to replace the teacher through such designs as *Anytown* or *Taiga*, only to support their mission of education. My goal as a designer, researcher, and learner is to help teachers improve their own instruction, reduce the amount of time it takes to deliver it, and make learning more enjoyable for students. The instructor and the

designer must always work hand in hand to produce meaningful learning while helping students grow to reach their own potential.

8.6 Future research

In terms of future research, there are three major lines that should next be explored: those involved with *Anytown* and those that focus on the use of games, game-like learning environments in general, and student problem-solving within game-infused problem-based learning environments. In terms of the *Anytown* environment, the role of peer teaching and support appeared to be an important part of both student successes on Quest tasks within the space and in overcoming major difficulties with the game-like pieces of the design. While this appearance is important, further research is needed to fully understand the role that peer support plays in learning using such an environment. Further, the role of peer interference with on-task behaviors as was seen between students C-20 and C-23 when C-23 fervently attempted to draw C-20 off-task is also an important next research focus.

Beyond peer support, the role of game incentives, such as receiving objects that permit the learner to do something special like opening a locked door, is also important to understand within such an environment. For example, while there were over 150 objects that students could earn or otherwise receive in *Anytown*, students found only a fraction of these during their time in *Anytown*. What still must be explored is which objects were most motivating to students? Which objects confused students or were useless? What is the role of intentional

frustration points set around gaining game incentives? Are students willing to work to overcome their frustrations if they are motivated by the reward in the game?

In terms of the larger video game genre and instruction, can games be harnessed to more effectively train students to perform real-world tasks related to standards in other content areas? What is the impact of the authenticity of a task? What happens to real-world performance when the simulation aspect of the game is unrealistic? Can such games be used to prepare students to use mathematics and social studies concepts to solve complex problems? What role can or do designed frustration points play in leveraging existing and emerging instructional designs to improve them?

Within this same area, researchers like Baylor and Kim (2005) are making strides with the use of pedagogical agents in learning environments. However, the complexity of these characters does not reach the level of primary instructor in many cases. Future research should explore the use of complex pedagogical agents that answer student questions, redirect students to tasks, suggest new learning tasks, have evolutionary dialogue and instruction based on student actions within the game or environment, and have rich personalities that are recognizable by students upon multiple contacts with students, similar to those characters presented in novels, television shows, adventure games, and movies. The most complex characters in *Anytown* have anywhere from nine to fifteen levels of dialogue that change dependent on the conditions under which the student interacts with them. However, the less complex characters often repeat

dialogue several times until their role broadens. What happens when a student bothers the old fisherman twice and he refuses to talk to them again and is rude? How does this impact their learning and play experience? How does this change how the trajectory of the game must then unfold? Does it impact the dialogue of other characters? What do students learn about social cues, norms, and interactions from such an experience that has real-world value?

Another important topic to be explored is how the principles of game design can be leveraged to improve non-digital, face-to-face instruction. How can teachers use the elements employed in video games to make a boring science lecture engaging and transferable to new contexts and situations? The design of instructional sequences that present instruction in ways that clearly link to student interests and appeal to what is truly interesting about a subject area may be one means of exploring this topic. In terms of a research agenda, a tenable one should focus on 1) reading, technology, and achievement, 2) teacher training to capitalize on innovation, 3) designed frustration points, and 4) problem-based learning extensions.

8.61 Reading, technology, and literacy

Based on findings from Steinkuehler's (2004) work with the game *Lineage II* combined with the findings of this study of the *Anytown* environment, the first area of interest is in exploring the relationships between student engagement, reading practices, and models of digital means of creating intrinsically motivating reading and writing practices for K-12 students. Krashen's (2004) review of

research related to reading and writing that increased reading practice is often correlated with improvements in student writing even more so than increase writing practice. He notes further that both increased reading and writing practice can help improve student acquisition of a foreign language which is a major issue in today's multicultural classroom. Future studies should examine whether this form of digital environment can motivate students to engage in regular reading and writing to improve both their first language skills as well as aid non-native English speakers in acquiring the language.

Also of interest is linking reading to the design of learning environments that can be prepared using those principles of engagement already employed by game companies, digital and analog, and by successful teachers to improve student willingness to read. Existing games such as Blizzard's *World of Warcraft* and White Wolf's *Vampire: The Masquerade* already provide books that compliment the game experience, providing additional information and stories about characters that might be experienced in the game. In fact, the pre-order copies of *World of Warcraft* were accompanied by copies of the first novel in a trilogy that helped to frame the world in which players would play while linking the new game to the story of *Warcraft III*. This helped to draw players into a new story without risk because it complimented their daily experience within the game.

However, these books fail to capitalize on the reading aspect as a link to improving or expanding game-play and visa versa. If success in the game were contingent upon or improved upon by successful comprehension of

accompanying novels, I hypothesize that both experiences would be improved and literacy skills might also. I believe that the development of a face-to-face or digital learning environment that is accompanied and complimented by a novel or series of novels that include clues and information that is revealed at multiple levels of inference would increase student motivation to read, student time spent reading, and therefore improve related literacy skills such as comprehension and recall.

For example, reading the text for basic understanding may reveal the codes needed to shut down a water processing plant that has become contaminated before the water can reach the town imaginary town of Rivendell. If the learner reads and draws more midlevel inferences, they might draw some conclusions about who the suspects in this contamination are, which helps them to find evidence to support their theory and draw closer to winning the game at this level. The experience would end differently for this reader because they were able to glean more information. Finally, for those who read at a higher level and are able to draw stronger conclusions, identify broader themes and deal with the abstract, mutable qualities of the story to develop a third, defensible solution, they would have yet another conclusion to the experience. Study of the motivating factors that might cause a player to try the experience multiple times, read the book or books more than once at different times, or improve reading comprehension and recall over time would all be of interest from such a design. This also begs the question of how multiple media can compliment one another without requiring that they all be digital media in order to benefit student learning.

While Clarke (1983, 1994) would argue that media can never influence learning, I would argue that it can aid in the presentation of material so that students are more willing to engage with curriculum and learn from it. This may be because the media (e.g. books, digital environment) include information necessary to successfully complete an intrinsically motivating task and can present the information in novel, efficient, or cognitively challenging ways to individual learners in a way that the teacher could never have time to do.

8.62 Teacher training to capitalize on innovation

As shown by the tension between teacher and system, any new curriculum will require the development of new classroom practices and the creation of training techniques at the university and in-service levels that encourage teachers to engage with emerging technologies in ways that prepare them for meaningful integration with content. I am interested in training teachers to use the technologies in an immersive way in which they must understand instructional technologies as student first, teacher second. Allowing teachers to experience the student's point of view should result in better technology integration because teachers should be less likely to take half-steps that result in un-engaging uses of technology because they have already experienced the damaging consequences first hand.

Further, research should examine if teachers trained to recognize when their administrative duties, such as answering repeated procedural and directional questions, if they engage in increased instructional discourse. Do

teachers spend more time providing specific feedback on student writing? Do they increase their discourse with students in the computer lab related to the characteristics of good writing such as proper spelling, punctuation and capitalization? If the teacher does not leverage the increased time they have in the computer lab to improve student learning as a result of the digital environment, then the innovation is not helpful. If future research shows that teachers are engaging in significantly increased instruction, feedback on student work, challenging poor knowledge constructions, and informal assessment of student learning, then the environment allows the teacher to engage in teaching behaviors associated with improvements in learning (Webb, Nemer, & Ing, 2006; Webb et al., 2004).

8.63 Designed frustration points

Lastly, I believe further study of the designed frustration point, as discussed earlier, is a tool for instructional design and learning that has its place as a subject of research in both digital and analog classrooms. This concept is presented in opposition to the *unintentional frustration points* that arise naturally through student experience with an instructional sequence and are the center-piece of just-in-time instruction design (Thiagarajan, 1993). I argue that the *designed* frustration point is superior to the *unintentional* because it allows for teacher preparation for providing rich scaffolds in the form of prepared lessons, directional statements that allow for student interdependence, and inclusion of materials that allow learners to overcome their own cognitive conflict.

Based on its successful application in the *Anytown* design, I am interested in developing other curricula that embeds such technical moments. I hypothesize that these moments allow learning to become more student-centered and challenging as learners and groups of learners discover their own power. This power should allow them to overcome cognitive challenges and walk the tightrope of their school day problems. Equally important is the intention that the design is sufficiently subtle that the student does not realize that the net is still there far below them, and their teachers are out in the audience cheering them onward to ever greater heights.

8.64 Problem-based learning extensions

While this study focused mainly on the issues related to the instructional design of the learning environment in this study such as teacher time spent on administrative tasks and learning outcomes, it does not present much data regarding the learner experience in using the learning environment. Future studies should spend time looking at the quality of the student experience, the strategies used by students in order to solve the ill-structured problems posed by the learning environment, the degree to which students work collaboratively to solve problems, and the extent to which they are able to construct valid arguments in support of their solutions. Other foci should include the extent to which teachers engage in asking cognitively challenging questions of students, provide tools and resources to students, and how often they model problem-solving for students who struggle to develop their own knowledge constructs.

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Appendices

Appendix A.
Observer checklist for teacher question-answering behavior using video and audio recordings

Type of question	*Duration of answer*	*Student ID#*
Directional/ Procedural		
Directional/ Procedural		
Directional/ Procedural		
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Directional/ Procedural		

Appendix B.
Writing application assessment instruments
(From California Assessment Program *released test)*

Writing Prompt A (Distal)
Witnessing an Argument

Writing Situation: Arguments or disagreements between people often create lasting hard feelings. You have probably seen two of your friends argue while you were with them. Sometimes we can simply watch disagreements without becoming involved in them.

Directions for Writing: Tell about a time when you witnessed an argument or disagreement between two people. Let the reader know what happened. Describe the people involved and how each person acted during the disagreement. Be sure to tell how the argument ended.

Writing Conventions

For this writing task, you will write an informational essay that:

a. is written to an identified audience.
b. establishes and supports a central idea.
c. concludes with a paragraph that summarizes the points.
d. uses fluid and legible cursive or joined italic.
e. demonstrates grade-level appropriate sentence structure, grammar, punctuation, capitalization,
and spelling.

2. Writing prompt – Distal
(From California Assessment Program *released test)*

Writing Prompt B (Distal)
The Group

Writing Situation: Every school has different groups of students. These students come together because of some common interest – sports, music, or school activities. Think of a group of friends about your age.

Directions for Writing: Write about this group. If this group has a name, give the name and the reason for the name. Explain what interest holds the group together. Describe some members of the group – what they look like and how they act. Tell about some adventures or activities of the group. Try to make this group come alive for your readers who do not know anything about the group.

Writing Conventions

For this writing task, you will write an informational essay that:

a. is written to an identified C-6nce.
b. establishes and supports a central idea.
c. concludes with a paragraph that summarizes the points.
d. uses fluid and legible cursive or joined italic.
e. demonstrates grade-level appropriate sentence structure, grammar, punctuation, capitalization,
and spelling.

3. Writing prompt – Proximal – Writing Traits
(From New Jersey ASK *released test.)*

Writing Prompt C
Describe the Picture

Directions: Using the picture on page 4 as a guide, write a story about what might be happening.

You may take notes, create a web, or do other prewriting work. Then, write your story on the provided paper.

Writing Conventions

For this writing task, you will write an informational essay that:

a. is written to an identified C-6nce.
b. establishes and supports a central idea.
c. concludes with a paragraph that summarizes the points.
d. uses fluid and legible cursive or joined italic.
e. demonstrates grade-level appropriate sentence structure, grammar, punctuation, capitalization,
and spelling.

4. Writing prompt – Proximal – Writing Traits
(From California Assessment Program released test*)*

Writing Prompt D
A Fad

Writing Situation

A "fad" is a fashion in dress, actions, items, or speech that is popular for a brief time. (i.e., Pokemon, baggy jeans, break dancing, scooters.) Think about some of the fads that students on your own campus follow. Which ones are acceptable at your school? Which fads have been banned by school officials? Think back to last year's fads and note which ones are still "in."

Directions for Writing

A student from the state of Virginia is seeking information for her school newspaper about popular elementary school fads that occur in other states. The school that she has chosen is yours. Write an article for her newspaper in which you report on the current acceptable fads at your school. Include information on which fads were popular last year but are no longer "in."

Writing Conventions

For this writing task, you will write an informational essay that:

a. is written to an identified C-6nce.
b. establishes and supports a central idea.
c. concludes with a paragraph that summarizes the points.
d. uses fluid and legible cursive or joined italic.
e. demonstrates grade-level appropriate sentence structure, grammar, punctuation, capitalization,
and spelling.

Appendix C.
Reading and Writing standards – *State of Indiana - Core 40 Objectives*

Writing Objectives

4.4.3 – (1) Select a focus (topic), organizational structure, and point of view based on purpose, C-6nce, length, and format requirements for a piece of writing.

4.4.3 – (2) Write informational pieces with multiple paragraphs that:

A. provide and introductory paragraph.
F. establish and support a central idea with a topic sentence at or near the beginning of the first paragraph.
G. include supporting paragraphs with simple facts, details, and explanations.
H. present important ideas or events in sequence or in chronological order.
I. provide details and transitions to link paragraphs.
F. concludes with a paragraph that summarizes the points.

Writing Application

4.5.3 – (3) Write informational reports that:

A. ask a central question about an issue or situation
D. include facts and details for focus
E. use more than one source of information, including speakers, books, newspapers, media sources, and online information.

Reading Comprehension

4.2.1 – (1) Use the organization of informational text to strengthen comprehension.

4.2.2 – (2) Use appropriate strategies when reading for different purposes

Appendix D.
Existing Curriculum for supporting writing

A. *Five Senses* - Teacher begins with a mini-lesson to remind students of the five senses that they already know PLUS a sixth which is referenced as “emotion.”

B. *Brainstorm* - Students brainstorm their experiences to develop a series of topics that involve each sense. Each sense will be used to develop a six paragraph descriptive essay. It is from this brainstorm that their topic sentence comes.

C. *Outlining/Organizing* – Students choose or are directed to use an appropriate means of organizing their intended writing so that they can best place each paragraph in an order that makes sense and outline what the content of each will essentially be. It is also here that students will write and insert topic sentences that make sense for the overall structure and each paragraph.

D. *Rough Draft* – Based on their organization structure, students write their first draft.

E. *Peer Review* – Students read each other’s work and give feedback to the author.

F. *Revision* – Based on this feedback, students revise their first draft and create a second.

G. *Teacher feedback* – The teacher reads and provides feedback to the student on their second draft. This includes grammar, spelling, and other issues in addition to content, quality of their descriptions, and organizational issues (sense-making).

H. *Final revision and publication* – Once the student has their teacher’s feedback, they revise and edit their second draft to create their final publishable piece. Depending on computer lab time or teacher requirement, this may include typing the final piece.

I. *Optional* – Writer’s notebook – These are used to store student writing ideas that come up over the course of the unit cycle.

J. *Optional* – Similar to the Mystery and Creative Writing Quests, there are a series of readings that students can do from a book of writing topics and prompting suggestions. This book is called “A Writer's Notebook: Unlocking the Writer Within You” by Ralph Fletcher. Three of these include: *Unforgettable Stories, Fierce Wonderings,* and

Memories. These prompt students to reflect on their experiences and investigate new ideas.

Appendix E.
Interview protocol for teacher pre-implementation interview

Epistemic beliefs about writing – Interview Questions

1. What do you do to help your kids become better writers?
2. From your experience, what is the most effective way to teach writing?
3. How much responsibility does the student have in learning to write? (vs. that of the teacher)
4. How do you identify struggling writers?
5. How do you help struggling writers to overcome their difficulties?
6. What do you believe makes a good environment for learning to write?
7. How is time spent during a typical writing period (writing, direct instruction, mini-lessons, sharing, conferencing, etc?
8. What is the role of non-language arts/reading activities during writing time in your classroom?
9. How do you create a curriculum to connect to the standards?
10. How do you feel about the use of technology in terms of teaching writing?

Interview protocol for teacher exit interview

Brainstormed questions:

- How is using this unit to teach LA/Reading different from traditional instruction?
- How much scaffolding do they do with it vs. traditional instruction?
- What is the teacher attitude towards using a technology-embedded lesson?
- What are the teacher's tacit beliefs about instruction?
- What doesn't the teacher like about using this product?
- What would they like to see done differently?
- What are their major criticisms of using the technology-embedded unit?
- What are the management obstacles the teacher faces when trying to use the unit?
- What system structures (period length, principal views, classroom structure) impede use?

Topic One

Systemic obstacles to using the QA LA/Reading unit

Lead-off question: Describe your average day when using the Quest Atlantis language arts and reading unit.

Lead-off question (comparison): Describe your average day when teaching writing.

Implicit/covert categories

- What is the teacher attitude towards using a technology-embedded lesson?
- What are the teacher's tacit beliefs about instruction?
- What doesn't the teacher like about using this product?
- What are the management obstacles the teacher faces when trying to use the unit?
- What system structures (period length, principal views, classroom structure) impede use?

Possible follow-up questions (Treatment only)

- Can you tell me about a time when time allotted for writing affected student learning with the unit?
- Tell me how you would you teach a traditional unit on this topic (descriptive writing) now? (Treatment only)
- Can you tell me about your training with technology integration into content areas?

- Can you describe any discipline or other management concerns that came up?
- Can you tell me about anything that might make using such a unit easier to implement?
- Can you describe an element of the unit that was hard to work with?
- Can you describe your general beliefs about how students learn?

Topic Two
Inherent problems with the instructional method (Treatment only)

Lead-off question: Describe any challenges you faced when implementing the unit.

Implicit/covert categories (Treatment only)

- How much scaffolding do they do with it vs. traditional instruction?
- What would you like to see done differently?
- What are major criticisms of using the technology-embedded unit?
- What are the management obstacles the teacher faces when trying to use the unit?
- What system structures (period length, principal views, classroom structure) impede use?

Possible follow-up questions (Treatment only)

- Can you tell me about a time when you spent time scaffolding the lesson in place of the 3-D avatars?
- Can you describe instruction in the unit that you would have liked to have seen handled differently?
- Can you describe challenges you faced in working with the writing unit?
- Is there anything from your experiences as a teacher that you think would be helpful in revising the unit?
- Can you describe a problem you faced that could be overcome by changes in the systemic design of the 3-D unit? (For instance, the length of time it takes to complete a Quest.)

Appendix F.
Interview protocol for student exit interview – Anytown

Lead-off question: Describe your day when you did Quests in *Anytown*.
Lead-off question (comparison): Describe a day when you worked on writing in class.

Implicit/covert categories

Systemic obstacles to use of the unit
Guidance
Scaffolding difficulties
Learning preferences
Game-like structures
Attitudes
Intrinsic/extrinsic motivation

Brainstormed and follow-up questions:

3-D environment (Treatment only)

A.) What do you like about *Anytown*?
B.) What do you dislike about *Anytown*? How would you change it?
C.) What in *Anytown* was most difficult to make work (interact with)?
D.) Describe a time that working on writing using *Anytown* was hard for you. Why?
E.) Did you have a favorite character in *Anytown*?
F.) Who was most helpful to you when you got stuck?
G.) Who helped you the most with your writing? Least?

Learning/instructional (Treatment)

A.) Did you learn anything from working in *Anytown*?
B.) Did you learn anything new about writing in the last month?
C.) Do you think your writing was better after you worked in *Anytown* than before?
D.) Do you like to write in class?
E.) What did you think about the activities/tasks you did in *Anytown*?
F.) What sorts of writing did you do that the teacher didn't tell you to do?
G.) What was most helpful to you? Least?
H.) Tell me about a time when your teacher helped you with something difficult.
I.) What did you learn from working with the editors?
J.) What did you learn from talking to the people in *Anytown*?
K.) Tell me about a time when someone in class (a student) helped you.
L.) Can you tell me the steps of the writing process?

Learning/instructional (Comparison)

A.) Did you learn anything new about writing in the last month?
B.) Do you like to write in class?

C.) What sorts of writing did you do that the teacher didn't tell you to do?
D.) Tell me about a time when your teacher helped you with something difficult.
E.) Tell me about a time when someone in class (a student) helped you.
F.) Can you tell me the steps of the writing process?

Cognitive/motivational (*Anytown* only)

A.) Do you like working on writing in *Anytown*? As much as in regular class? Why?
B.) What makes working on writing in *Anytown* different from the regular classroom?
C.) Did working on writing in *Anytown* make you like writing any more or less than before?
D.) Was there anything in *Anytown* that was more fun to describe than the others?
E.) Did you ever go back to characters like the editors to help you when you got stuck?

Attitudinal (*Anytown* only)

A.) Would you want to practice writing by using *Anytown* again?
B.) How do you feel about writing?
C.) Did using *Anytown* to practice writing change this for you at all?
D.) Will you go back to *Anytown*?
E.) Are you looking forward to writing again?

Other questions are expected to come up as a result of observation over the course of the collection period.

Appendix G.
Example of Carspecken's (1996) Reconstructive Validity Horizon Analysis, Meaning Field Development, and Interactive Sequence Analysis

Taken from and unpublished manuscript

(14) **[RHYTHM BEGINS: tic-tac, wall] Seradis:** *Okay, do you think we're supposed to move?* (whispering to Bartlok)

(15) **Bartlok:** *I think we're supposed to move.* (whispering to Seradis)

(16) **Seradis:** *Maybe.* (pause) *Okay, let's* (unintelligible) (Whispering to Bartlok)

(17) **Bartlok:** *Which do you think? I guess we push the "A" we continue?* (whispering to Seradis) (long pause) *Which door do you think it is?*

(18) Both women laugh loudly in response to this question.

(43) **Bartlok:** *(unintelligible)* concurrently with **Seradis:** *We can't figure out where we're supposed to (unintelligible)* (both women are still laughing through this dialogue)

[43a] *"We can't figure out where we're supposed to (O.C. do?)*

[MF:
"I do not know what to do." AND\OR
"I should know what to do." AND\OR
"Tell me what to do." AND\OR
"The game should have told me what to do." OR
"How are we supposed to know what to do?" AND\OR
"There is a problem with the game." AND\OR
"The game should not be this hard to figure out."
"I have done what I can do to figure this out, now I need help."

[43b] (both women are still laughing through this dialogue)

[MF:
"Despite the confusion, I am still enjoying this." OR
"I am laughing to cover up my irritation with this game." AND\OR
"I am trying to have a good attitude about this." AND\OR
"I am glad to have someone else to share this negative experience with." OR
"It is good to have someone else to share an experience with." OR
"This is funny." OR
"This is stupid." OR
"I am really annoyed." AND\OR
"I am going to laugh in response to my anger, rather than hurt Scott's feelings."

Reconstructive Horizon Analysis

Foregrounded Validity Claims

Possible Objective Validity Claims

- "I do not know what to do."
- The game has rules.
- I do not know all the rules are.
- There is a direction I am supposed to go in to play the game.
- I do not know where I am in the game.

Possible Subjective Validity Claims

- "There is a problem with this game."
- "This is funny."

Possible Normative Validity Claims

- "I should know what to do."
- "The game should have told me what to do."
- "The game should not be this hard to figure out."
- The rules of the game should be more clearly stated.
- The directions within the game should be more clearly stated.
- The researcher should know the rules.
- The researcher should be able to give directions.
- I should be able to reference the rules when I need to do so.
- I should know how to reference the rules when I need to do so.
- I should be able to access the directions when I need to do so.
- I should be able to access the directions when I need to do so.

Possible Identity Validity Claims

- "I am a game player."
- "I am a consumer."
- "I am a participant."
- I am an elf wizard in the game.

Near Backgrounded Validity Claims

Possible Objective Validity Claims

- The game will continue.
- There is something that can be done that will allow me to continue.
- Moving my avatar in a particular direction will continue the game.
- The researcher can help me solve my problem.

Possible Subjective Validity Claims

- I do not feel I can go any farther.

- I do not feel I can do this without help.
- I do not feel secure in solving this problem on my own.
- I feel afraid to make a mistake.
- I would feel more secure with expert guidance.
- I feel anger with the game for not providing guidance.
- "I am trying to have a good attitude about this."
- "I am glad to have someone else to share this negative experience with."

Possible Normative Validity Claims

- Games should provide proper instructions.
- The researcher, as an expert, should know what to do.
- As a game player, I should know what to do.
- If the game does not explain the rules sufficiently, the researcher should.

Possible Identity Validity Claims

- I am a novice game player.
- The game contains the rules governing game play.
- The game contains directions for the players.
- The researcher also contains directions for the players.
- The researcher is a resource for game play.
- If the game does not explain the rules sufficiently, the researcher can.

Remote Validity Claims

Possible Objective Validity Claims

- It is OK to ask for help.
- The avatar's movements cause events in the game.
- Telling the researcher that I am having a problem will elicit a response from him.
- "I am going to laugh in response to my anger, rather than hurt Scott's feelings."

Possible Subjective Validity Claims

- I do not feel very patient.
- I feel annoyed.
- I feel frustrated.
- "I have done what I can to figure this out, now I need help."
- "Despite the confusion, I am still enjoying this."
- "I am laughing to cover up my irritation with this game."
- "It is good to have someone else to share an experience with."
- "This is stupid."
- "I am really annoyed."

Possible Normative Validity Claims

- Rules should be clear in games.

- It is important that I know what to do.
- When I take an action with the controls, the avatar should move.

Possible Identity Validity Claims

- I am a novice game player.
- I am not a very good game player.
- I am not in charge here.
- The game is in charge.
- The researcher is in charge.
- I am a learner.
- The game is an instructor.
- The researcher is a possible instructor.

(44) [New Bid] **Researcher:** *I think it's up to the left.*

Appendix H.
Sample of Critical Analysis using *Anytown* data

Sample Meaning Fields and Interactive Sequence Analysis

SEQUENCE BEGINS

(bid) 22:36 – FS12: When we find things can we write them down in there?

(bid accepted, new bid) 22:37 – C.: You can take any notes you want.

(new bid) 22:47 – FS4: I don't know what that person is saying.

(bid rejected, new bid) 22:51-22:54 – C.: Read it again. (pause) There.

Meaning Field (22:51-22:54)
MF: As a teacher, I should expect you to read.
MF: You need to read. (Possible Normative Validity)
MF: You aren't reading.
MF: All students should read.
MF: I want you to read this.
MF: I want you to tell me what to do.

(bid) 22:58 – C.: What's he asking you to do?

Meaning Field (22:58)
MF: You should be able to tell me this. (Possible Backgrounded Normative Validity)
MF: You should take notes. (Possible Foregrounded Normative Validity)
MF: Taking notes is important. (Possible Backgrounded Normative Validity)
MF: All students need to follow directions. (Possible Backgrounded Normative Validity)
MF: This is something you can answer by yourself. (Possible Normative Validity)
MF: You need to read. (Possible Foregrounded Normative Validity)
MF: You aren't reading. (Possible Foregrounded Normative Validity
MF: You aren't following directions. (Possible Objective Validity Claims)
MF: I think it is important to following directions. (Possible Subjective Validity)

(bid accepted, new bid) 23:01- FS4: He says I need to do two things before I…

(bid clarification) 23:04 – C.: What two things?

(bid) 23:07 – FS4: The first thing is to ask Anita downstairs…

(bid accepted, new bid) 23:08 – C.: Anita, okay…and then…

(bid) 23:11 – FS4: Ask about the writing process…

(bid accepted, new bid) 23:15 – C.: And then? You have to go find her. Just like you found Jim, you're going to have to find Anita.

SEQUENCE ENDS

2. Sample validity horizon analysis

Foregrounded Validity Claims related to:

(bid rejected, new bid) 22:51-22:54 – C.: Read it again. (pause) There.

Possible Objective Validity Claims

You need to read.
You aren't reading.
You aren't reading.

Possible Subjective Validity Claims

There is a problem with you.
You would know this if you read.

Possible Normative Validity Claims

As a teacher, I should expect you to read.
The student should have known to do this.
The game should not be this hard to figure out."
The directions should be clear.
The student should understand the directions.

Possible Identity Validity Claims

I am a teacher
I am an expert
I am a student.

Near Backgrounded Validity Claims

Possible Objective Validity Claims

The game will continue.
There is something that can be done that will allow me to continue.
Learning this information will continue the game.

Possible Subjective Validity Claims

I am annoyed that you didn't read.
You can do this on your own.
You don't need my help.
You need to help me.

Possible Normative Validity Claims

Students should read.
I should be able to expect you to read
Everyone should have read this, including you.
Everyone should be able to tell me what they should do in the game.

Possible Identity Validity Claims

You are a reader.
The learning environment includes the rules.
The game contains directions for the players.
The teacher also contains directions for the learners.
The teacher is a resource for overcoming my frustration.
If the game does not explain the rules sufficiently, the teacher can.

Remote Validity Claims

Possible Objective Validity Claims

It is OK to ask for help.
It is not OK to ask for help if it is already in the directions.
Telling the teacher that I have a problem will give a response.
I am not going to give you the answer. You have to earn it.

Possible Subjective Validity Claims

I do not feel very patient.
I feel annoyed.
I feel frustrated.
“I have done what I can to figure this out, now I need help.”
“This is stupid.”

Possible Normative Validity Claims

Rules should be clear in games.
It is important that I know what to do.
You should follow directions.

Possible Identity Validity Claims

I am a novice game player.
You (the student) need to be in charge.
I am not in charge here.
The game is in charge.
The system is in charge.
I am a learner, too.
The game is an instructor.

The designer is probably the instructor here.

3. Power analysis, umbrella norms, roles, interactive rhythms

3.1 Interactive Rhythms

Tic-tac, wall rhythm – frustration

This rhythm occurred when a student would ask for directions related to the task and the teacher flatly refused and redirected them to a peer.

Ping-pong – dialogue

The ping-pong dialogue occurred whenever a student was resistant to using the text in the learning environment to gain directions. The teacher and students would go back and forth as the teacher would redirect the student to read an

3.2 Umbrella Norms

Within this particular sequence, there are a series of tentative umbrella norms related to how the participants were to appropriately learn to find directions and rely on the system. Due to the fact that the participants had not spent much time in Quest Atlantis (1 day) prior to the implementation, the norms they brought with them as to how to work together, get directions, and how to act in a classroom were very evident in the first two periods. As the implementation progressed, some of the norms they brought to the gaming environment about survival and their expectations had to be renegotiate between student and teacher as students learned to rely on the system and were weaned off of the teacher's directions.

Umbrella norms related to this group can be viewed as: 1.) students must do what the teacher says; 2.) completion requires cooperation; 3.) rules of the game must be negotiated with the teacher; 4.) the system has directions; 5.) the system has more information than the teacher does; 6.) work is judged by the teacher exclusively; 7.) success requires that I listen and read; and 8.) success requires that I am self-directed. However, these norms evolved over time.

The meaningful acts within this dyad were generated with the following general group norms in place: 1.) actors should listen to the teacher; 2.) actors should consult one another when they have questions; 3.) actors should act in a manner that shows consideration for the other player/learner; 4.) actors should explore the rules together; 4.) actors should be responsible for their own well-being in the game; 5.) actors should check with the teacher if rules are unclear; 6.) actors should share what they learn with one another through out the game; 7.) actors should show consideration for one another’s concerns regarding game play and the learning environment.

Both the umbrella and other general norms can be found through both the verbal interaction of the learners in the real world and their interactions within the game environment through the agency of their avatars.

The importance of these norms becomes apparent throughout game play as the participants rely on one another more and more as the information they

need to be successful requires them to learn new information as they encounter frustration points. This reliance on one another and the system rather than the teacher for success becomes more evident over time.

3.3 Roles

Within the context of the transcript there are around fifty-five participants, each of whom plays their own, changing roles. As the players interact with one another and move through the game, their roles shift fluidly, without much negotiation for identity. Neither participant had met for longer than a fifteen second introduction in a grocery store, so neither had preexisting notions of the roles the other should or could play.

Student

When students acted out these roles initially, it was clear that the role of the student in both classrooms was to be passive and silent. As they became more self-directed, this role changed to include teacher, coach, friend, and sharer of information through multiple modes of communication.

The Inquiring Student. This was the first of two predominant roles assumed by the players throughout the observation. The position is characterized by observing facts about the game environment or the effects of actions then questioning the other participant or the researcher as they learned the rules of the game and negotiated what would be considered appropriate behavior on the part of the players throughout the game.

In this role, tacit normative claims include:

"A novice gamer/learner should ask questions."
"A novice gamer/learner should learn from their peers."
"A novice gamer/learner should learn from their teacher."

Tacit identity claims relevant to this role are:

"I am a new learner."
"I am able to learn from others."
"I am able to learn from the game."

The Tentative Teacher. This second role was provided by some students as they learned and had information to share with the other player. It was acted out either through spoken directions to the other player or by showing the other player what was to be learned by modeling it on the controller. There was also an element of empathy within this role in which the person in the teacher role empathized with the plight of the player who was struggling. Again, this role shifted fairly seamlessly into that of student throughout the transcript.

In this role, tacit normative claims include:

"A teacher should teach what they can."
"A teacher should take time when explaining."

"A teacher should listen to their students."
"A teacher should have some level of knowledge or expertise greater than that of the student."

Tacit identity claims relevant to this role are:
"I am capable of teaching others.'
"I am both a novice teacher and learner in this context."
"I am not an expert with this material."

3.4 Analysis of Interactive Power

(bid) 44:23 – C.: Have you guys made your maps yet?
Teacher asks if students are following directions and completing task.

(bid rejected) 44:24 – MS6: No.
Student says he has not.

(bid) 44:25 – C.: Have you started them?
Teacher asks if students have initiated task.

(bid rejected) 44:26 – MS6: No.
Student confirms that he has not begun task.

(bid) 44:27 – C.: Okay, go back to your original goal.
Teacher orders students to review task.

(bid) Have you talked to Jim?
Teacher asks if they have done any part of the task.

(bid accepted) 44:31 – MS6: Yeah.
Student confirms completion of one part of the task.

(bid) 44:33 – C.: Start making a map, but you don't have to have it finished today. (bid)
Teacher orders that he begin the next part of the task.

(bid accepted, new bid) 44:38 – MS6: Okay, I thought we could just work on… (bid)
Student questions the order.

(bid clarified) 44:39 – C.: And then on three, it says 'To turn in.' 'The Quester will describe their favorite part of Anytown and your least favorite. Use lots of descriptive words when you do this.' That's your actual Quest that you're going to be writing.
The Teacher continues order, ignores student question.

(bid accepted) 45:50 –MS6: Okay.
Student agrees to order.

Appendix I.
Scoring rubric for proximal writing prompts

Grade 4 Third Prompt Rubric Informational Report Writing a Newspaper Article

4	☒ Fully addresses the prompt. ☒ Is clearly organized in a logical sequence that frames a central question about an issue or situation. ☒ Is appropriate for the intended audience. ☒ Is a multi-paragraph composition with an introduction that establishes a central idea, supporting details that include facts and details for focus, and an effective summary conclusion. ☒ Has a variety of sentence patterns that include compound and complex sentences. ☒ Has effectiveness and variety of word choice. ☒ Has descriptive language that uses well-chosen sensory details. ☒ Has grade-level appropriate spelling, grammar, capitalization, and punctuation; contains few, if any, errors that do not interfere with understanding the writing. ☒ Has fluid, legible handwriting using cursive or joined italic.
3	☒ Responds to the prompt. ☒ Is organized in a logical sequence. ☒ Is appropriate for the intended audience. ☒ Is a multi-paragraph composition with an introduction, some supporting details, and a summary conclusion. ☒ Has more than one sentence pattern that include compound and complex sentences. ☒ Has some variety in word choice. ☒ Has some descriptive language and sensory details. ☒ Has mainly grade-level appropriate spelling, grammar, capitalization, and punctuation; contains some errors that do not interfere with understanding the writing. ☒ Has legible cursive or joined italic handwriting with appropriate spacing and most letters formed correctly.
2	☒ Attempts to respond to the prompt. ☒ May lack organization. ☒ May be inappropriate for the intended audience. ☒ May lack proper paragraphing and/or details that support a central idea. ☒ Contains mainly one sentence pattern; may use some compound sentences. ☒ May have little or no variety in word choice. ☒ May contain little or no descriptive language or sensory details. ☒ Has handwriting that is difficult to read with errors that may interfere with meaning.
1	☒ May not respond to the prompt. (May be off topic.) ☒ Lacks organization; may not support a central idea. ☒ May be inappropriate for the intended audience. ☒ Has mainly incomplete and/or incoherent sentences. ☒ Contains mainly basic sight words with no descriptive language. ☒ May contain frequent and numerous errors in spelling, grammar, capitalization, and punctuation that interfere with the understanding of the writing. ☒ Handwriting may be mostly illegible.

Writing Sample Scoring Rationale Third Prompt, Grade 4 Informational Reports Writing a Newspaper Article

NEW JERSEY REGISTERED HOLISTIC SCORING RUBRIC

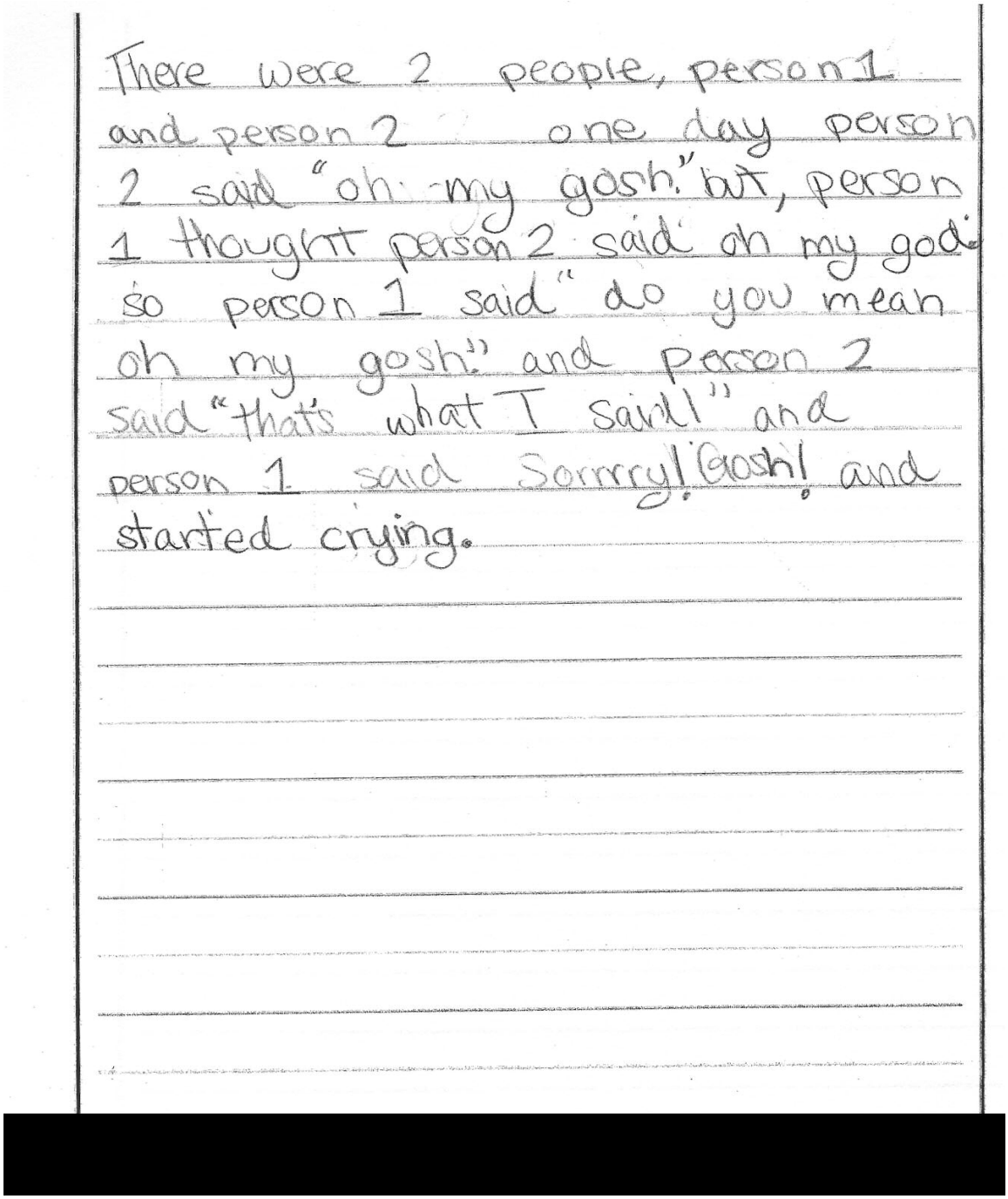
In scoring, consider the grid of written language	Inadequate Command	Limited Command	Partial Command	Adequate Command	Strong Command	Superior Command
Score	1	2	3	4	5	6
Content and Organization	• May lack opening *and/or closing*	• May lack opening *and/or closing*	• May lack opening *and/or closing*	• May lack opening *and/or closing*	• Generally has opening *and closing*	• Has opening and *closing*
	• Minimal response to topic; uncertain focus	• Attempts to focus • May drift or shift focus	• Usually has single focus	• Single focus	• Single focus • Sense of unity and coherence • Key ideas developed	• Single, distinct focus • Unified and coherent • Well-developed
	• No planning evident; disorganized	• Attempts organization • Few, if any, transitions between ideas	• Some lapses or flaws in organization • May lack some transitions between ideas	• Ideas loosely connected • Transitions evident	• Logical progression of ideas • Moderately fluent • Attempts compositional risks	• Logical progression of ideas • Fluent, cohesive • Compositional risks successful
	• Details random, inappropriate, or barely apparent	• Details lack elaboration, i.e., highlight paper	• Repetitious details • Several unelaborated details	• Uneven development of details	• Details appropriate and varied	• Details effective, vivid, explicit, and/or pertinent
Usage	• *No apparent control* • Severe/numerous errors	• *Numerous errors*	• *Errors/patterns of errors* may be evident	• *Some errors that do not* interfere with meaning	• *Few errors*	• Very few, if any, errors
Sentence Construction	• Assortment of incomplete and/or incorrect sentences	• Excessive monotony/same structure • Numerous errors	• Little variety in syntax • Some errors	• Some errors that do not interfere with meaning	• Few errors	• Very few, if any, errors
Mechanics	• Errors so severe they detract from meaning	• Numerous serious errors	• Patterns of errors evident	• No consistent pattern of errors • Some errors that do not interfere with meaning	• Few errors	• Very few, if any, errors

NON-SCORABLE RESPONSES*	**(FR)**	Fragment	Student wrote too little to allow a reliable judgment of his/her writing
	(OT)	Off Topic/ Off Task	Student did not write on the assigned topic/task, or the student attempted to copy the prompt.
	(NE)	Not English	Student wrote in a language other than English.
	(NR)	No Response	Student refused to write on the topic, or the writing task folder was blank.

Content/Organization	Usage	Sentence Construction	Mechanics
• Communicates intended message to intended audience • Relates to topic • Opening and closing • Focused • Logical progression of ideas • Transitions • Appropriate details and information	• Tense formation • Subject-verb agreement • Pronouns usage/agreement • Word choice/meaning • Proper Modifiers	• Variety of formations • Correct construction	• *Skills* intact in: • Spelling • Capitalization • Punctuation

Appendix K.
Examples of student writing at each score point

Score Point 1


There were 2 people, person 1 and person 2 one day person 2 said "oh my gosh." but, person 1 thought person 2 said oh my god so person 1 said "do you mean oh my gosh!" and person 2 said "that's what I said!" and person 1 said Sorrry! Gosh! and started crying.

Score point 2

The Fight

My friends get in fights sometimes and I have witnessed a lot but there was one fight that they had lasted for days. It started when one of my friends was leaving another one of my friends out of a game she was playing. She was playing with a group of people that think they are so cool. They were playing like they were cheerleaders. They let the friend who was feeling left out play, but they didnt let her be on the team she wanted to be on. Then they didnt let her play at all. She ran and told a playground supervisor and they talked to the girls. The girl feeling left out started to cry and they all yelled at each other. They were yelling things like, "Your Mean", "I dont want to be your friend anymore, and "Quit being a baby." Then [redacted] again but some of them apologized and they were friends again.

Score Point 3

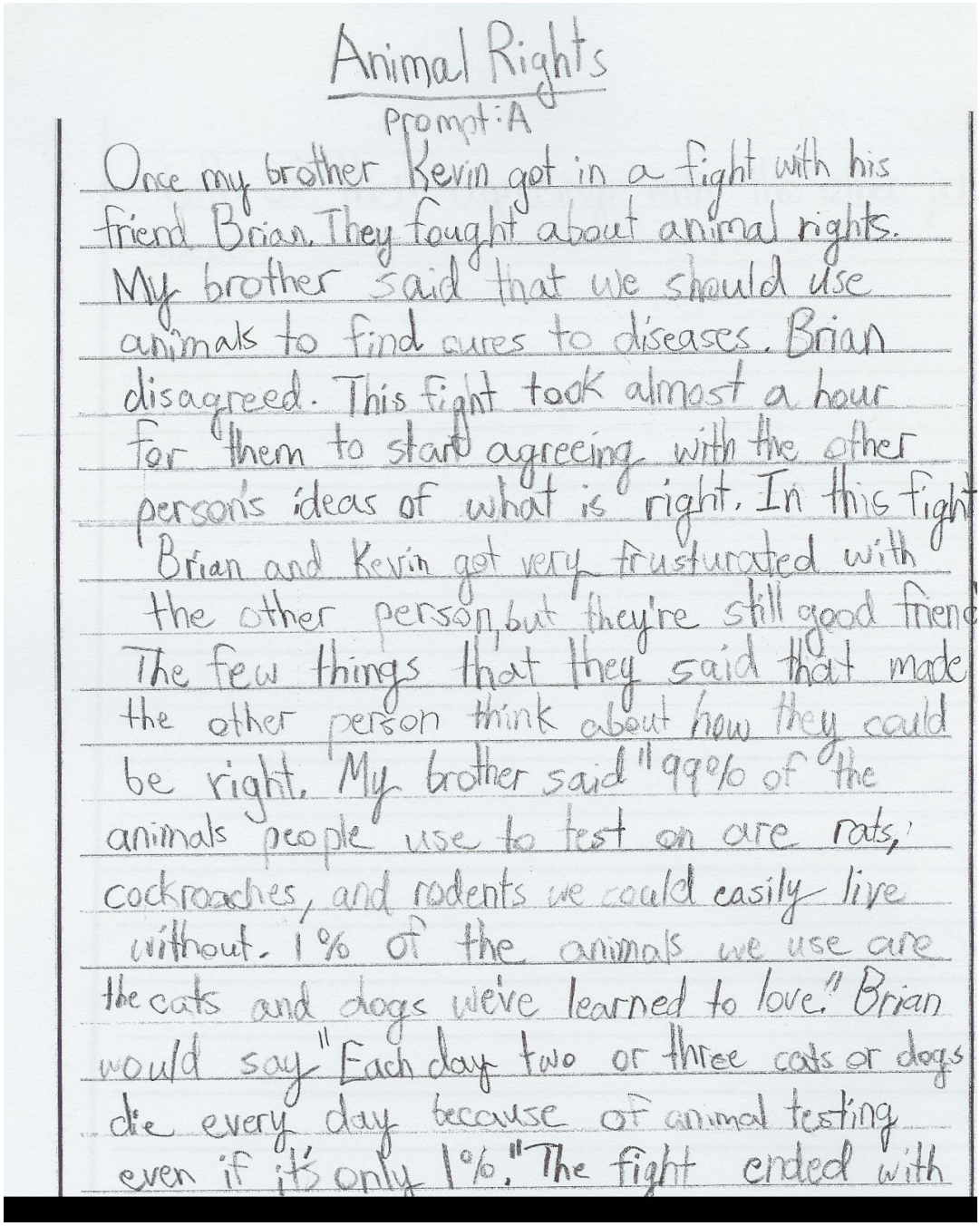
I am going to write about a argument I have witnessed. This particular argument started on my friend Jeremy [redacted] 10th Birthday on November 18 2005 Wich happend to be the day Harry Potter and The Goblet of Fire came out on theaters so first we went to see Harry Potter and the Goblet of Fire and then we would go over to his house have cake and ice cream and bean nachos till round midnight and eather go home or sleep over.

P.S. No one reall slept that night

But when Harry Potter and the Goblet of fire was finised me, Bela [redacted], and my friend Henry [redacted]'s Friend Henry whose last name I can't recall, (I'll just say Henry L. when it's Henry [redacted] and just call the other Henry plain old Henry.) Henry's Brother, Henry L.'s Friend Toby, the annoing and last but not least Toby's big brother Joel, went to Henry L.'s house for cake and ice crean and presants. Dand after we had cake and ice crean and opend presants we started playing a video game calle XXL and Bella [redacted] and Henry L. had a hage

argument about who would face who in the XXL snowboarding tournament so We figured that Bella [redacted] was the best, in 2nd Toby the best, in 3rd Henry (not L.) brother, in 4th Henry L., in 5th Me, in 6th Henry (not L.) so after that imense argumen that we shouldn't all face eachother we disided to mate Bela play everyone, then Toby the abnoctios play everyone but Bella then Henry's (not L's) brother faced everyone except Bella and Toby and so forth untill everyone played the opisite so Henry faced everone, I faced everyone ex Henry, and so on.

Score Point 4



Animal Rights

Prompt: A

Once my brother Kevin got in a fight with his friend Brian. They fought about animal rights. My brother said that we should use animals to find cures to diseases. Brian disagreed. This fight took almost a hour for them to start agreeing with the other person's ideas of what is right. In this fight Brian and Kevin got very frusturated with the other person, but they're still good frien The few things that they said that made the other person think about how they could be right. My brother said "99% of the animals people use to test on are rats, cockroaches, and rodents we could easily live without. 1% of the animals we use are the cats and dogs we've learned to love." Brian would say "Each day two or three cats or dogs die every day because of animal testing even if it's only 1%." The fight ended with both of them agreeing with the other perso ideas.

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Curriculum Vitae

EDUCATION

Indiana University-Bloomington, Bloomington, IN 2003 to 2006
Ph.D. in Education, Instructional Systems Technology

University of Houston, Houston, TX 1998
M.Ed. in Education, Curriculum and Instruction

Western Michigan University, Kalamazoo, MI 1995
B.A. in English and Political Science
Areas of Concentration: Creative Writing, Political science
Minor: Philosophy

TEACHING EXPERIENCE

2005 **Stanford University** Palo Alto, CA

Lecturer, "Simulations and Games for Learning Workshop"
Stanford Center for Innovations in Learning Summer Institute, July 25-29, 2005

- Acted as co-instructor and presenter
- Coordinated student activities for the week
- Presented existing and new theories on the links between games, simulations, and learning
- Guided students in the development of their own game or simulation prototype

2003-2004 **Indiana University** Bloomington, IN

Lecturer, R341 –*Development of multimedia in IST*

i. Responsible for teaching Macromedia Flash, Photoshop, and Dreamweaver

Assistant instructor, R541 – *Instructional Design and Theory*

- Responsible for teaching digital video production using Adobe Premiere, Apple iMovie

2001 - 2003 **Hightower High School**, Ft. Bend ISD Missouri City, TX

Instructional Technology Specialist

- Responsible for teacher and student training on all Microsoft Office products, SASi Xp, Integrade Pro, and instructional hardware such as SmartBoards, laptops, engineering equipment
- Engaged teachers in the integration of technology into all aspects of curriculum
- Conducted weekly seminars and tutorials on technology use and integration
- Trained teachers in the use of Macromedia Flash, Photoshop, and Dreamweaver
- Provided instruction in basic digital video production using Adobe Premiere, Sony Vegas

- 2000 - 2001 **First Colony Middle,** Ft. Bend ISD
  Sugar Land, TX

English Teacher, 8th grade

- Nominated for Teacher of the Year for First Colony Middle School
- Coached boys basketball and girls track

- 1999 - 2000 **Hargrave High School**, Huffman ISD Huffman, TX

English Teacher, 10-11th grades

- Tutored all Texas Assessment of Academic Skills takers prior to test

- 1995 - 1999 **Olle Middle School**, Alief ISD Houston, TX

Social Studies, English Teacher 6-8th grades

- Nominated for Teacher of the Year for Olle Middle School (1996-97)
- Worked with the Annenberg Challenge Grant for Urban School Improvement
- Team leader for team 8B in 1996-97
- Coached boys football and basketball
- Interim chair of the social studies department (1996-97)

RELATED EXPERIENCE

2004 - Present **Indiana University-Bloomington** Bloomington, IN

- Graduate assistant**,** *Quest Atlantis* project (National Science Foundation)
    - Researcher
        - Focused on the impact of narrative structures on student participation in an online learning environment.
            - Researched the impact of a PBL, digital learning environment on student science content knowledge and retention
            - Examined student technology use and identity
            - Examined student the impact of a rich digital learning environment on student writing practices (achievement and voluntary work)
            - Examined the impact of rich digital learning environments on teacher instructional and feedback practices
    - Designer
        - Author of two novels "Archfall" and "Shardflower" in support of the **Quest Atlantis** project
        - Designed and developed the *Anytown* language arts and reading unit for online learning with 4-6th grade students based on Indiana standards
        - Development of underlying **Quest Atlantis** narrative structures for web logs, pre- and in-service teacher participation, and all other story-based work
        - Extensive use of Photoshop and Bryce modeling software for rendering objects for the 3-D space

2003 - 2004 **Indiana University-Bloomington** Bloomington, IN

- *Instructional Systems Technology Laboratory Manager*
    - Responsible for maintenance of computer laboratory hardware and installation of all department software
    - Provided instruction regarding the use of both hardware and software in the department

CONFERENCE AND SEMINAR PRESENTATIONS

- "Using a Digital Learning Environment Scaffolds to Improve Student Writing in a PBL-style Instructional Space"
  American Educational Research Association Annual Meeting,
  San Francisco, CA April 7-11, 2006

- "Transfer of Learning in Complex Learning Environments"
  American Educational Research Association Annual Meeting,
  San Francisco, CA April 7-11, 2006

- "Researching a MUVE for teaching writing: The Anytown Experience"
  Society for Information Technology and Teacher Education International Conference, Orlando March 20-24, 2006

- "A pre-service teacher experience: The Council Actors"
  Society for Information Technology and Teacher Education International Conference, Orlando, FL March 20-24, 2006

- "The Effectiveness of Narrative: Research on Curricular Materials for a Digital Learning Environment"
  Society for Information Technology and Teacher Education International Conference, Orlando, FL March 20-24, 2006

- "Simulations and Games for Learning Workshop"
  Stanford Center for Innovations in Learning Summer Institute
  July 25-29, 2005

- "Coming to Terms with Communities of Practice: A Definition and Operational Criteria."
  American Education Research Association Conference, Montreal, Quebec 2005

- "What are we talking about? A common vocabulary for discussing games and simulations in the context of instruction and training."
  Association for Educational Communications and Technology Conference, Chicago, IL 2004

- "Technology Grants and Rural Schools: The Power to Transform."
  Association for Educational Communications and Technology Conference, Chicago, IL 2004

- "Definitional issues in games and simulations for education."
  Instructional Systems Technology Conference, Bloomington, IN 2004

PUBLICATIONS AND PAPERS

- Barab, S. A., Warren, S., Del Valle, R., & Fang, F. (2006). Coming to terms with communities of practice: A definition and operational criteria. In J. A. Pershing (Ed.), *The handbook of human performance technology: Principles, practices, and potential* (3rd ed.). San Francisco, CA: Pfeiffer.

- Barab, S. A., Warren, S., & Ingram-Goble, A. (2006). Academic play spaces. *American Educational Research Association Annual Meeting. San Francisco*.

- Barab, S. A., Zuiker, S., Warren, S., Hickey, D., Arici, A., Ingram-Goble, A., et al. (In preparation). Developing a theory of formalisms: Situating socio-scientific inquiry for schools. *Educational Psychologist*.

- Pershing, J. A., Warren, S. J., & Rowe, D. T. (2006). Observation methods for HPT. In J. A. Pershing (Ed.), *The handbook of human performance technology: Principles, practices, and potential* (3rd ed.). San Francisco, CA: Pfeiffer.

RELATED CURRICULUAR PUBLICATIONS

- Warren, S. (2005). *Archfall* (1 ed. Vol. 1). Bloomington, Indiana: Quest Atlantis Publishing.

- Warren, S. (in press). *Shardflower* (1 ed. Vol. 2). Bloomington, IN: Quest Atlantis Publishing.

SERVICE

- Graduates in Instructional Systems Technology (GIST),
  Indiana University Bloomington, IN 2004 Vice-president for Information Technology

- American Educational Research Association Annual Meeting □ *San Francisco, CA* □ *2006 Proposal Reviewer*

- Society for Information Technology and Teacher Education International Conference □ *Orlando, FL* □ *2006* □ *Proposal Reviewer*

- International Conference of the Learning Sciences □ *Bloomington, IN* □ *2006* □ *Proposal Reviewer*

- Instructional Systems Technology Conference □ *Bloomington, IN* □ *2005* □ *Proposal Reviewer*

- The handbook of human performance technology: Principles, practices, and potential □ *Bloomington, IN* □ *2005* □ *Chapter Reviewer*

- Instructional Systems Technology Conference □ *2004 Proposal Reviewer*

- SWAT Team
  Texas Computer Educator Association Conference □ *Austin, TX* □ 2002 □ *Technology support and implementation staff*

MEMBERSHIPS

- American Educational Research Association (AERA)

- Association for Educational Communications and Technology (AECT)

- Association for the Advancement of Computing in Education

- Graduates in Instructional Systems Technology (GIST)

CERTIFICATION

- Texas teaching certificate (Life)
    - English/Language arts and reading
    - Social studies

TECHNOLOGY TOOLS

- Expertise in Adobe Photoshop, Image Ready, and Premiere
- Expertise in scripting with html, PHP
- Instructor of Macromedia Suite – Flash, Authorware, Dreamweaver, Director
- onCourse curriculum development
- Instructor for digital still and film production
- Instructor of Microsoft Office

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