DESIGN VARIABLES OF ATTRACTION IN QUEST-BASED LEARNING

by

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DEDICATION

To Ali, the best friend and love anyone could have. To Kim, Kennedy, Keaton, and Kelly for their eternal patience and long-suffering during 6 months without their father.

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ABSTRACT

Critics of the American education system point to student boredom, lack of personalized and relevant instruction, and a deficit of 21st century skills as challenges to producing productive citizens of a modern, digital society (Barab et al., 2009; Eccles & Wingfield, 2002; Ketelhut, 2007; U.S. Department of Education Office of Educational Technology, 2010). Digital learning, including game-based approaches, offers opportunities to bring about meaningful, engaging, individualized learning (Barab & Dede, 2007; Gee, 2005; Squire, 2003). Quest-based learning is an instructional design theory of game-based learning that focuses on student activity choice within the curriculum, which offers promising pedagogical possibilities in the area. This study expands upon current research of video game characteristics and variables of attractiveness in learner choice. Identifying these attractive characteristics in game-based educational design can increase engagement (Barab et al., 2009), educational effectiveness (Sullivan & Mateas, 2009), and impact instructional design decisions.

Quests were coded and tagged to identify features and attributes. An educational quest taxonomy was developed building on Merrill's Knowledge Object (Redeker, 2003; Wiley, 2000) classification and expanded to include current digital tools and thinking. Electronically collected decision data from a quest-based learning management system was analyzed using descriptive statistical analysis and data mining techniques. Educational quests were differentiated by a number of data points and identified as more or less attractive using an initial interest score and a completion score. User rating was also considered for descriptive purposes. Data mining and text mining highlighted the specific characteristics of attractive quests including clusters of characteristics identified as most attractive as well as their significance. Suggestions for future attractive quest-based learning design are suggested. (Keywords: Quests, quest-based learning, game-based learning, 3D GameLab, play styles, learner preferences, rewards, badges, gamification, MMORPGs, virtual environments, informal learning.)

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CHAPTER 1

INTRODUCTION

Purpose Statement

Students learn and achieve more academically when motivated and engaged (Ames, 1992; Boekaerts, 1997; Bronack, Riedl, & Tashner, 2006; Dede, 2009; Eccles & Wingfield, 2002; Papert, 1998; Vaughn & Horner, 1997). Absence of motivation in school is attributed to irrelevant or uninteresting coursework, lack of meaningful feedback or encouragement, and boredom (Barab et al., 2009; Dweck, 1986; Eccles & Wingfield, 2002; Ketelhut, 2007; U.S. Department of Education Office of Educational Technology, 2010; Wentzel, 1997). These factors are recognized as one of the leading contributors to poor performance, reduced attendance, and student dropout (Dweck, 1986; Eccles & Wingfield, 2002; U.S. Department of Education Office of Educational Technology, 2010; Vallerand, Fortier, & Guay, 1997). Consideration of motivational technology-enhanced methods to engage students in curriculum (which this study is defining as a key aspect of "attractiveness") has been identified as a critical component of 21st-century schools (Chatfield, 2010; Squire, 2003).

Video games used in an educational environment are found to be motivating to students (Hoffman & Nadelson, 2009) and can improve academic performance (Barab & Dede, 2007; Gee, 2005; Squire, 2003). They can provide a series of interesting choices (Squire, 2003), opportunity for inquiry, investigation, or exploration. Video games reward users in multiple ways (Anderson, 2003; Barab et al., 2008; Koepp et al., 1998; Jegers, 2007), offer an opportunity to learn from failure without long-term penalty (Barab et al., 2009; Gibson et al., 2003), and can serve as a social space for collaboration with multiple users (Gee, 2005). Rich game narratives can also provide a context for specific subject matter (Gee, 2005; Hirumi & Stapleton, 2009; Lazzaro, 2005). Many games separate multiple long-term objectives into short-term goals, tasks, and quests (Chatfield, 2010; Squire, 2003; Zagal, Fernandez-Vara, & Mateas, 2008). These characteristics are motivating to students (Chatfield, 2010).

Game-based and quest-based learning and their unique pedagogies imply a practice somewhere between the serious work of education and the playful exploits of gaming. Quest-based learning draws its roots from video game architectures. The quest-based approach can be organized around learner choice where participants choose from pools of individual quests (interactions, activities, missions, etc.) that accumulate experience points to satisfy the needs of the standards and curriculum. This highly personalized and tailored approach to instructional delivery, when combined with other game-based curricular approaches, shows promise as a compelling and powerful tool for learning and engagement (Barab, Scott, Siyahhan, Goldstone, Ingram-Goble, Zuiker, C., & Warren, 2009).

Problem Statement

Unfortunately, little research has been done in quest-based education to determine the attractive or compelling characteristics of quest-based learning activities. As quest-based learning activities involve student choice, the attractiveness of, and interest in, these self-selected learning activities plays a role in the student's willingness to attend to them (Baek, Klinger, Johnston, & Snavely, n.d.; Bellotti, Berta, Gloria, & Primavera, 2009; Wentzel, 1997). Engagement in, and selection of, learning activities is important in successful student outcomes. Failure to motivate or engage students through effective learning design leads to disinterest, boredom, and can eventually lead to dropout (Vallerand, Fortier, & Guay, 1997).

This type of research needs to be conducted because attractive or compelling characteristics can be designed as part of quests (Charsky, 2010). Like all learning activities, quests can be designed to utilize media, methods, and design that can motivate or demotivate students. Popularity and success rate data in quest-based learning systems can inform teachers and instructional designers (Barab et al., 2009). This data can support or reject notions of attractiveness within these student populations. More effective learning design can be the product of a thoughtful and detailed study of such characteristics (Papastergiou, 2008). Since quest-based learning is supported by learner choice through choosing such activities, lack of interesting activities reduces intrinsic motivation. The result of not determining these characteristics could be quest-based learning design that fails to compel or engage its users to select it.

Teachers and designers of digital learning experiences without this knowledge could create learning quests using less effective design considerations. For example, a quest designed for a student to read a chapter and answer the chapter questions might fail to captivate or interest a student (Boekaerts, 1997; Lindtner & Dourish, 2011). This simple read and respond scenario could ultimately disengage a student. Simply overlaying a game process may not be significantly motivating without other aspects of attractive or compelling quest design. However, teachers or instructional designers who are aware of potentially attractive or compelling quest-design characteristics could create quests that were more likely to be selected by students and thus lead to more successful student outcomes.

Research Questions

The overarching research aimed to identify the design variables that contribute to the attractiveness of a quest evidenced by user selection, completion, and rating. This can be evidenced by the motivation of students to select and complete them. Therefore, the research questions guiding this study included: 1) What characteristics are common in those quests most selected by students in a quest-based learning environment? 2) What characteristics are present in those quests that are completed? 3) What characteristics exist in quests more highly rated by students?

These questions were investigated by looking at quests designed in the 3-D GameLab quest-based learning platform and were restricted to those characteristics that can be controlled (e.g., embedded video, images, step-by-step procedures, etc.). Additionally, primary guiding questions related to the overarching research question are important to support and frame it. These are listed below.

1. What were the characteristics of educational quests as they currently exist in the 3D GameLab?

2. What was the taxonomy of quest characteristics (including combinations) currently used in the test group?

3. What different types of quest construction (goals, activities, tools, deliverable, organization) existed?

4. What combinations of variables produce more attractive quests visible through learner selection, completion, and rating?

5. Based on qualitative and quantitative measures, which design variables were most likely to contribute to the attractiveness of a quest, and thus, learner selection, completion, and rating?

Quests are a combination of multiple variables, some visible before selection, and others after. These externally and internally visible characteristics may influence attractiveness. Determining and identifying the current characteristics of quests could be supported by investigating the following areas. Further characteristics may be gleaned by investigating **Error! Reference source not found.** below.

Table 1-1. Quest characteristics

Externally Visible Characteristics	Internally Visible Characteristic
Quest-icons	Images
Short-descriptions	Embedded video
Tagging	Embedded objects
Completion time	Links to materials or tools outside the quest
User ratings	Interaction with non-digital tools or activities
Category	Quest task-oriented, goal-oriented, or oriented in some other way
Standards	Standards
Internally Visible Characteristics	
	Images
	Embedded video
	Embedded Objects
	Links to materials or tools outside the quest
	Interaction with non-digital tools or activities
	Quest task-oriented, goal-oriented, or oriented in some other way
	Socialization or Collaboration
	Free/open exploration vs. restricted
	Walk-through or detailed instructions
Additional Considerations	
	Do the characteristics of attractive learning quests reflect those of attractive game quests?
	Does the potential for related quest rewards, badges, or achievements influence the attractiveness of a quest?
	Do combinations of characteristics add to the attractiveness of an activity over

	another? Do combinations exist that make quests less attractive?

Assumptions and Limitations

The following assumptions are relevant to the study:

1. Students select many activities independently based on interest or desire and are not influenced by an imposed or implied order. All required quests were be identified as such.

2. Characteristics emerge showing a difference between quests, showing them to be attractive.

The following limitations are relevant to the study:

1. The level of attraction of the individual to a quest characteristic is not something that was addressed in this study. To date, no sufficient instrument to measure levels of attractiveness of educational content was discovered. Neither was the data collection through the quest-based learning management system able to support the differentiation of individual characteristics. This may be a valuable element to consider moving forward.

2. The characteristics of attractive quest-based learning design are limited to a singular course and population. All of the participants are preservice teachers and may be conditioned to look at educational material through a specific lens. Despite other demographic differences, this population may be different than students in other disciplines.

3. The 3D GameLab LMS data collection was limited to the basic behaviors related to quest viewing, selection, and completion. As such, it was not possible to track individual learner' actual behaviors within the quests. The data collected allows

for analysis of quests based on all users' collective behaviors related to viewing, selection, and completion leveraged against other characteristics including user rating, completion time, etc.

Significance

Game-based environments for learning represent a growing trend in academic research with major government, private, and institutional support. Many suggest that games and game-based architectures offer a compelling entrée into learner motivation that can be tied to their neurobiological underpinnings (Bateman & Nacke, 2010; Nacke et al., 2011). Gaming environments, while ubiquitous (Lenhart, Jones, Macgill (2008), have not seen widespread implementation (Squire, 2003). Empirical studies are beginning to be conducted with more frequency (Squire, 2003) but have not produced frameworks that are widely accepted. Educational gaming using consoles including Wii, XBOX, and Playstation, as well as off-the-shelf games with commercial titles like Civilization, Age of Empires, The Sims, and Spore have been used and reported in small studies. More educational research has been done in virtual environments like Second Life, Quest Atlantis, ActiveWorlds and others where the game construct was created by the teachers or designers (Antonacci & Modaress, 2008; Barab et al., 2008; Ketelhut, 2007; Ketelhut, Nelson, Clarke, & Dede 2010; Wagner & Ip, 2009; Waters, 2009). While these have been helpful in framing the use of game-based and quest-based approaches, little research has been conducted demonstrating a broad curriculum with a game overlay.

Developing and understanding what attracts and sustains learner interest represents a significant area of potential research. Game-based and quest-based approaches represent a significant potential for delivering meaningful learning by employing alternative forms of access, interaction, and feedback. Game-based feedback (GBF) has been shown to successfully motivate student engagement and enhance the experience (Amory, 2007; Barab & Dede, 2007; Charles, Charles, McNeill, Bustard, & Black, 2011). Unfortunately, while GBF has been shown to enhance educational feedback and student engagement, instructional practices supported by GBF lack supporting research beyond a handful of case studies (Charles et al., 2011).

Therefore, a study of the characteristics of attractive or compelling quests and their effect on student selection and success within a course of study could inform teachers, instructional designers, and curriculum workers. This research reveals a detailed list of current characteristics, patterns in characteristics, taxonomies of characteristic combinations, quest orientations, quest organizational structures, reward conditions, and other characteristics related to quest-based learning. It is also reveals characteristics that could be placed in a rank order by likelihood of attractive or compelling characteristics. Suggestions are also be made about characteristics that might impede the likelihood of quest selection or completion.

A study of characteristics of attractive quest-based learning serves future work in both research and pedagogical development across disciplines. The relationship of quest characteristics to attractiveness and quest success is outlined, thus further research can be planned and implemented. Findings in this area also suggests pedagogy for game-based and quest-based approaches.

Individual commercial, off-the-shelf, or serious games are motivating to students and have been successfully implemented into existing curricula (Becker, 2007; Gee, 2005; Hinske, Lampe, Magerkurth, & Rocker, 2007; Kafai, 2006). Technologies that allow traditional instruction to be delivered in a game-based format are rare and still emerging, and little research has been conducted to support pedagogy for the design of motivating instruction of this kind (Charsky, 2010; Przybylski, Rigby, & Ryan, 2010). Characteristics that attract or captivate a learner's attention and trigger the desire to attempt a learning activity (quest) in a game-based educational environment represent a gap in our knowledge.

Further understanding of the characteristics associated with attractive educational quest design helps teachers and instructional designers develop learning activities more likely to attract, compel, and engage learners in this form of game-based learning. As a result of this gap in knowledge, it is important to investigate the characteristics of attractive and compelling quest-based learning activities as evidenced by learner quest selection. The purpose of this study was to investigate this gap.

Definition of Terms

This study identifies the characteristics of attractive and successful quest-based learning design. The following are definitions of terminology used in this study.

Attractiveness

The "attractiveness" of a quest references the characteristics that draw in, entice, cause fascination, or otherwise attract a player/learner to choose an activity based on a relative personal preference. This attraction is based on the individual's prior experience, likes and dislikes, and decision frame or conceptions of the acts, outcomes, and contingencies of the decision itself. The attractiveness differentiates high preference from low preference tasks (Papastergiou, 2008; Tversky & Kahneman, 1981; Vaughn & Horner, 1997).

For the purposes of this study, overall quest "attractiveness" is defined as the operational relationship of three components: capturing one's interest, sustaining one's effort, and resulting in a meaningful, personally relevant (highly rated) learning experience. By this definition, it is possible to quantitatively characterize the student experience through the use of recordable variables. Interest can be quantified by students viewing and choosing quests. Sustaining one's efforts can be quantified by quest completion. User rating can serve to quantify meaningful and personally relevant learning experiences.

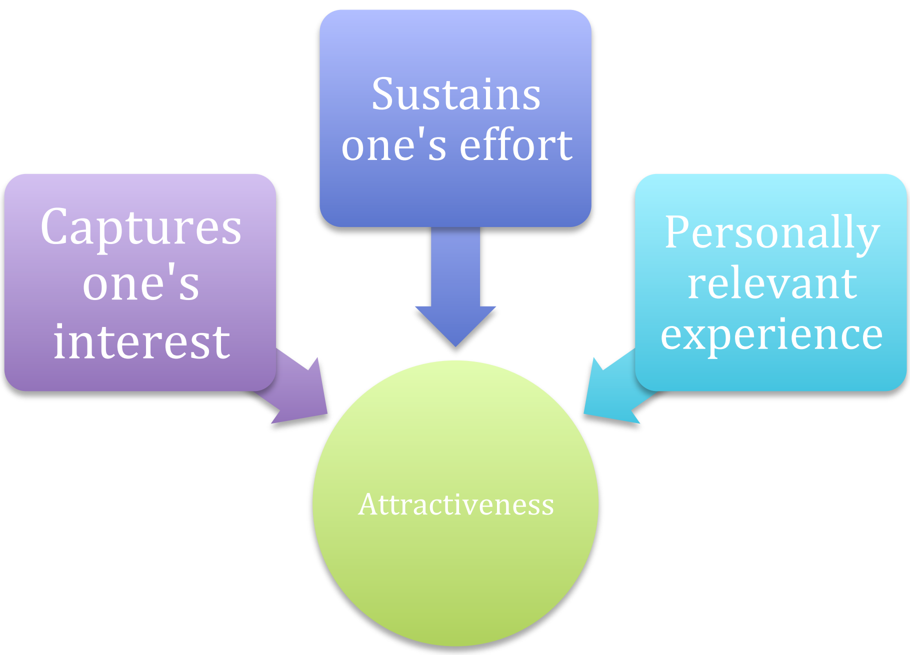

Figure 1-2. Elements of Attractiveness

Although a personally relevant learning experience was maintained as part of the overall definition of attractiveness, issues utilizing user rating made it difficult to apply to the analysis with the same degree of confidence as the other factors. These details are highlighted in Chapter 4.

Game-Based Learning

Game-based learning (GBL) deals with applications and games that have defined learning outcomes. They typically balance the subject matter and game play with the ability to apply what is learned to the real world. GBL includes games off-the-shelf, commercial titles, and those designed to meet learning objectives (a.k.a. educational games) (Van Eck, 2006).

Quests

In both video game and quest-based learning architectures, quests are goal-oriented (or task-oriented) searches for something of value that regulate or guide a player/learner through the narrative of the game/course (Charsky, 2010; Howard, 2008; Sullivan, Mateas, & Wardrip-Fruin, 2009). "Quests involve a series of trials, puzzles, and tasks (such as locating secret chambers and obtaining hidden information) that the participant must conquer for their character to advance to the next game level" (Lange, 2010, p. 27). Little research has been done on the difference between game-based quests in serious games and those designed for learning.

Conclusion

This chapter introduced the primary research question, "What are the design variables of attractive quest-based learning?" It also provided detailed guiding questions to support and focused the study. It outlined the need and significance of this research by highlighting gaps in our collective knowledge, offering benefits, and suggesting a potential impact to this emerging field of study.

Moving forward, the study of play, games, gaming environments, and neurobiology has been highly instructive in educational research. A detailed review of literature supporting this research was conducted to supply a framework of understanding, common language, and theoretical underpinnings, which sustain the results of this research. Chapter 2 introduces this literature and its implications for answering the research questions.

CHAPTER 2

REVIEW OF LITERATURE

Introduction

In response to falling graduation rates, low student engagement, and demand for higher standards and accountability, the educational community is exploring alternative learning approaches and systems, engaging and empowering practices, including game-based methodologies (U.S. Department of Education, 2010). This literature review establishes a framework to answer the research question, “What are the design variables of attractive quest-based learning?”

This literature review investigates how studies of game-based and quest-based approaches have determined variables of effectiveness and in what contexts. It also explores how instructional approaches can be designed effectively for multiple learning, play, and personality styles by answering the following questions:

- In what ways do gaming constructs resonate enough with youths and adults to serve as frameworks in education?
- What research exists that identifies design variables that are most likely to contribute to the attractiveness of a quest, and thus, learner selection, completion, and user rating?
- Research that explores how combinations of variables produce more attractive quests as evidenced by learner selection and completion.

As quest-based learning draws its roots from video game architectures, understanding the importance and relevance of those architectures in this emerging educational methodology is critical. What are the specific characteristics of quest-based experiences in video games that are attractive to a variety of learners, and can be addressed as part of quest-based learning design?

In this chapter, four areas of research are addressed: 1) games and play, 2) the ubiquity of video games, 3) learner motivation through play, and 4) game-based learning.

Games and Play

Caillois (1961) suggests that living is a juxtaposition of work and play. It is important to consider games and play as a quintessential component of culture and, by reflection, schooling (Chatfield, 2010). Understanding the role of play and games is critical to the study, development, and application of learning methodologies (Gee, 2006; Squire, 2003). The literature reviewed in this section clarifies conceptions and definitions of games and play in the context of society, both ancient and modern. This is done to establish its relevance in the educational frame.

Play is Ever-Present

While the definition and derivation of play is broad and diverse, *it* is elemental. Play exists in every culture and corner of the globe with humanity engaged in regular, organized play and games (Caillois, 1961; Juul, 2003). Even foundational civilizations like the Inca, Romans, and Egyptians also had deep-rooted traditions of games and play that have been preserved through their artifacts and art (Bell, 1979). Play is ubiquitous and central to every civilization and, as such, represents a shared understanding (Malaby, 2009; Bell, 1979).

Play is simultaneously specific and ambiguous: Play is free, voluntary, uncertain, and unproductive, yet regulated (Caillois, 1961; Juul, 2003; Papert, 1998).

These definitions suggest fun, pleasurable, or carefree activities that denote a positive experience. Philosophically, playful experience is an attitude, a representation, and a readiness to improvise (Malaby, 2009). Play is not work (Malaby, 2009), which is defined as providing for one's basic needs or supporting well-being (Caillois, 1961). This understanding of play is, by its very nature, attractive as an educational tool.

States of Play

Play is a state of mind that individuals enter into (Bateman & Nacke, 2010). In other words, play is an additional behavior attached to an activity. As such, a state of mind (or play) reflected in the behavior. The singular act of bouncing a tennis ball is not play. It's physics. What individuals do with this physical event transforms it into play. We test its tolerances, interactions, tendencies, and try to predict the behavior of the tennis ball through play. As described by Van Eck (2007), play is perhaps the most effective learning technique. He asserts that the first two years of life are spent in unguided, unbridled play.

From Play to Game

There is, however, a difference between play and games. Salen and Zimmerman (2003) offer a salient definition of a game asserting, "A game is a system in which players engage in an artificial conflict, defined by rules, that results in a quantifiable outcome" (p. 80). By this definition, play and games are closely associated, but still quite different. Games are socially contrived practices that allow participants to enter into a state of play (Bateman & Nacke, 2010).

Connections can now be drawn between work or activity, play, and games. Walking down the sidewalk is simply work, an activity used to get from one place to another. By arbitrarily deciding to avoid stepping on cracks or seams in the sidewalk, it becomes play. A simple rule is added which changes the intent and the state of play is entered. When a consequence is added, by this description the artificial conflict of, "Step on a crack, break your mother's back" (Cole, Calmenson, Tiegreen, 1990, N.P.) it becomes a *game* (Salen & Zimmerman, 2003).

As more than just a way to differentiate work from play or games, (Salen & Zimmerman, 2003) they identify a path by which we can transform education work into education games. This can be done by 1) identifying or implying rules, 2) associating or developing artificial conflict, and establishing 3) quantifiable outcomes (Salen & Zimmerman, 2003). In education and learning design, layering games and play over work and can serve as a powerful and compelling motivational tool and is a valuable entrée into this arena. Also, understanding that play and games, including in an educational environment, are fundamentally motivating supports this research to identify the characteristics of attractive quest-based learning.

Video Games Are Ubiquitous

The literature in this section examines the pervasive and ubiquitous character of video games in American society across age, gender, and cultural boundaries. As quest-based learning and quest design capitalizes on tenets of the gaming paradigm such as experience points, rewards, long and short-term aims, and choice, the ubiquity of gaming principles is important because they don't need to be taught and because the principles of their design are embedded in our society and digital world. Many are learned by actually engaging directly with the game. The literature addresses the type and content of commonly played games, supporting a positive view of video game use and play as a tool appropriate for education.

The Ubiquity of Games

Video games are one of the most popular and pervasive pastimes among American teens and adults (Lenhart, Jones, Macgill, 2008; Lenhart, Kahne, Middaugh, Macgill, 2008). Digital games exist ubiquitously in pockets of culture and society in myriad forms. Games are embedded in devices like iPods, media players, cameras, and even calculators. They saturate social networks, support television and movie titles, and accompany commercial products (Gee, 2010; McGonigal, 2010). Commercial hand-held, computer, and console games constitute more than $10.5 billion in annual sales (Siwek, 2010) and occupy nearly half of American homes (Zickuhr, 2011). Smart phones and mobile devices allow various forms of digital play practically anywhere. Forty-six percent of teens play games on their mobile phone (Lenhart, Ling, Campbell, & Purcell, 2010). Chatfield (2010) posits that in our modern digital culture, we can access video games in virtually any part of our world. Games are ubiquitous.

Age and Gender in Game Play

Digital gameplay crosses generational and gender boundaries. Among teenagers, the vast majority, 99% of boys and 94% of girls, reported playing a variety of computer-based, web-based, mobile, portable, or console games (Lenhart et al., 2008; Siwek, 2010). Within the teen population, play is a social endeavor with 76% of young people (ages 13-17) reporting gaming with others whether in the room or online. Teens report interest in a variety of different game types. The majority of players frequent multiple gaming genres (racing, puzzle, sports, action, adventure, rhythm, strategy, simulation, fighting, etc.) with more than 80% playing more than five different types. Teens understand and use games.

Gameplay is not just a characteristic activity of young people. Video games are also prevalent with more than half (53%) of American adults and highly common

(81%) in adults under the age of 30, especially in student populations (Lenhart, Jones, & Macgill, 2008). Like their youthful counterparts, adults engaged in digital gameplay cross gender divides with about half of all men (55%) and women (50%) reporting regular play. Computer gaming, as opposed to console, handheld, or mobile gaming, is more prevalent in adult players. Adults are also avid gamers.

Variety in Gameplay

For many, the moniker of *gamer* inspires imagery of violent play, sexual content, and social isolation (Anderson, 2003; Gee, 2010; Zaphiris & Wilson, 2007). Weber, Ritterfiled, & Mathiak (2006) attribute these assumptions to the prevalent negative attitudes toward gaming. Zaphiris & Wilson (2007) posits the notoriety and uproar of games series like *Grand Theft Auto*™, among others, contributes to public prejudice toward gaming activities, especially in youth. In the first nationally representative study of both teens and adults relative to their video gaming habits, Lenhart, Jones, & Macgill (2008) dispels those myths by showing gameplay distributions by genre (see Table 2-1).

Table 2-1. Gameplay Distributions by Genre

Genre "examples"	% teens who play this genre
Racing (NASCAR, Mario Cho, Burnout)	74%
Puzzle (Bejeweled, Tetris, Solitaire)	72
Sports (Madden, FIFA, Tony Hawk)	68
Action (GTA, Devil May Cry, Ratchet and Clank)	67
Adventure (Legend of Zelda, Tomb Raider)	66
Rhythm (Guitar Hero, Dance Dance Revolution)	61
Strategy (Civilization IV, StarCraft, C&C)	59
Simulation (The Sims, Roller Coaster Tycoon, Ace Combat)	49
Fighting (Tekken, Super Smash Bros., Moral Kombat)	49
First-Person Shooters (Halo, Counter-Strike, Half-Life)	47
Role-Play (Final Fantasy, Blue Dragon)	36
Survival Horror (Resident Evil, Silent Hill, Condemned)	32
MMOG's (World of Warcraft)	21
Virtual Worlds (Second Life, Gaia, Habbo Hotel)	10

Adapted from Lenhart, A., Kahne, J., Middaugh, E., Macgill, A. (2008). Teens, video games, and civics. Retrieved from Pew Internet & American Life Project website: http://www.pewinternet.org/PPF/r/263/report_display.asp

As reported in the above Table 2-1, the top three genres of gameplay include racing, puzzles, and sports. Approximately half (49%) of teens report playing fighting games, and 47% playing first-person shooter games. Even though half of respondents reported playing games that include some form of violence, research has demonstrated a non-significant effect on transference of violence from gameplay to real life (Bartholow, Sestir, & Davis, 2005).

In summary, gaming constructs do resonate enough with youth and adults to serve as frameworks in education. Play is ever-present, video games are ubiquitous, teens and adults understand and use games in myriad ways and settings, and violent and sexual content represent only a minority share of the game genres played without evidence of a transference effect (Poole, 2000). The literature puts forward the notion that gaming is natural, engaging, and ubiquitous.

Play Styles

People play games for different reasons based on the types of experiences they enjoy or prefer (Lenhart, Jones, & Macgill, 2008). Educators, psychologists, and video game developers recognize the diversity in both player and play style. The exploration of player style and player preference in video games is similar to unique student characteristics (Joyce, Weil, & Calhoun, 2004) and serves to inform support of differentiated instruction (Grotzer, Dede, Metcalfe, & Clarke, 2009; Jensen, 2008). Understanding student characteristics, and its relationship to play style, how the learner prefers to move through the environment, allows for a thoughtful design of experiences that meet the needs of individuals. Many educational games and commercial games used in education, while en vogue, do not universally meet the needs of all students (Dede, 2005; Hoffman & Nadelson, 2009). Focusing on the research and thinking applied to player preferences and player styles in game design serves to better inform design considerations in education.

Diversity of Play

Not all play is created equal. Caillois (1961) put forward the organization of four classifications of games: *alea* (chance), *mimicry* (simulation), *agon* (competition), and *ilinx* (vertigo or confusion) based on the types of play found in both the ancient and modern world. Caillois described not only the types of play as they existed alone, but in the ways that they were paired. Bell (1979) proposed unique variations of historical game type including race, war, positional, mancala (pebble moving), dice, and domino games. These early categories denote the variety of games in interest and purpose. As such, they are valuable from an anthropological perspective and demonstrate that diversity in gameplay is not exclusively a condition of the modern paradigm.

Bartle (1996) described different types of play in a single video game genre, multi-user dungeons (MUDs). As a text-based multiplayer computer game, MUDs are a form of interactive fiction that use computer, leader, or player role-play interactions as part of gameplay (Achterbosch, Pierce, & Simmons, 2007; Bartle, 1996; Cox & Campbell, 1994). His examination suggested that individual players view the same game differently from one another based on characteristics that identify the source of a player's interest or *play style*. He organized these play styles into *killers, achievers, socializers*, and *explorers* relative to their interactions in the game environment. Their location on Bartle's *interest graph* (Figure 1) was related to the way that they acted or interacted with the players or the virtual world (Achterbosch et al., 2007).

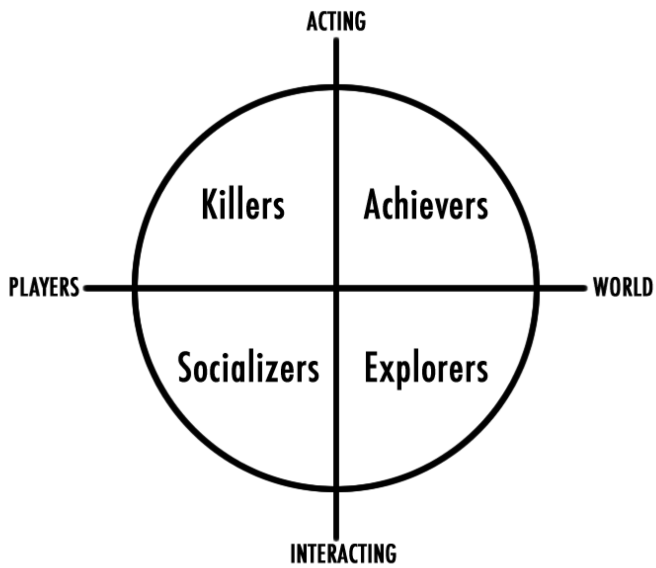

Figure 2-1. Bartle's Interest Graph (1986). This figure shows the differentiation between four play types observed in MUDs. Numbers represent the dimensions in centimeters. Adapted from Bartle, R. (1996) Hearts, clubs, diamonds, spades: Players who suit MUD's. *Journal of MUD Research* 1, 1.

Killers act on other players while achievers act on elements of the virtual world. *Socializers* interact with other players while explorers focus on interactions with the virtual world. Though in the same game-space, players engaged in different ways with different outcomes. Bartle also observed that s player's preferred play style can switch depending on the game, environment, as well as the influence of other players (Achterbosch et al., 2007; Bartle, 1996).

It is important to point out that Bartle's typology was constructed ad hoc and generated through informal observations of players exclusively engaged in MUDs. Bateman and Nacke (2010), however, suggest that his observations maintain an anthropological validity.

BrainHex, DGD1, and Player Satisfaction

Building off the initial work of Bartle, researchers within the video game industry focus on patterns of play and player personality styles to inform understanding and development of new games. BrainHex, a player satisfaction model, is an analytical tool designed to identify game characteristics and activities that are the most satisfying to the player (Bateman & Nacke, 2010). Bateman (2004) posit that player-personality types exist, similar to those identified by the Myers-Briggs (1962) Typology Index (MBTI) developed as a research instrument used to measure broad personality types (Bateman & Nacke, 2010). Modeled after the MBTI, BrainHex is a game personality survey that computes individual player types through a forced choice, self-reported, personality questionnaire, similar to a psychometric type survey (Nacke et al., 2011).

Play styles, identified as *BrainHex Archetypes,* inform the satisfaction players receive through types interactions in games similar to those described by Bartle

(1996). Bateman (2004) and Nacke et al. (2011) present and expand these characteristics as seven different player archetypes: *seeker, survivor, daredevil, mastermind, conqueror, socializer,* and *achiever*. The web-based instrument provides the user with a personal *BrainHex Archetype* (see Table 2-2), detailed play-style characteristics, and a graphic image depicting their *BrainHex Class*.

Table 2-2. BrainHex Archetypes, Play-style Characteristics, and Class Symbols

BrainHex Archetype	Play-style Characteristics	Class Symbol
Seeker	Associated with exploration, this play style finds pleasure and enjoyment in viewing, navigating, and discovering elements of the virtual environment often through strong sensory experience.	
Survivor	Players who enjoy high tension related to fear or anticipation of terrifying situations preferred this play style.	
Daredevil	Risky or harrowing gameplay behaviors that involve elements like speed, heights, etc. are emblematic of this place style.	
Mastermind	Task oriented. Puzzle solving, strategizing, and successful decision-making are characteristics of this archetype.	
Conqueror	Challenge oriented. Defeating difficult adversaries, struggling to win, And conquering other players offers of this archetype enjoyment.	
Socializer	Socially oriented. Talking to, helping, and building trusting relationships with other players serves as the primary source of enjoyment. The game construct is secondary to the socialization.	
Achiever	Goal oriented, motivated by short and long-term achievements and success across the whole of an environment.	

Note: Adapted from BrainHex Archetypes (Bateman, 2004).

Table 2-2 shows the different orientations, motivations, and interests associated with the BrainHex Archetype model. The graphic representation of each

Archetype is shown as a distinct class symbol. Unique to the BrainHex classification, player styles may include two classes (i.e., Achiever/Socializer or Survivor/Daredevil).

<u>Play Types and Educational Games</u>

Game designers focus on and consider the end-user *experience* (Koster, 2005; Poole, 2000) while educational designers deliberate over end-user *results* (Amory, 2007). Developing educational games, or using game-based approaches like quest-based learning, require consideration of both (Gibson et al., 2007) as they focus on attracting learners to attend to effective learning activities.

O'Brien, Lawless, and Schrader (2010) synthesized *Gagne's Five Categories of Learning Outcomes*, *Bloom's* (1956) *Taxonomy of Educational Objectives*, and *Jonassen's (2000) Typology of Problem Solving* as a theoretical foundation. They identify four genres of educational games: *Linear*, *Competitive*, *Strategic*, and *Role-playing*. These genres are differentiated by the type of interaction, function of play in the game, and skills required for success.

Linear games require linear logic for the player to be successful while *competitive* games require both linear logic and play that anticipates the actions of other live or computer controlled players. *Role-playing* games mediate success through the player's ability to develop and maintain a multifaceted character within a social environment (O'Brien et al. 2010). Strategic planning is required to successfully manage complex systems and typify *strategic* games. The genres represent the authors' assertion that different games are designed to appeal to different types of play.

This taxonomy supports teachers, designers, and researchers in considering the educational affordances of different games (O'Brien et al. 2010). This is meaningful because it provides a framework through which video games can be integrated by game-type while tying them to theoretical foundations in education offering this framework as a means of effective integration of video games into the classroom.

Malaby, Bartle, Bateman, and others sought to understand play styles in order to "create better and more enjoyable games" (Bateman & Nacke, 2010, p.1). Work by Bateman (2004) and others have been influential in understanding characteristics in educational gaming. Defining preferences and learner styles in a game-based or electronically-mediated educational environment serves the needs of teachers, curriculum workers, students, and designers. While much research has been put forth concerning learning styles, little work has been done to identify characteristics in learning communities where games are employed as primary tools of instruction. This represents a gap in our collective knowledge and thinking regarding this emerging trend and specialization in education and educational design. The work of Bartle, Bateman & Nacke, and others in the realm of these player personalities and preferences represents an opportunity to develop tools, instruments, and assessments that will help learner, teacher, and designer create more engaging and effective learning experiences. It will also help to formulate algorithms and other computer supported means by which active and ongoing learner profiles can support the distribution of just-in-time learning activities influenced by curricular needs and learning metrics.

Learner Motivation Through Play

Much work has been done identifying the psychological and biological factors that contribute to the pleasure and enjoyment of video games. The proposed research supports these connections by investigating factors attributed to pleasure, enjoyment, fear, anger, and other neurochemical responses. Using this research base to identify attributes, conditions, preferences, and patterns related to video game play and neurobiological responses supports identification of characteristics of attractive quest-based learning design.

Motivating Factors in MMORPGs

Looking to uncover specific motivating factors and characteristics of players of massive multiplayer online role-playing games (MMORPGs), Yee (2006) collected survey data (n= 6,675) over a three-year period. Players of several prominent and popular commercial games were contacted through a third-party socialization tool (IGN) of which they were members. Results assert that motivating factors in MMORPGs are (in order of appeal):

1. Relationship: The motivation of interacting with other users and form meaningful relationships that are supportive (Yee, 2006).
2. Achievement: Becoming powerful, collecting items, gaining rank or prestige.
3. Immersion: Enjoyment derived from being in a fantasy world or becoming someone else.
4. Escapism: Using the virtual world to escape from real-life stress and problems.
5. Manipulation: Deceiving or objectifying other users for personal gain or satisfaction.
6. Lead: Motivation to lead others

7. Solo/Group: The desired to play alone or in the context of a team.

Yee's study of MMORPGs and motivation support the notion that different characteristics appeal to, and thus motivate, different users. His findings assert variations in motivators by gender. Male players (n=5,939) surveyed were significantly more likely to be driven by Achievement and Manipulation factors while female players (n=736) were significantly more likely to be driven by the *relationship* aspect of MMORPGs. Yee is careful to articulate that while differences existed between male and female players, he does not suggest that they play different games, but rather the MMORPG genre is broad enough to appeal to both genders in different ways.

Is important to point out that these results may be influenced or skewed by the pool of respondents that were recruited and selected from the MMORPG social network site. These sites are popular with more serious players and fewer casual players and may not be representative of the population. Also worthy of consideration, MMORPGs are played by only 21% of teenagers (13 to 17) and only 23% of adults report playing online games (Lenhart, Kahne, Middaugh, & Macgill, 2008). Yee's (2006) findings, while illuminating and valuable, explore only one small segment of gamer populations and a single genre of gameplay environments. Broad statements concerning the motivations of gamers found in this study may be unique to MMORPGs. More research is needed to explore whether these findings in player motivations are ubiquitous or anomalous.

<u>Pleasure Centers</u>

The human brain operates using systems of neurotransmitters that regulate everything we do (Baxter & Murray, 2002). These neurotransmitters regulate pleasure and pain, socialization and fear, through intricate chemical reactions and interactions (Biederman & Vessel, 2006). Different systems within the brain interact to perform cognitive, physical, and emotional functions (Baxter & Murray, 2002). While we do not understand them fully, functional magnetic resonance imaging (fMRI) has helped to isolate different regions of the brain that perform or react to fundamentally different emotions or tasks (Biederman & Vessel, 2006). These *centers* locate the processes related to *pleasure* (nucleus accumbens), *socialization* (hypothalamus), *fear and excitement* (amygdala), *association and socialization* (hippocampus), and *decision making* (frontal lobe) into regions that interact with one another chemically (Baxter & Murray, 2002; Biederman & Vessel, 2006; Weber et al., 2006). The nucleus accumbens, or *Pleasure Center*, releases the neurotransmitter dopamine, which shares a chemical similarity to cocaine (Bateman & Nacke, 2010). These processes are mediated through the frontal lobe of the brain, often referred to as the *Decision Center* and associated with cognitive function. Thus, motivations, rewards, and decisions are closely aligned (Biederman & Vessel, 2006).

At the core of the brain's pleasure center is the neurotransmitter dopamine (Berridge & Robinson, 2003). Dopamine provides a feeling of enjoyment and is released in the process of rewarding experiences like food, sex, and competition. It can also be released as a result of neural stimuli like learning, discovery, affirmation, or memories (Biederman & Vessel, 2006). Highly addictive and habit-forming dopamine serves to reward the brain and trigger reward-seeking behaviors (Bartle, 1996; Bateman & Nacke, 2010; Berridge & Robinson, 2003). Strong neural stimuli like learning that can trigger reward-seeking behaviors is recognized as a powerful tool for student motivation.

Much interest has been placed in dopamine release related to enjoyment, excitement, fear, and other emotional responses and their implications in video gameplay. The work of Bateman & Nacke (2010) organizes and correlates different neurotransmitter functions with previously catalogued BrainHex play style preferences.

BrainHex and the Neurobiology of Play

Complex chemical processes in the brain create pleasure. This neurobiological effect can be experienced in multiple ways (Bateman & Nacke, 2010; Nacke et al. 2011). Bateman & Nacke (2010) connect neurobiological perspectives with models of play through a cross-disciplinary literature review. The findings demonstrate a direct application of the understanding of brain-based responses to recurrent patterns inherent in play. Their findings, aligned to BrainHex archetypes, resulted in a biologically-grounded player satisfaction framework. It is important because it connects emerging understanding of neurobiological factors in the brain to the experience and affect of playing video games, as outlined in Table 2-3 below.

Table 2-3. Bateman & Nacke' s BrainHex Archetype, Play Style, and Neurobiological Reward Systems.

BrainHex Archetype	Play-Style Characteristics	Neurobiology Implications
Seeker	Associated with exploration, this play style finds pleasure and enjoyment in viewing, navigating, and discovering elements of the virtual environment often through strong sensory experience.	Endormorphin is produced when the brain encounters rich patterns of often sensory information.
Survivor	Players who enjoy high tension related to fear or anticipation of terrifying situations preferred this play style.	Relief of terror releases epinephrine associated with excitement which enhances the effects of reward triggered dopamine.
Daredevil	Risky or harrowing gameplay behaviors that involve elements like speed, heights, etc. are emblematic of this place style.	Epinephrine released through risk-taking and the subsequent relief enhanced the effects of dopamine release.
Mastermind	Task oriented. Puzzle solving, strategizing, and successful decision-making are characteristics of this archetype.	The pleasure center and the decision center are closely related. Good decisions are rewarded.
Conqueror	Challenge oriented. Defeating difficult adversaries, struggling to win, And conquering other players offers of this archetype enjoyment.	Difficult situations cause the production of epinephrine (adrenalin) associated with arousal and excitement and norepinephrine associated with anger. Testosterone Is suggested to play a role as well.
Socializer	Socially oriented. Talking to, helping, and building trusting relationships with other players serves as the primary source of enjoyment. The game construct is secondary to the socialization.	Comfort, social connection, and trust as associated with the release of oxytocin.
Achiever	Goal oriented. Motivated by short and long-term achievements and success across the whole of an environment.	Dopamine is triggered through the satisfaction of achieving goals.

Table 2-3: Adapted from "BrainHex: Preliminary results from a Nero biological gamer typology survey." By L. Nacke, C. Bateman, & R. Mandryk, 2011, Paper presented at the 10th International Conference on Entertainment Computing. Vancouver, BC, Canada.

The findings align the BrainHex archetype and corresponding play-style characteristics with their corresponding pathways to dopamine release. For example, survival (relief from fear or daredevil behaviors) triggers the neurotransmitter *epinephrine* which then produces dopamine. Thus, surviving a zombie onslaught, for some players, is an attractive way to get pleasure. Perhaps counter-intuitively, the pleasure center is activated through something frightening or seemingly unpleasant (Bateman and Nacke, 2010). Harrowing, risk-taking behaviors in games also ultimately trigger dopamine release, as part of the relief from the *epinephrine* trigger stress. This work sustains Bartle's (1996) original assertions that pleasure in a single game-type can be reached in multiple ways.

Bartle's research supports the notion that different types of play yield unique rewards that feed the pleasure center in different ways and trigger habit-forming dopamine release. Individuals, in turn, develop a "simple preference for certain types of stimuli" (Biederman & Vessel 2006, p. 248) that may drive them toward seeking certain types of rewarding activities. The implications for quest-based learning design proposes that players self-selected activities may be rewarding their brains based on personal preferences. They may also make decisions based on preferred neurobiological triggers, although this suggestion is not supported in the research.

It is important to point out those dissenting opinions about the power of dopamine as a pleasure neurotransmitter exists. Berridge & Robinson (2003) suggest that dopamine alone is neither necessary nor sufficient to solely generate the pleasure response, offering that other critical neurotransmitters aid in the process. Bateman and Nacke (2010) suggests that epinephrine, specifically, may enhance the reward system in some way and that the combinations of certain neurotransmitters, epinephrine and dopamine for example, may be more habit forming than dopamine alone.

Aside from their own work with the BrainHex instrument, Bateman and Nacke (2010) have not completed any empirical research in neurobiological patterns. They have only tied neurobiological patterns to gameplay through their player satisfaction models. While a number of tests, instruments, and studies have been able to make connections between different types of gameplay and specific neurobiological interactions, no other work as of yet correlates those neurobiological interactions with play-style preferences. This offers a potential direction of this research in the future.

Game-Based Feedback as a Motivator for Students

One of the motivating characteristics of video games is found in the copious amount of feedback generated by the players actions in the course of gameplay (Chatfield, 2010; Gee, 2006). The feedback itself is highly rewarding.

Game-based Feedback (GBF) applied to education can have a positive effect on student motivation and engagement. As stated by Charles, Charles, McNeill, Bustard, & Black (2010), "A crucial incentive for engagement with the learning process is *affirmation*" (p. 639). Affirmation is described as a condition by which the student recognizes that they are making measurable progress. When there is a failure to deliver this feedback, confident student engagement suffers.

Charles et al., (2010) described the implementation of the GBF system at the University of Ulster to test the hypotheses of the engaging characteristics of various forms of game-based feedback to an educational experience. They assigned points to specific activities and challenges (both voluntary and non-voluntary) within a module like a computer game and built student profiles similar to popular video game system player profiles that provided detailed feedback on a student's engagement with their modules. Response to this system by students was mixed. A majority of students appeared to engage with the system while a small number objected to the competitive comparisons to their peers and the feedback (Charles et al., 2010). The authors suggest that GBF may be more beneficial to weaker students and those that are more capable or confident. They suggested that this is due to the need for more detailed and ongoing feedback. They conclude that feedback plays an important role in empowering a learner to establish and understand their educational identity (Charles et al., 2010). The GBF approach can further enhance educational feedback and student engagement. The implications are that prompt and meaningful feedback may be attractive to students and the proposed study may provide evidence of its role in attractive quest-based learning.

The literature supporting best practices in game design are instructive. McMahan (2003) describes immersion, engagement, and presence as three critical characteristics in game level design. As levels are described as goal-oriented units of the larger game, levels and quests, as units of measurement and game progress can be used interchangeably for the purposes of attraction. Immersion is described as the conditions by which the player can be "caught up in the story" (McMahan, 2003, p. 68) or conditions of the game. Poole (2000) posits that immersion is, in fact, the videogame manifestation of *flow* as described by psychologist Mihaly Csikszentmihalyi which can be a Zen[-like] experience" (Poole, 2000, p.168) where actions and decisions flow according to internal logic, almost automatically. Immersion can be created by a complex or engaging narrative, a story and its characters, patterns of play that demand attention, intriguing visuals, or any characteristics that draw a player in (McMahon, 2003) but does not need to be a photorealistic three-dimensional digital world.

Engagement, as a product of videogame level or quest design, can be described as attraction to characteristics supporting the gameplay but not necessarily directly linked to it (McMahan, 2003). Engagement is further described as the emotional investments made in the gameplay (Koster, 2003; McMahan, 2003) that supersede the apparent irrationality of the play. Players remain engaged because they have a vested interest in the outcome. This is valuable in educational quest design, because game principles can support engagement and activity by adding layers that create or add value or meaning to activities that otherwise might not hold meaning.

Presence is described as the desire to attend to a type of gameplay or environment. A player's presence within such an environment is an indicator of both its immersion and engagement. Designing quests with these characteristics could be an effective strategy for long-term loaner engagement and success.

Summarizing the literature in this section, game-play styles can be aligned with neurobiological interactions. With tailored game-based feedback, strong neural stimuli from play and learning can trigger reward-seeking behaviors. This suggests play and game constructs are a powerful tool for student motivation. The chemical and hormone interactions, which reward the brain and pleasure center with dopamine and other neurotransmitters, thus may also lead to categories of motivational engagement by players that can be studied for relationships with selection, completion, and rating data in the 3D Game Lab context.

Game-Based Learning

Gaming environments allow students to access learning in effective ways not afforded by traditional Web-based distance education, specifically active, applied experiential learning that engages physical, emotional, and cognitive resources of the learner. Creative teachers that employ experiential learning in game-based environments capitalize on the application of concepts through an overt or active exchange (Weusijana, Svihla, Gawel, & Bransford, 2009). Through concrete, physical, emotional, and cognitively active play, users create their own experiences and construct their own knowledge.

Effective virtual and game-based environments for learning also support multiple means for students and instructors to interact with one another (Gratch & Kelly, 2009). Students in highly social settings often serve as both creators and consumers of the collective knowledge that emerges (Bronack, Riedl, & Tashner, 2006). In addition, recognizing successful behaviors or strategies from those they perceive as successful, learners in a social context learn through shared activity (Bronack et al., 2006). Tools of socialization and interaction allow participants to develop relationships with others, participate in complex social hierarchies, and develop robust digital communities (Gratch & Kelly, 2009). Learning can occur as a result of one's own actions or by observing the results of the actions of others.

Educational games, as well as off-the-shelf "serious games" in an educational setting, have a risen in popularity and practice over the last decade (Gee, 2005; Squire, 2003). A common belief exists that the combination of deliberate educational content infused with game-like elements serve to make existing curriculum more engaging (Barab et al., 2009). Research has shown that games can be effectively employed not only as tools of engagement (Annetta, Minogue, Holmes, & Cheng, 2009; Hoffman & Nadelson, 2009) but to quantifiably improve student learning and understanding. The literature, however, is devoid of research focused on a purely game-based classroom. While empirical studies show that games and game-based learning can have a significant impact on engagement and/or learning in individual units, subjects, or lessons, no published research exists showing the effect of a fully game-based approach to classroom instruction.

Quest-Based Learning

The path through the narrative of an educational course is often a fixed *pearl chain* (Aarseth, 2004) of activities, assignments, quizzes, and tests. Traditionally, the course work is delivered along a prescribed timeline, with fixed values and deliverables, and often lacks flexibility or opportunity for improvisation. Conversely, the most popular and successful games offer myriad choices within rich and compelling narratives that inspire players to push forward (Sullivan, Mateas, Wardrip-Fruin, 2009). The following literature focuses on the characteristics of activities and assessments delivered in a form called *quests*. Quests are basic units of game-based progress and interaction that parallel those of educational content in that they are units of activity within the larger scope of the curriculum (Barab & Dede, 2007). Exploration of the research and thought around what game researchers and designers consider "good gameplay" (Squire, 2003) serves to inform and support an emerging framework for quest-based learning. Investigation of the structure, taxonomy, and organization of game-based quests help inform the generation of theory toward quest-based education.

Choice as a Core Component

Good gameplay is a series or collection of interesting choices (Squire, 2003). By this definition, *good* gameplay is more meaningful, enjoyable, and sustaining through a series of interesting and worthwhile opportunities (Ashmore & Nitsche, 2007). Stagnant or uninspiring gameplay, by contrast, simply provides a series of tasks to perform (Sullivan et al., 2009).

In the context of games, a quest represents a goal-oriented search through which the player tries to collect, retrieve, or achieve something of value (Howard, 2008; Sullivan et al., 2009). Many games, including role-playing games (RPGs), use quests to direct a player through gameplay. Multiple quests often form the building blocks of the larger game narrative and denote progress to a satisfying end or completion of the game (Ashmore & Nitsche, 2007). Additional definitions or derivations commonly found in literature describe these gaming units as missions, events, activities, goals, and challenges. Game-based quests, as opposed to educational units, frequently include elements of choice.

Quest Definitions and the Structure of Quests

Quests as "dramatized searches that can follow certain themes or patterns" (Ashmore & Nische, 2007, p. 504) fit within the narrative of the game world and are often aligned with a character's personal, religious, or psychological journey. Quests typically contain an objective, task, and success/failure conditions (Ashmore & Nitsche, 2007). A quest from the fantasy-based MMORPG World of Warcraft ™ demonstrates these three components. In the quest *A Fowl Shortage*, the objective is to assist Daryl Riknussun, a non-player character (NPC), to prepare a "cock-a-leekie soup." The task is to collect 6 *Dun Morogh Chickens* from a nearby section of town. The success/failure conditions are tied to the player's ability to collect the correct number of chickens and return to the NPC that delivered the quest.

In some quests, the task may be an ordered or fixed series of steps that allow the player to achieve the winning condition. Other quests offer a more open set of conditions and choices that might still allow the player to meet the objective. Likewise, the success/failure conditions may be more stringent and include variables like time, that the player remain undetected, etc. As the game progresses, quests typically become larger, more complex, difficult, and require more knowledge, skill, or ability. Within the immersive world of the game, quests closely align with the narrative or story associated with it (Ashmore & Nitsche, 2007). As game players are participating as explicit characters within the game, or at least an alternate identity, the narrative becomes an important component of the quest.

Sullivan et al. (2009) described two distinct quest structures: task-based and goal-based. Task-based quests include an inflexible list of tasks designed to be completed in a specific order. The objective has a predetermined list of tasks necessary to meet it. For example, in order to rescue the princess, the player must find the sword, build the boat, cross the moat, and climb the tower. The next step in the process is simply not available until the proceeding task is met. This can be frustrating for players when they visualize a more effective solution, but game mechanics will not allow them to complete it. Goal-based quests establish the objective with a clear end point and the player chooses how to complete it. True goal-based quest design allows for interesting player choice with multiple ways to fulfill the quest with no one solution being obviously better than others.

Player frustration occurs when a quest appears goal-based but requires an arbitrary, predetermined solution. Suggesting a possible direction for effective quest-based design, Sullivan et al. (2009) indicated that most quests are a fixed list of tasks and do not adjust based on what the player has done. This is evidenced by the number of combat quests at the core of most video games because they are relatively easy to regulate and every player can do them.

Transposing the characteristics of game-based quests to that of quest design for learning, the characteristics of objective, tasks, and success/failure conditions as highlighted by Ashmore & Nitsche (2007) propose a parallel design consideration. While not new to instructional design, these characteristics overlaid with a rich narrative and infused with additional considerations advance the idea of a unique and engaging quest-based unit of instruction.

The Narrative Roots of Quests

Quests, as units of gameplay, find their origins in tabletop RPGs like a Dungeons & Dragons™ where a Dungeon Master (DM) leads a group of players through a semi-scripted adventure (Aarseth, 2004; Sullivan et al., 2009). Gameplay is directed by the DM with many calculations brought about by multiple rolled-dice interactions. These roles mediate elements of gameplay, including turn-based combat, stealth, elements of chance, etc. (Sullivan et al., 2009). The DM provides an engaging depth of experience by supporting creativity, socialization, and an opportunity for players to engage in the interesting choices proposed by Squire (2003). Sullivan et al. (2009) point out that as these RPG's like Dungeons & Dragons ™ moved from the tabletop to the computer, the complex computations of combat, per se, were easily adapted. Elements of a flexible story arc and character development, which had been supported by a human DM, were minimized or abandoned because of the complexities of programming computer-based role-playing games (CRPGs) (Ashmore & Nitsche, 2007; Sullivan et al., 2009).

Quest Taxonomies

Sullivan et al. (2009) describe one of the purposes of quests as thematic meeting to player actions. Within games, much of the basic action is repetitive in nature and represents only a handful of behaviors. In a typical MMORPG, quest taxonomies represent a handful of actions transposed over multiple conditions and environments. Quests might ask a player to kill, collect, deliver, talk to, escort, or use an object, special ability, or NPC in any number of combination (Sullivan et al., 2009) with killing representing more than half of available quest activities (Sullivan et al., 2009). These can be combined in a number of ways including the following.

- Kill a specific number of a given enemy.

- Kill a specific enemy until they drop a number of an item that the player collects.
- Collect a specific number of an item.
- Deliver an item to a location or NPC.
- Go to and talk to an NPC.
- Escort to a location and/or protect an NPC.
- Use a special ability or item.

As a player advances through a complex quest-driven game, the difficulty of these quests increases as the player's skill level does. However, the quest taxonomies remain largely the same. Additional characteristics that can be layered on these quests include unique or compelling locations, cooperation or collaboration of multiple players, and a multitude of creatures, monsters, and foes.

<u>Digital Learning Object Taxonomies</u>

Lessons and educational activities are made up of learning objects (McGreal, 2004) that are self-contained, exchangeable, shareable, and modifiable units of learning (McGreal, 2004; Redeker, 2003; Wiley, 2000). McGreal (2004) posits the purpose of learning objects is to facilitate the use of educational content or knowledge units online or in a technology mediated platform. Redeker (2003) describes knowledge units as the smaller building blocks of learning objects. A single learning object, i.e. Washington Crossing the Delaware, may be constructed using multiple knowledge units, including digital text, digital music, video, graphic image, simulations, games, etc. Wiley (2000) describes these building blocks of learning objects, similar to toy LEGO blocks. They can be combined in multiple ways at the directive of the teacher, instructional designer, or student. Figure 2-2 shows a graphical representation of the hierarchy of learning objects to form components, lessons, modules, program, and course.

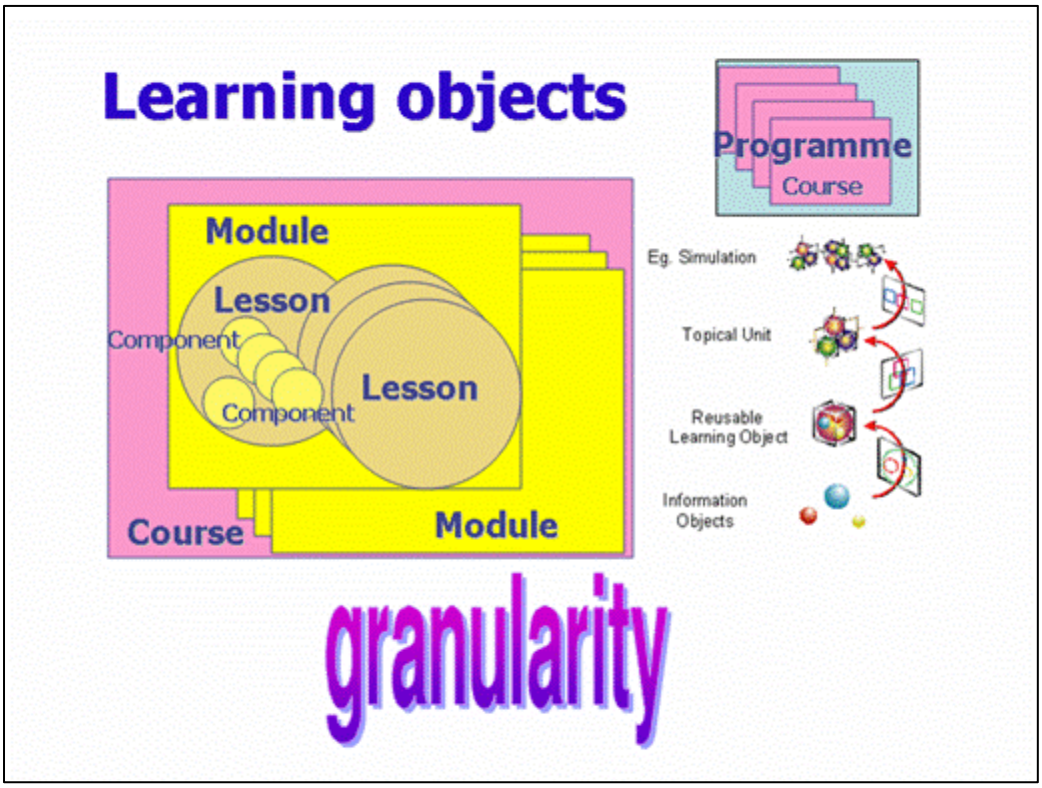

Figure 2-2. Learning Object Granularity. From McGreal (2004). Learning Objects: A Practical Definition.

While the learning objects may be valuable in developing a taxonomy of educational quest design, the knowledge objects are one characteristic important for identification. Examples of knowledge objects that are found in online instruction are in table 2-4.

Table 2-4. Knowledge Object List (McGreal, 2004; Redeker, 2003; Wiley, 2000)

Function	Type
Static	Digital Text Image
Dynamic	Hyper text, web page Video Animation Audio

Interactive	Simulation Game Embedded Object

For the purposes of this study, the evaluation focused on a limited number of learning object characteristics, as too broad of a scope of interaction could confound, confuse, or conceal possible significance. Building upon the conclusion of the study, it may be possible to expand the definitions and scope further. This will be the responsibility of future research.

Organization of Quests Within Games or Narratives

The worlds in which games are created are subject to the limitations of programming, memory, and design savvy (Ashmore and Nitsche, 2007). Quests are designed to be situated between the context of the game environment and the content created for participants to interact with. In the same way, educational activities are situated between the context of the course (Algebra 201) and specific-content standards to be learned. Because of the limitations of the computing platform, the norm of game design has more often been handcrafted level design than an individual user-generated experience (Ashmore and Nitsche, 2007). Handcrafted levels or quests can ensure experience within the narrative of the game but lack the ability to fully consider the experience, interest, propensities, and aims of the individual player. In educational-quest design, these characteristics will be important because of their alignment to emerging trends and individualized instructional approaches.

Ashmore and Nitsche (2007) delineate organizations of quests worth noting. They may be best described in the following manner: linear order, hierarchical, situational, and lock and key.

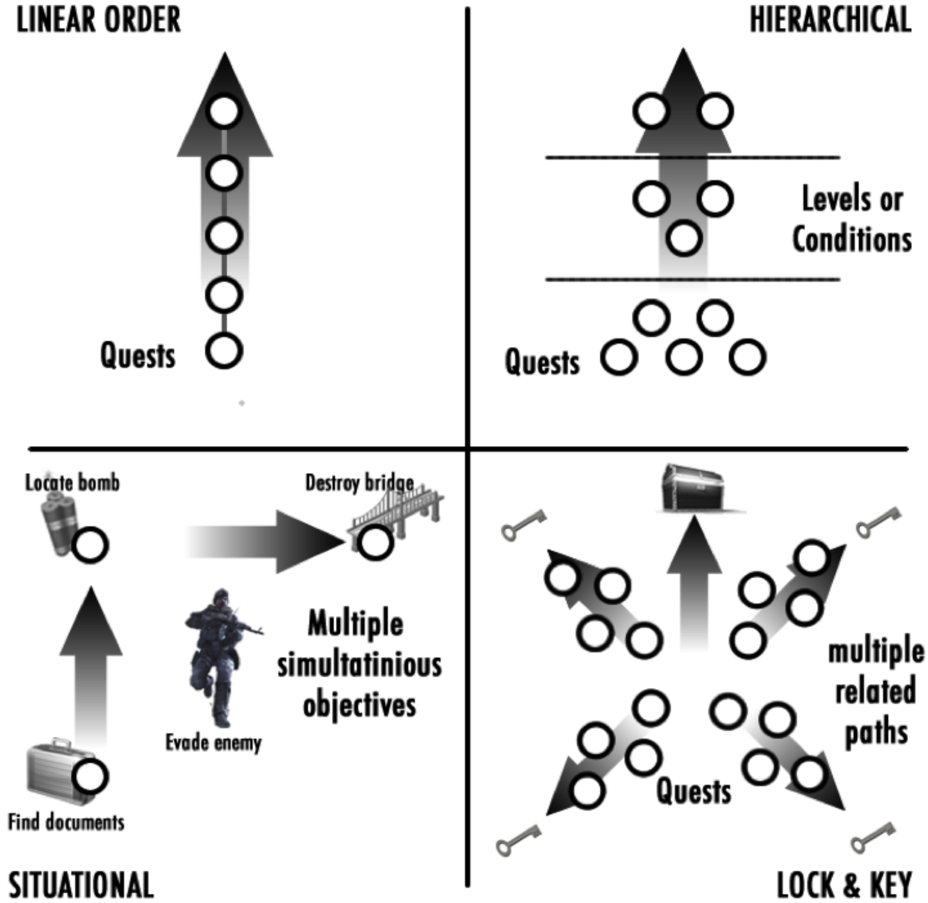

Figure 2-3. Ashmore and Nitsche (2007) Quest Organizations.

Simply put, the linear organization of quests is that of a pearl chain, or strict linear order. Each quest must be completed in order. The hierarchical allows quests to be revealed gradually as part of a larger meta-structure. Leveling up through the quests is a common feature. Situational quest organizations often include multiple quests set up in a larger narrative mission. A player may take a valuable object to a meaningful location of their choice and defend it against an onslaught of enemies. Some choice is given and creativity is rewarded. The final organizational structure is described as lock and key (Ashmore & Nitsche, 2007). *Zelda: Ocarina of Time* typifies this organization. Quests lead to the collection of multiple key-like items that unlocked parts of a much larger whole. They can be completed in any order and allow for some freedom and agency, but are necessary for the winning condition of the overall game. The winning condition may look different depending on the player. The quests become the common pathways by which players can reach their desired goal.

Implications for Educational Quest Design and Quest-Based Learning

Quest-based learning might also consider the concept of Transformational Play (Barab et al., 2009). The methodology of *Transformational Play* includes the projection into the role of a character, engagement in a fictional problem context, application of conceptual understanding, and the opportunity to examine one's participation in terms of the impact on the immersive context.

This literature suggests it might be possible to create better and more enjoyable learning experiences by identifying the characteristics of attractive quest-based learning. Also, the unique player type and game-type identifications, especially when tied to theory and research in neurobiology and learning theory serve as a powerful overlay when considering educational choices made by students in a quest-based learning environment. These could be used separately or in tandem to create unique learner profiles.

Summary

This literature review considers whether game-based and quest-based approaches are viable and how they can be designed effectively for multiple personality, learning, and play styles. Games and play are shown to be a motivating and ever-present element of the human experience. The literature demonstrates that gaming constructs resonate well enough with youths and adults to serve as a framework in education, citing their prevalence and ubiquity in modern society.

Players of games are attracted to and enjoy different styles of play, even within the same gaming environment. Thus, numerous play-styles exist and can be exploited for learning and engagement. Neurobiological research coupled with research supporting play-styles advances the notion that a broad range of games may offer brain-based rewards to players in different ways. Game-based learning approaches are well supported by research and practice providing evidence of testable attributes of attractive quest design. Additional, testable variables are present in research involving video game quest design. The implications of designing attractive quest-based learning supported by the concepts involving quest taxonomy advanced by Sullivan et al. (2009) are intriguing. Adopting, synthesizing, or developing an educational quest taxonomy could support developing a quantitative best-practices approach to quest-based delivery. This unique set of characteristics and variables could be combined with structure and organization characteristics presented here to support the development and methodology surrounding quest-based learning design.

As a whole, the review exposes numerous characteristics, attributes, and elements that have the potential of supporting a study of variables of attractive quest design in quest-based learning. Further investigation into this arena could put forward criteria that would aid in the development of more effective quest-based learning design.

CHAPTER 3

METHODOLOGY

Introduction

The purpose of this study was to identify the characteristics of attractive quest-based learning activities as evidenced by learner selection and completion. Guiding questions for this study included: 1) What characteristics are common in those quests most selected by students in a quest-based learning environment? 2) What characteristics are evident in those quests that are completed?

Addressed fully in Chapter 1, the following methods provided the strategy for answering this and the related research questions and provided rationale for the procedures that were used. These methods also identify the participants used in the study and their characteristics, demographics, and sample orientation. The measures and instruments used are also clearly outlined and detailed.

Research Design

Research on the effectiveness of educational approaches and techniques requires a synthesis of meaningful, unbiased, and reliable evidence (Martin, 2010; Slavin, 2008). Many researchers, institutions, and organizations like the What Works Encyclopedia (WWE) and the Best Evidence Encyclopedia (BEE) espouse a focus on data-driven, empirically-based consideration of educational programs and approaches. No study is perfect, so selection of appropriate, economical, and thorough research methodologies to address the research question is critical (Davies, Williams, & Yanchar, 2008; Horn, Snyder, Coverdale, Louie, & Roberts, 2009; Slavin, 2008).

Slavin (2008) calls for a return to an evidence-based evaluation of educational approaches and programs utilizing research methodologies that consider randomized designs, larger sample sizes, and studies longer than 12 weeks.

This study utilized a quantitative research design to identify the characteristics of attractive quest-based learning. This was done by employing data-mining techniques and tools SAS Enterprise Miner version 6.2 using data captured from the 3-D GameLab learning management system. Fayyad, Piatetsky-Shapiro, & Smyth (1996a) offer data mining as a process of Knowledge Discovery in Databases (KDD) through 1) data selection, 2) data cleaning, 3) data transformation, 4) data mining, and 5) results evaluation and interpretation. This process was used to find quantitative evidence.

Characteristics of this quantitative research design included descriptive statistics. These descriptive statistics guided the process of data mining. This was done to identify patterns in the data that might not be otherwise observable. Analysis was focused on a large volume of LMS interactions collected from 98 students.

The survey instrument was validated using the SPSS. Martin (2010) submits that the use of un-validated instruments or techniques in the classroom is problematic. He suggests that evidence-based pedagogy and practice are critical. This is necessary to avoid what Yates (2005) describes as "illusory correlations and fundamental computational bias." In inferential statistics, many suggest that research producing strong reliable evidence should be conducted such that a high degree of importance is placed on effect size, statistical power, confidence intervals, reliability and validity coefficients, and a randomization where possible (Horn et al., 2009 ; Shelby & Vaske, 2008, Smith, Levine, & Lachlan, 2002; Zientek, Capraro, & Capraro, 2008).

However, the whole data set was collected and analyzed, an inferential measure of reducing the error were not necessary (Fayyad, Piatetsky-Shapiro, & Smyth, 1996b).

Participants and Sample

The research was conducted using four face-to-face sections of an introductory educational technology course for pre-service teachers enrolled at a university in the northwest United States. The course focused on the use of productivity and Internet tools for teachers in a classroom setting. It provided practical skills and methodological/pedagogical strategies for the implementation of word processing, presentation, spreadsheet, and Internet technologies for teaching and learning. The course was offered as one of two pre-requisites for admission to upper-division education courses. For this reason, students often take it in their second year of undergraduate studies.

Course

The participants from this introductory educational technology course for pre-service teachers met twice weekly for 85 minutes during a16-week course in the Fall 2011 semester. The course used the 3-D GameLab Quest-based learning management tool that allowed students the opportunity to participate in as many as 66 quests in six categories: context (18), presentations (5), portfolio (9), spreadsheets (4), web tools (23), and word processing (7).

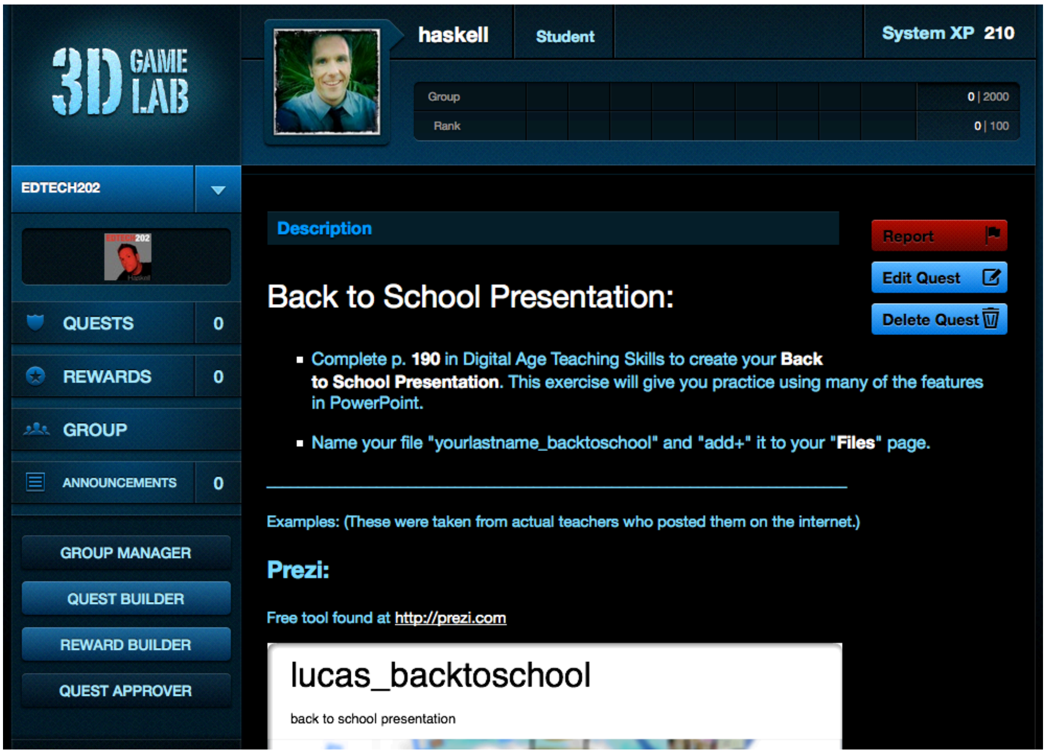

Figure 3-1. Screenshot of the Back to School Presentation quest from EDTECH-202.

These educational quests were the basic units of progress within the larger scope of the quest-based curriculum (Barab & Dede, 2007) similar to assignments, projects, readings, and other educational interactions in traditional academic settings. Participants in this course selected activities from a pool of available quests. Each quest was also aligned to one of the primary curricular categories and corresponding International Society for Technology in Education National Educational Technology Standards for Teachers (ISTE NETS-T).

Each quest had an associated experience point (XP) value that contributed to an accumulating overall score. The XP value for each quest varied and was set by the instructor/course designer ranging from 10 to 100. Each student's XP accumulated toward a winning condition, a course completion of 2,000 points and submission of a completed portfolio of work. Unlike traditional assignments and activities that offer flexible grading, quests had fixed XP values, which were absolute. If students submitted a quest that did not fully meet the expectations, it was returned by the instructor with notes and modifications. Students could resubmit a quest as many times as was necessary to perfect it without penalty.

As student XP accumulated throughout the course, progress was gaged by advancement through 11 ranks (See Fig. 3-1). Ranks were set at predetermined fixed intervals and served as prerequisites for many quests. Of the 65 quests available to students throughout the course, only seven were initially visible and selectable. All others were subject to prerequisites including ranks, quests, badges, and XP. The winning condition of the course was set at a completed portfolio and 2000+ XP for an A. Other grades were available at 1750+ (B), 1500+ (C), 1250 (D), and 1249 (F). The number of quests required to meet the winning condition varied (**μ**=39.31, SD=2.51).

Figure 3-2. Course Ranks for EDTECH-202.

Class sessions were comprised of seven mandatory teacher-led full group quests, 10 optional teacher-led small group quests, and 21 student-directed open lab sessions. Because students in the EDTECH-202 course had the ability to choose their activities from multiple options, students pursued activities that interested them the most. This student choice allowed for the testing of the attractive characteristics of the quests themselves.

Measures

Human Participants

This research was subject to the review of the Boise State University Institutional Review Board (IRB). In compliance with the Department of Health and Human Services (DHHS) regulations for research involving human participants, the IRB (Assurance Number: #FWA00000097; IORG0000591) reviews all research to protect the welfare and rights of human subjects who participate in research conducted at or through the university. All research involving human subjects conducted by researchers at the University must be reviewed by the IRB in compliance with Federal, state, and university regulations. The study was conducted entirely by using existing data mined from the 3-D GameLab learning management system and from the results of a technology use and proficiency survey titled, "Examining Preservice Teachers Technology Competencies" (Haskell & Pollard, 2008) used for course improvement. Before extracting or extrapolating any data, a research proposal was presented and approved by Boise State University IRB (#EX-104-SB12-006) and is referenced in Appendix C.

Security and Privacy

Preserving the privacy of research subjects is the first priority of the researcher. The 3D GameLab system has been designed to reflect guidelines set forth by the Family Educational Rights and Privacy Act (FERPA) and Children's Online Privacy Protection Act (COPPA). Compliance with these acts ensures that personal or identifiable student information is not unwittingly shared with other users or made public. All participants selected for the study are over the age of 18. Student identities have and will remain masked with a student-selected GamerTag (or nickname). Individual student experiences are detailed or highlighted in the reporting. The technology use and proficiency survey did produce personally identifiable information and only serves to provide general demographic and descriptive findings.

Procedure

The sample size for this study utilized the navigational and decision data of 98 participants enrolled in four sections of the introductory educational technology course for pre-service teachers. Due to the relatively small number of students participating in a specific treatment, all student navigational and decision data was included as a purposive sample (Godambe, 1978) thus avoiding the pitfalls of selection bias, Type-I (or II) error, or other inferential measurement errors.

Consent

Under the guidelines of the governing university institutional review board (IRB) and in compliance with Title 45, part 46, Protection of Human Subjects, research was conducted using existing data collected “in such a manner participants cannot be identified, directly or though identifiers linked to the participants” (Moreno, Caplan, & Wolpe, 1998; OHRP, 2009). Aligned with the Basic HHS Policy for Protection of Human Research Subjects (Federal policy for the protection of human subjects; notices and rules, 1991), existing data can be used provided that "research is conducted in established and commonly accepted educational settings, involving normal educational practices such as…research on regular instructional strategies." The research focused on the characteristics of the quests or activities that students interacted with, not the students individually. At no point were students identified as individuals. For these reasons, subject consent was not sought to use this information after the fact.

Instruments

The study utilized data previously collected from an instrument titled *Technology Proficiency and Use Survey* developed by Haskell and Pollard (2008) to provide demographic and technology fluency data of the sample population, but was not directly correlated to the data mining (Appendix A; Haskell & Pollard, 2008). The tool was originally developed to discern the characteristics of undergraduate preservice teacher candidates engaged in an introductory educational technology course. Data collected from the self-report online survey was used to develop a profile of the population students entering the pre-service course for teachers. It was designed to identify the following information:

- Background: Demographic data including gender, years out of high school, university academic program, teaching emphasis, and technology use in high school by application type.
- Usage: Weekly hours dedicated to specific technology-mediated interactions (e-mail, social networking, games, etc.).

- Proficiency: Self-reported skill in a broad range of technologies (file management, word processing, spreadsheets, etc.).

The instrument (Appendix A) used a 4-point scale (1 = often, 4 = never) to determine technology usage by type of respondents while in high school. The tool used 6-point scales (1 = none, 6 = 8-10 hours per week) that measure use of communication tools, gaming activities, and digital entertainment and leisure practices. It also used a 5-point scale (1 = no experience, 5 = very strong) that measures self-reported skill in file management, word processing, presentation software, spreadsheet software, Internet, Youtube, text chat, email, social networking, computer and console gaming, and others. This instrument was used to provide additional demographic, descriptive, and comparative data to supplement the data mining. The instrument has not been validated.

It is important to note that this instrument cannot be correlated to data mining results as it does not identify individuals. As such, it only provides an overview of the participant's profile.

Procedures

In order to accurately prepare the existing data for data mining prior to extraction, it was necessary to perform cleaning, coding, and organizing data in the 3-D GameLab system. This allowed for alignment of quest characteristics more amenable to effective analysis. The following procedures were necessary to prepare the data.

1. A taxonomy was developed and standardized that identified key quest types and characteristics.
2. 3-D GameLab quests tags were modified to include these characteristics.
3. Unnecessary or confusing tags were removed.

These procedures are outlined more specifically in the following sections.

Coding for Taxonomy

Coding quest types and characteristics to determine an educational quest taxonomy was performed. The purpose of this step was to code characteristics of quests for the purpose of tagging for analysis and data mining, which required uniformity. No such educational quest taxonomy was discovered. The coding scheme was developed using the educational taxonomy and learning object classification schemes adapted from Redeker (2003), McGreal (2004), and/or Wiley (2000) with those game-based taxonomies of Bateman and Nacke (2010) and Ashmore & Nitche (2007). This framework was not fully developed and needed to be supplemented and filled out at the beginning of the analysis phase of the study. It supported the identification and tagging of 5 primary areas for each quest.

1. What *Knowledge Objects* were present? Digital text, image, video, embedded object, etc., in three different categories: static, dynamic, and interactive (McGreal, 2004; Redeker, 2003; Wiley, 2000).
2. What organizational features were employed within the quest description? Headings, bullets, numbers, lines or separators, etc.
3. Is the quest goal-based or task-based? (Sullivan et al., 2009)
4. What digital tools can the student interact with (word processing, video production, animation, etc.)?
5. What is the deliverable (blog, document, presentation, no deliverable, etc.)?
6. Additional characteristics (Redeker, 2003)

Once the basic quest taxonomy was been adapted from the above, a systematic review of all quests in the targeted course was completed to determine if the quest taxonomy was sufficient to proceed to tagging. Once the comprehensive quest taxonomy was created, it was used to generate tags to the quests to assist in the data mining and analysis.

Digital Learning Objects

Wiley (2000) describes *digital learning objects* (DLO) as any digital resource that can be reused to support learning. They are small units of instructional components applicable to multiple learning contexts. Learning objects are also defined, not just as bundles of learning materials, but as "interactive web-based tools that support the learning of specific concepts by enhancing, amplifying, and/or guiding the cognitive processes of learners" (Kay & Knaack, 2008, p. 147). A DLO centered around the American civil rights movement might include knowledge units such as a news article about the Freedom Riders, Martin Luther King's "I have a dream" video, and an image of segregated drinking fountains, etc. Individually, these elements or *Knowledge Units* (or knowledge objects) can be applied to other courses of study like journalism, forensics, or photography (Redeker, 2003). Their value as learning objects is in their construction and application. A DLO can be constructed with individual or combinations of *Knowledge Units* (KU) that make up a single unit of study.

DLOs are stored in a digital, often web-based, repository and can be brought together to form lessons, activities, or units of instruction (McGreal, 2004). In this way, educational quests and DLOs are similar and can share classifications. For continuity, types of KUs adapted for the quest classification include small bits of text, digital images or photos, live data feeds (like stock tickers), live or prerecorded video or audio snippets, animations, and smaller web-delivered applications. These are defined below and detailed in Table 3-1.

Knowledge Units Types

Specific knowledge units were identified in the taxonomy and displayed in the quest tags. In future versions of the 3-D GameLab software, the system will likely identify these knowledge unit components and automatically tag them. Table 3-1 is a list of knowledge units originally identified by McGreal (2004) and supplemented to reflect emerging knowledge unit types and those observed in the 3D GameLab quests.

Table 3-1. Knowledge Unit Types

Text
image
table
hyperlinks
resource
example
video description*
video content
video tutorial*
embedded object-static*
embedded object-interactive*
narrative/role-play*

Note: *Indicates expansion of existing KU classification.

Organizational Elements

Identification of organizational characteristics provided insight into quest attractiveness. Fleming and Levie (1993) assert clearer visual organization as essential characteristics of effective instructional message design. A reasonable and open-text display supported by appropriate organizational characteristics serves to gain and maintain learner attention, and thus attractive design (Fleming & Levie, 1993). The following characteristics were added as tags to quests when present: Headings, bullets, numbers, accents (bold, italics, underline, strike through), procedures, and line/separator.

Tools Used by Students

Different digital tools can be attractive and engaging to different users (Wiley, 2000). Identification of these tools in quest tags served as an additional variable for attractiveness. Like knowledge types and organizational elements, tools used by students were listed in the tags of the quest in which they were found for the purpose of classification and data mining. Table 3-2 is a list of tools used in 3D GameLab.

Table 3-2. Tools Used by Students

• apps store	• ARIS	• Blogger
• Google doc	• Google Site	• iPod touch
• Camtasia	• Cinch	• email
• games	• presentation software	• SmartBoard
• spreadsheet	• survey	• twitter
• video camera	• video production tools	• video streaming
• voicethread	• Voki	• Webquest
• webquest	• word processor	• word processor
• youtube	• mobile device	• none

Deliverable Type

Students may be attracted to different types of artifacts or interactions in quests or learning objects (Sullivan et al., 2009). For example, a quest that requires a participant to write a paper may be less attractive than one that requires the student to create a short video. Including these characteristics in a quest's tags allowed for classification and data mining. The quest tags often included more than one type. Deliverables were specifically identified from the following list in Table 3-3.

Table 3-3. Student Deliverables

• account creation	• animated object	• blog posts
• Google doc	• Google Site	• iPod touch
• choice	• Cinch object	• cooperative product
• digital text	• document-stylized	• document-text
• embed/link	• embedded object	• evaluation
• participation	• presentation	• reflection
• spreadsheet	• video	• video walk-through
• VoiceThread participation	• Webpage	• wiki

Task or Goal-Oriented Quests

Sullivan et al. (2009) described two distinct quest structures: task-based and goal-based. Task-based quests include an inflexible list of tasks designed to be completed in a specific order. Goal-based quests establish an objective with a clear end point and the student chooses how to complete it. A simple identification of task-oriented or goal-oriented disposition added to the quest tags allowed for classification and data mining to be performed. As such, the above described game-based approach was applied using the following two definitions adapted for the educational quest taxonomy.

- *Task-based quest*: a detailed list of procedures that produce a uniform product.
- *Goal-based quest*: Activities that provide an outline of the deliverable with freedom to embellish or create

Additional Data

In addition to the tag data described above, data about four other characteristics was also available. This data was automatically recorded through user interactions and was leveraged as additional dependent variables. They include the XP value of the quest, average time to complete (as reported by students), average user rating, and category. These values were included in the data set and used for categorization and data mining.

Later Research

Although considered for this original taxonomy, some areas of quest characteristics were removed. Wiley (2000) proposed that quests (or learning objects) are defined by depth of interaction. These areas were defined as fundamental, combined-closed, combined-open, generative-presentation, and others. In much the same way as Bloom's taxonomy, identification of quests as they relate to demonstrating higher order thinking skills proved problematic.

Redeker (2003) suggests identifying the learner's role in the classification of digital learning objects. This learner's role is respective to the interaction the learner will have. These primary areas include the learner's role as a receptive, internally interactive, and cooperative. While these were compelling ways of looking at these initial quests, difficulty in identifying these characteristics in both coding and identification by students make it problematic.

Quest Tags

All quests in the 3D GameLab system include a field for alphanumeric tags. This allows users to search for quests in the system by keywords. The quest tags in the study group have not been standardized to allow for appropriate analysis. Standardization of keywords is a critical step to ensure patterns are detectable in data mining (Fayyad, Piatetsky-Shapiro, & Smyth, 1996a). Using the coding of the quest taxonomy, all quests in the course system were tagged with the appropriate tags. All other descriptive tags were either made uniform or were removed. This prepared and cleaned the data for data mining.

Descriptive Analysis

As the 3D GameLab system records all actions, views, clicks, and user events, over 100,000 data records exist for the analysis. The statistical analysis software tool JMP SAS 9 and Enterprise Miner 6.2 were used to perform the majority of the analysis on the data collected in four primary areas: user profiling, quest profiling, survey results, and predictive modeling. User, quest, and activity data was collected from 3D GameLab within the date range of course activity.

The descriptive analysis included demographic data collected from both the 3D GameLab tool (age, occupation, location) and from the survey instrument (gender, teaching emphasis, technology skill, and practice). It is important to note, quest behavior data by student was not correlated to results from the survey because the instrument does not collect identity. Additional group and user behaviors are described in Chapter 4, including login frequencies, total XP earned, quest related XP vs reward XP, quests completed, quests dropped or left unfinished, average time reported, as well as badges, awards, and achievements earned.

Quest data was also described, including average and range of XP, average completion time, user rating, category, completed, not completed, dropped, and average completion window. Using an algorithm described below, quest-specific data supported the creation of multiple attractiveness scores, which combined with tag data to determine attractive characteristics.

Data Mining

Data mining is a technique ideal for identifying pathways to success and failure within a system of many complex decisions (Fayyad, Piatetsky-Shapiro, & Smyth, 1996c) and is ideally suited for analysis of large quantities of data. The data mining was performed using statistical analysis SAS Enterprise Miner version 6.2. It illuminated student participation patterns and associations. Behavioral inferences were drawn from meta-patterns related to what they viewed and how long as well as which quests were attempted, completed, or dropped, in that order. Recordable behaviors in the 3D GameLab system are listed in Table 3-4.

Table 3-4 Detectable Behaviors

Click/View Dispositions (recorded by system)	Explanation
Add quest feedback	Submitting a quest for approval (text is required)
Browse groups	Looking at groups that are available to join
Comment on a quest attempt	Leaving a public comment available to other users
Drop a quest attempt	Removing a quest from the users "in progress" list
Expanded a quest to view more info	Expanding a quest to view more info
List quests in group	Selecting "Quests" button showing all "available", "in progress", and completed quests
Load quest feedback form	Clicking the "Complete" button in an active quest
Quest submitted for approval	Finalizing the quest submission process
Start a new quest attempt	Selecting the "Start Quest" button
Switch to group	Switching to a group the user belongs to
Updated a student	Saving edits to a users playercard and account details
View a group's announcements	Viewing group announcements
View a quest's details	Viewing an "in progress" quest
View group dashboard	Selecting the "group" button.

View playercard	Selecting the "GamerTag" to view student playercard
View quest attempt	Selecting and viewing a "completed" quest
View reward	Selecting a reward from the rewards page to show details
View rewards	Selecting the "reward" button
Viewed an announcement marking it read	Selecting and viewing an individual announcement

Navigational pattern analysis was also conducted using sequential association rules to analyze the activity logs. Path analysis was conducted to show the relationship between key behaviors. Table 3-5 shows the specific analysis applied to each research question.

Table 3-5. Research Questions and Analysis Techniques

Research Question	Analysis	Data Sets/Variables
1. What are the characteristics of educational quests as they currently exist?	Descriptive statistics and cluster analysis	Quest details and Tags
2. What is the taxonomy of quest characteristics (including combinations) currently used in the test group?	Descriptive statistics and cluster analysis	Quest details and Tags
3. What different types of quest construction (goals, activities, context, deliverable, organization) exist?	Descriptive statistics and cluster analysis	Quest details and Tags
4. What combinations of variables produce more attractive quests visible through learner selection, completion and rating?	Descriptive, classification, clustering, segment profiling, regression, text-mining	Quest details, tags, Attraction score, interest score, success score, completion score, user comments
5. Based on qualitative and quantitative measures, which design variables are most likely to contribute to the attractiveness of a quest, and thus, learner selection, completion and rating?	Descriptive, classification, clustering, segment profiling, regression, text-mining	Quest details, tags, Attraction score, interest score, success score, completion score, user comments

Predictive modeling was conducted using several analyses. Decision trees were used to predict a students performance under similar circumstances (Fayyad, Piatetsky-Shapiro, & Smyth, 1996a). Decision trees (by anonymous individuals and groups) were generated using dependent variables, including frequency of login, XP, number of attempts, returned quests (failed attempts), success rate, individual quest completion time, rewards, quest characteristics, quest rating, demographic factors, and other variables.

Quantifying Attractiveness

In an effort to determine what attractive variables or characteristics exist in educational quests, it was necessary to determine if, in fact, they were quantifiably attractive to the student or not. The study identified the characteristics that lead a student to “select" a quest. While initial attraction might be valuable in selecting some quests, as the student selects more quests, additional factors likely contributed to the selection of future quests. Three significant events occurred within the 3D GameLab system that helped to identify whether or not a quest was attractive to the user. Distinct decisions were made by the user and recorded by the system that helped to determine attractiveness as follows.

1. Interest: After viewing the quest details, did the student start the quest?
2. Completion: After starting the quest, did the students complete, drop, or leave the quest unfinished?
3. Experience: After completing the quest, how did the student rate it?

Quantifying interest alone was likely not enough to determine overall attractiveness. It was possible that the initial student interest could be high because of certain characteristics (i.e., embedded video, opportunity for collaboration, etc.). However, if the student failed to complete the quest because it proved difficult, uninteresting, or otherwise unmanageable, this would not be reflected in its "attractiveness." Furthermore, it is reasonable to assume that the student would be less likely to engage in a similar type of quest in the future. Since the purpose of the research is ultimately to identify characteristics of attractive quest-based learning, quantifying the interest (at the point of selection) and completion experience is required. Use of the students selected user rating served as a descriptive element.

After thorough research, no studies were uncovered that combined the elements necessary to utilize an instrument for quantifying the attractiveness of educational quests. The following was selected as a method for combining all three phases into a single attractiveness score.

For the purposes of this study, overall quest "attractiveness" is defined as the operational relationship of three components: capturing one's interest, sustaining one's effort, and resulting in a meaningful, personally relevant (highly rated) learning experience (see Fig. 3-3). By this definition, it is possible to quantitatively characterize the student experience through the use of recordable variables.

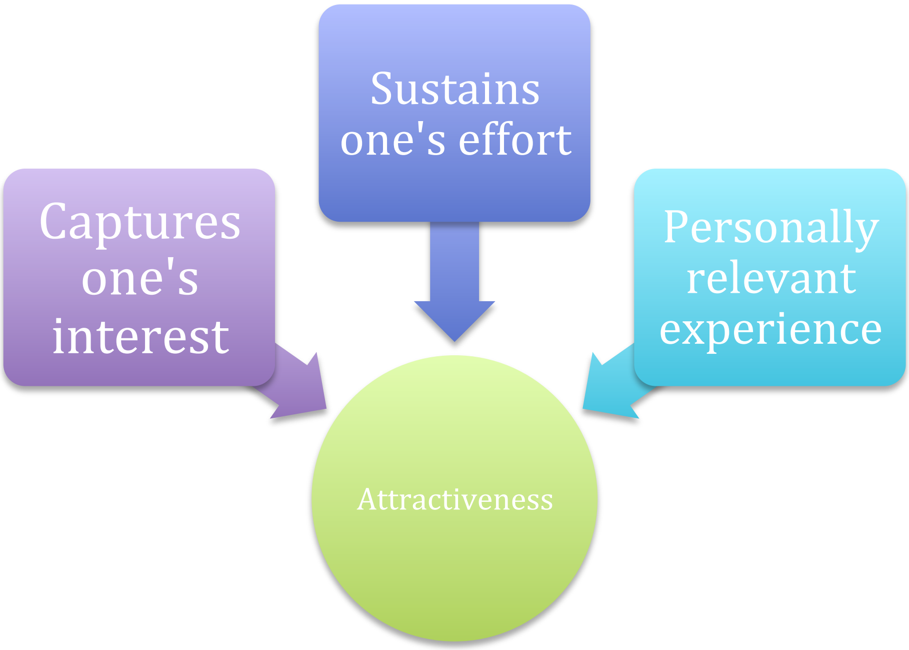

Figure 3-3. Quest Attractiveness Diagram

Interest can be quantified by students viewing and choosing quests. In the system, students could view a list of available quests that show the quest icon image, quest name, XP, average time, user rating, category, and due date if applicable (Fig. 3-4).

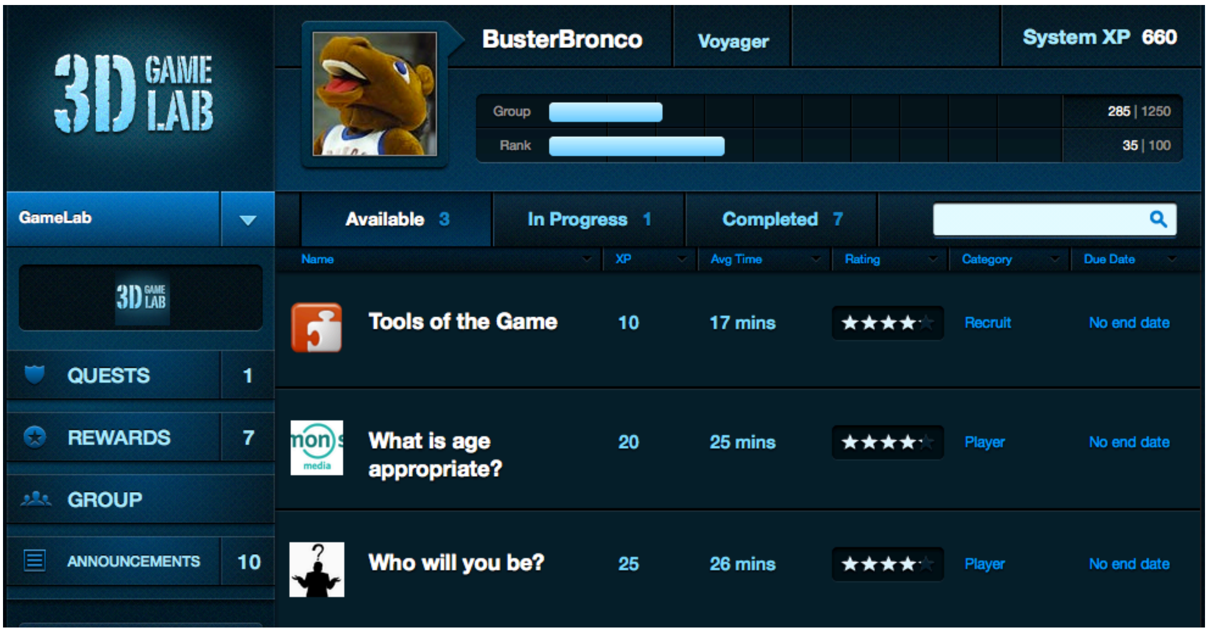

Figure 3-4. 3D GameLab available quest menu.

Users could “click” on an individual quest to see an expanded view of an individual quest that includes a short description, tags, public comments, and the ability to start the quest (Fig. 9). This additional information may compel a student to start the quest or dissuade from proceeding.

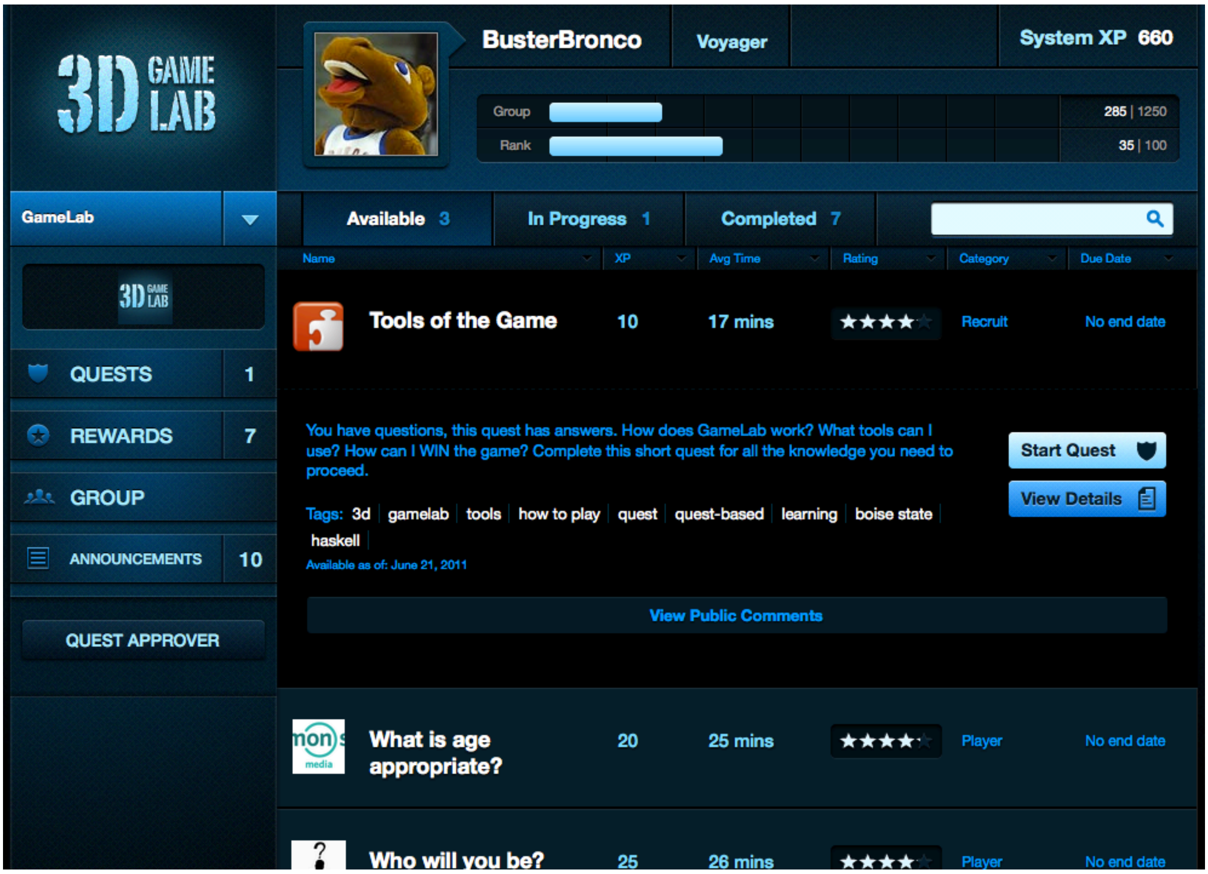

Figure 3-5. Expanded quest view in 3-D GameLab quest menu.

As navigational and decision-making data was recorded by the 3-D GameLab system, the number of times each quest was *expanded* vs. *started* by each user was mined from the system and a value created for comparison. Rather than a ratio, a conversion percentage was generated and expressed as a decimal value. This value was used so that it could be averaged with the other points of attraction. The formula for calculating interest is found in Fig. 3-6.

$$Interest = \frac{Quest\ Started}{Quest\ Expanded\ View} = (i.e.).454$$

Figure 3-6. Formula for quantifying quest "interest" or the initial attractiveness of the quest as evidenced by selection with the intention to complete.

The attractiveness of a quest was also quantified by its ability to hold the student's interest. Thus, sustaining one's efforts can be quantified by quest *completion*. 3D GameLab recorded each occurrence of quests being selected, dropped, or left unfinished. This was quantified using the formula in Fig. 3-7 and stated as a conversion percentage expressed as a decimal value.

$$Completion = \frac{Quest\ Completed}{Quest\ Started} = (i.e.).812$$

Figure 3-7. Formula for quantifying quest "completion" or the attractiveness of the quest as evidence by its completion.

User rating also served as a possible way to quantify meaningful and personally relevant learning experiences. At the completion of a quest, students are asked to rate the quest using a five-star system (Lowest = 1 star, highest = 5 stars). The students also reported completion time for the purpose of an aggregated average completion time visible to other users and comments available to potential users (Fig. 3-8).

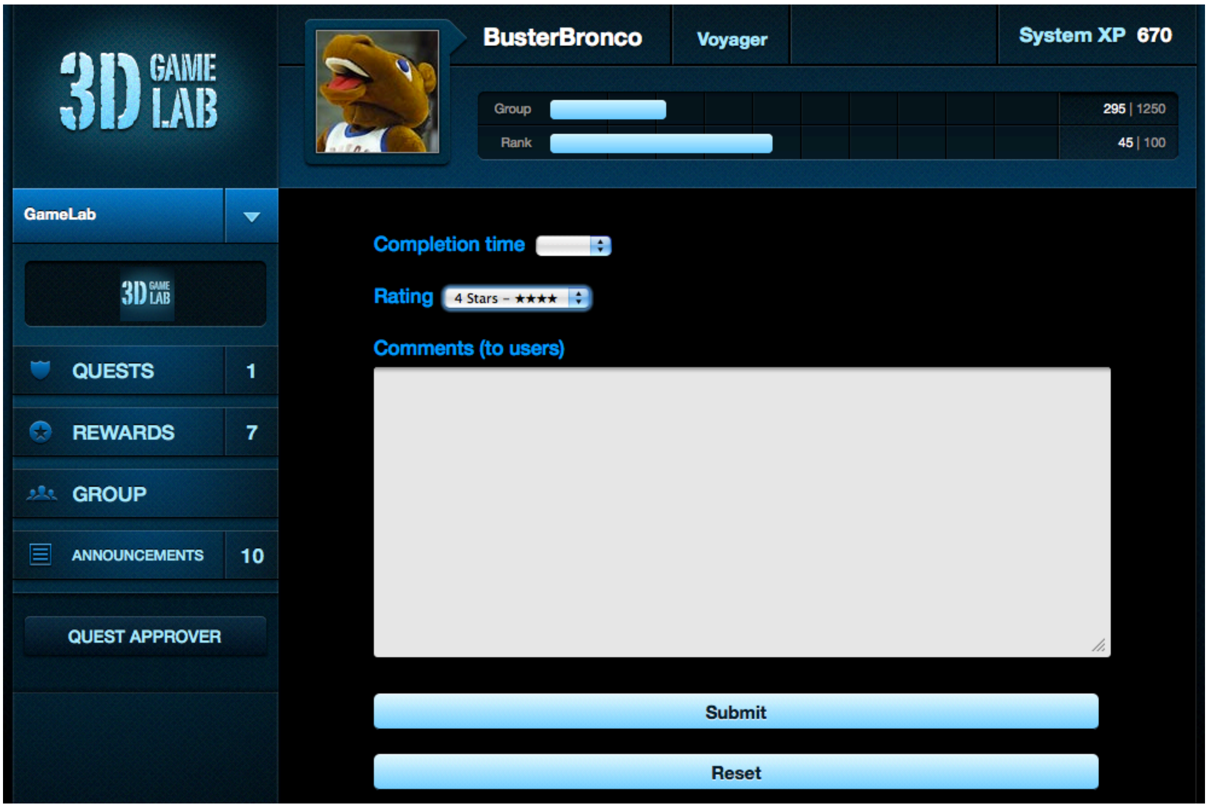

Figure 3-8. Quest completion and rating screen

The user experience cannot be expressed in the same way a conversion %. It is an average of values selected between one and five. In order to express it similarly, as value between .001 and 1, it was necessary to divide the average user rating by the possible rating of 5 as seen in Fig. 3-9.

$$Experience = \frac{User\ Rating}{Rating\ Possible\ (5)} = (i.e.).922$$

Figure 3-9. Formula for quantifying quest "experience" or attractiveness of the quest as evidenced by user rating

It was proposed that the average of these three attraction values could lead to an overall attractiveness score representing all three phases of student interaction with the quest. These are outlined below in Table 3-6.

Table 3-6. Formulas for the Areas of Attraction

Area of Attractiveness	Formula	Evidenced by
Capturing one's interest	$= \frac{Quest\ Started}{Quest\ Expanded\ View}$	Selection
Sustaining one's effort	$= \frac{Quest\ Completed}{Quest\ Started}$	Completion
Personally relevant learning experience	$= \frac{User\ Rating}{Rating\ Possible\ (5)}$	User Rating
Overall attractiveness	Average of all three	Average of all three

While these areas of attraction proved initially promising to generate an overall attractiveness score, concerns about inconsistencies in user rating yielded a comprehensive attractiveness score including only selection and completion. This is referenced and detailed in Chapter 4.

Text Mining

The final step of the analysis was text mining (Baker & Yacef, 2009). Tan (1999, N.P.) describes text mining or text data mining as "knowledge discovery from textual databases" and refers to the process of "extracting interesting and non-trivial patterns or knowledge from text documents." It was applied to analyze ratings and text comments of individual quests as well as high, medium, and low rated quests. The Gini gain formula was used which can determine parameters for ratings. Text mining analysis was applied to areas of quest tags, users generated comments, and users question submissions.

CHAPTER 4

RESULTS

Introduction

As introduced in chapter 1, this study identifies the design variables that contribute to the attractiveness of a quest through user selection, completion, and rating. This is evidenced by the motivation of students to select and complete quests quantified by interactions with quests. Therefore, the research questions guiding this study included 1) What characteristics are common in those quests most *selected* by students in a quest-based learning environment? 2) What characteristics are present in those quests that are *completed*? 3) What characteristics exist in quests *more highly rated* by students? These questions are answered and detailed below.

This chapter approaches the research questions holistically and addresses and presents them in explicit sections. These sections are named and described below and appear in the following order.

1. **User Characteristics and Experience:** Identifying the characteristics of the participants in order to frame the research findings.
2. **Quest Taxonomy:** Identifying the characteristics and taxonomy of characteristic combinations as developed through coding, tagging, and analysis in order to frame the research findings.
3. **Quest Characteristics and Attractiveness:** Describing attractiveness of individual and clustered characteristics using descriptive statistics and cluster analysis in order to respond to the research questions.

4. **Predictive Modeling:** Describing the results of decision tree analysis; the purpose of predicting attractive characteristics.

The user characteristics and experience section, subsequent descriptive statistics, and profiling identified and quantified the experience of the study participants (N=98). It describes participant demographic details, interactions with quests, system rewards, persistence, and overall success within the course.

The quest taxonomy section identifies the characteristics of quests by knowledge unit (KU) types, organizational components, tools present, tools used by students, deliverable type, and whether the quest was goal-oriented or task-oriented. This was done to unify the coding for the purposes of data mining and analysis. This section will also present common characteristics and taxonomic types.

The section focused on quest characteristics will describe attractiveness through multiple analyses as a product of descriptive statistics, data mining, and profiling. Using an interest score, completion score, and a rating score, it is possible to identify, categorize, and describe characteristics individually and in clusters. Cluster analysis provided the most meaningful results, including text mining. These findings will be detailed in this section.

Finally, the predictive modeling results are detailed to describe possible pathways to student success. A conclusion is then offered.

User Characteristics and Experience

Participant Demographics

The participants took an online survey as part of introductory course activities in an effort to determine overall “levels of technology fluency and patterns of use…[including] comfort and fluency in unique areas including software, mobile communications, gaming, social networking, and prevalent secondary school technology experience" (Haskell & Pollard, 2008). Data was collected in three areas: learner background, current technology usage, and proficiency in specific technologies. This data can be used to create a more detailed description of these participants and is helpful in understanding the population.

Demographics and Dispositions

The student sample (n=98) is represented by 65 women and 33 men. Students in these courses declared elementary education (33.7%), secondary education (49%), or K-12 (4.1%) as areas of intended teaching certifications, with others unsure (2%) or not pursuing teaching certification (10.2%). Areas of specialization are outlined in Table 4-1.

Table 4-1. Distribution of Teaching Emphasis within Sample Population

Teaching Emphasis	#	%
Elementary	19	19%
English	17	17%
none/undecided	13	13%
Mathematics	8	8%
Social Studies	6	6%
Other	6	6%
Art	5	5%
Music	5	5%
Physical Ed/Health	5	5%
Science	5	5%
Bilingual	3	3%
Early Childhood	2	2%
Business Ed	1	1%
Coaching	1	1%
Services	1	1%
Spanish	1	1%

More than 58% of these students completed high school after the year 2008 with 17.3% of participants having completed high school more than 10 years ago.

The most common declared preferences in teaching emphasis included elementary education and English/Language Arts. An overwhelming majority (90%) of the respondents indicated "daily" computer usage with the remainder being frequent computer users (3-4 days per week).

The participants were mixed in age ranging from 18 to 53 (**μ**=23.7, SD=1.45). Specific distributions are referenced in Figure 4-1

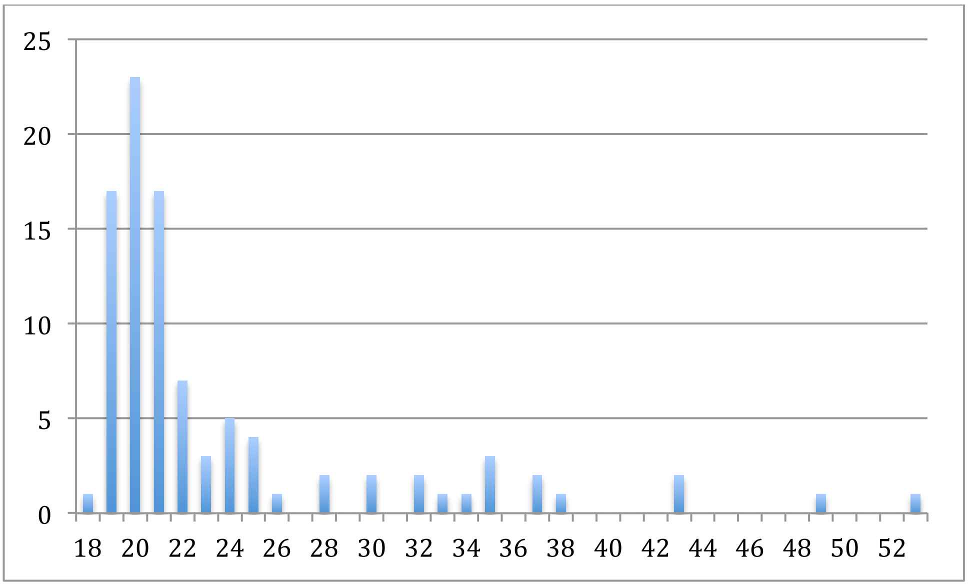

Figure 4-1. Participant Age *Distribution*. While a large number of students were age 19 to 22, other decades, age groups, and generations were represented.

<u>Population Technology Proficiency</u>

The survey tool "Examining Preservice Teachers Technology Competencies" (Appendix A) illustrates patterns of technology use and proficiency. Based on their stated experiences and opportunities in high school, students had an understanding of different software and productivity tools prior to college including word processing (88%), presentation software (81%), spreadsheet software (58%), and educational software titles (49%). The survey also reports social networking, e-mail, and mobile text messaging as common uses of technology (avg. <1 hr/week). Less common (avg. >1 hr/week) activities include photo sharing, blogging, discussion boards, and computer text or video chat. Many of the educational quests include the opportunity to use tools and skills listed above.

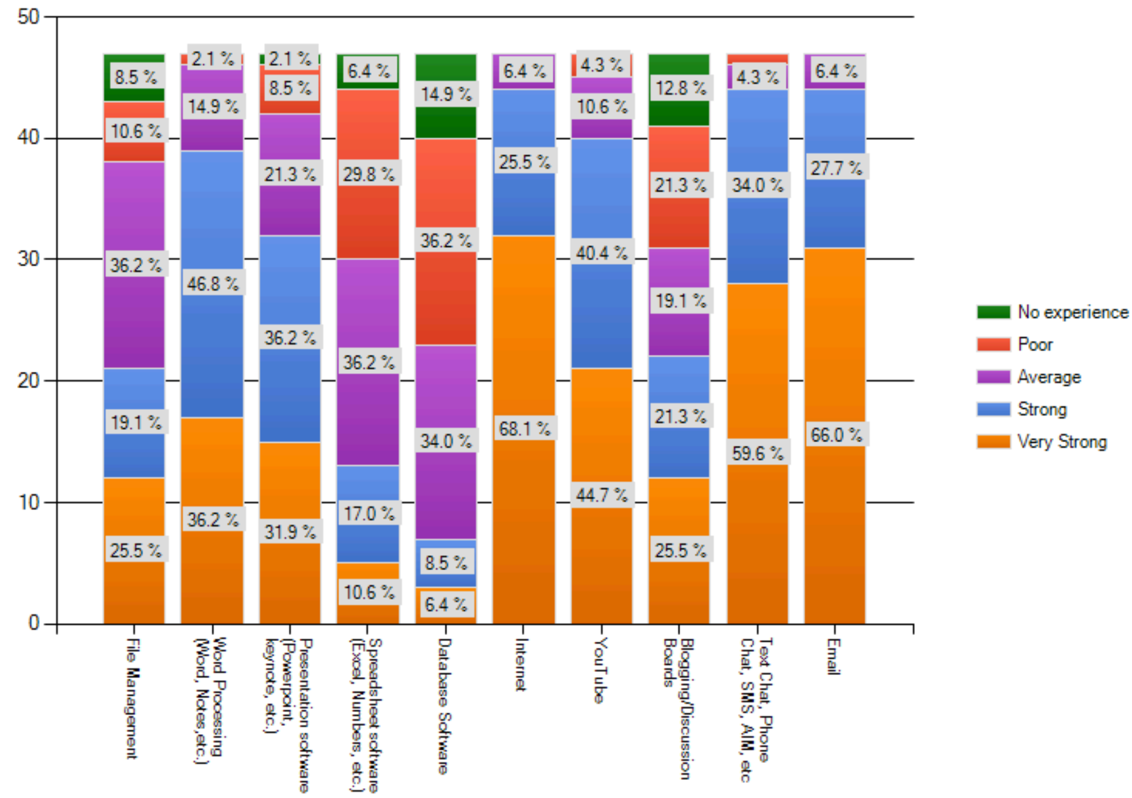

Figure 4-2. Technology Skill by Type. Self-reported technology skill levels from "Examining Preservice Teachers Technology Competencies" (Appendix B).

<u>Gaming Experience</u>

The participants in this study are experienced in a variety of video games and, by association, experienced in videogame mechanics. According to the survey (Appendix B), 92% of students in this group play video games of some kind. Digital game play was most commonly delivered on mobile devices with 49% of respondents playing more than one hour per week. The survey also reported gameplay on other devices including console or handheld games like Wii, Xbox, Playstation, and

Gameboy, both offline (47%) and online (29%). A third of students (34%) reported playing computer games online. As quest-based learning is a game-based approach, participant fluency in video games is an important characteristic of this population.

Participant Activity and Productivity

The data for the participants indicated that 3,598 quests were completed out of the 4,445 quests attempted during the 16 week course, an overall completion rate of 80.9%. Participants completed an average of 36.4 quests each with the high being 48 and low of 23. The lowest number of completed quests of participants who successfully completed the course was 33.

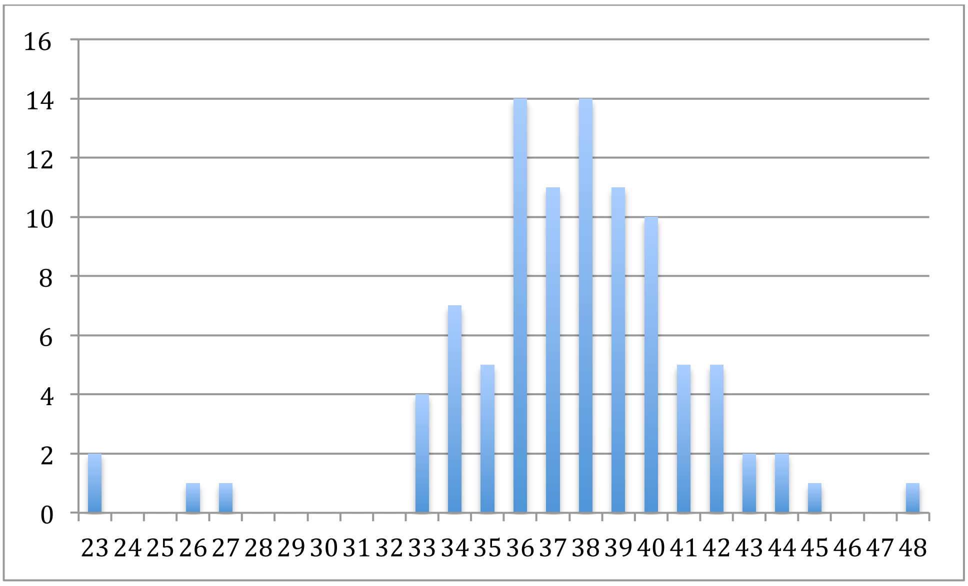

Figure 4-3. Frequency of Quests Completed Distribution. This chart shows the distribution of completed quests within the participant group.

Table 4-2. Participant Quest Experience Data

Student Gender	Avg Ratings Given	Avg Quest Rating	Avg Completion Time	Avg # Comments
F (N=65)	27.91	4.26	36.42	30.61
M (N=33)	29.72	4.42	32.06	31.69
Totals	**28.51**	**4.31**	**34.97**	**30.97**

One component unique to the study was the ability for the system to collect user self-reported experience data including quest rating, quest time (time to complete), and user text comments. These characteristics are displayed below in Table 4-2. The data displayed shows small differences between male and female participants.

Course Completion

Of the 98 students who started the course, 91 completed with a grade worthy of advancement. As previously mentioned, the course did not utilize traditional grading structures. All activities were in essence pass/fail. If the submitted quest did not meet the requirements for acceptance, it was returned with corrective instructions. This meant all completed and approved quests earn the maximum point value, because students had the ability to resubmit quest that were not approved without penalty. As such, participants could continue working toward their desired grade, overcoming failed attempts in the process. Figure 4-4 shows the final grade results and distribution across all possible grades.

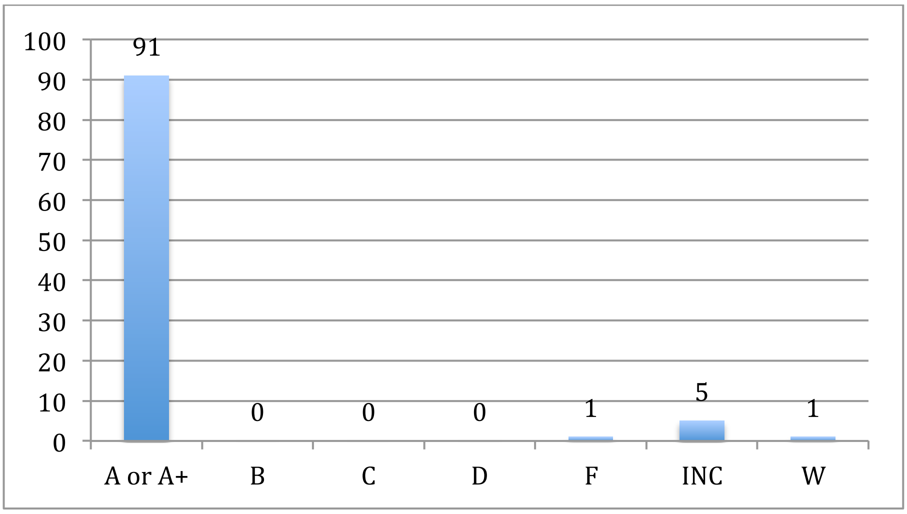

Figure 4-4. Final grade distribution. This figure indicates the number of students who earned each of the grades available in the course.

As shown in Fig. 4-4, one student received an F, five received incompletes and are continuing to work toward course completion, and one student withdrew from the University during the course of the semester. All other students earned an A or A+. Students who received an A+ earned more than 10% beyond the required 2,000 XP winning condition of the course, or greater than 2,200 XP. Figure 4-5 shows the distribution of students who achieved the winning condition. More than half of students who received an A continued to submit quests and received an A+.

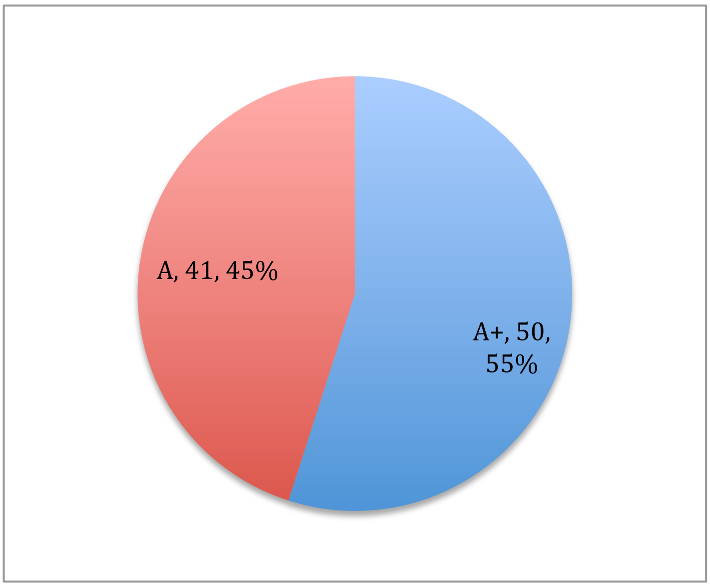

Figure 4-5. Distribution of "winning" grades. The possibility to achieve the highest grade possible in the class was always available. 55% of all students who completed the class received an A+.

Quest Completion

One of the unique characteristics of the course was the ability for students to progress through material without an overt construct of chapters, units, modules, etc. There were no due dates associated with activities and no minimum or maximum completion requirements. This meant students could advance through the curriculum at a self-selected pace or as quickly as they desired. As such, the completion (or "win") time was variable. The student who completed the course the quickest and did so in 22 days, averaging 12.41 quests completed per week. Participants averaged just under three completed quests per week (**μ**=2.89, SD=1.45).

$$Quests\ completed\ per\ week = \frac{Quest\ Completed}{Weeks\ Spent} = 2.89$$

Figure 4-6. Formula for quests completed per week.

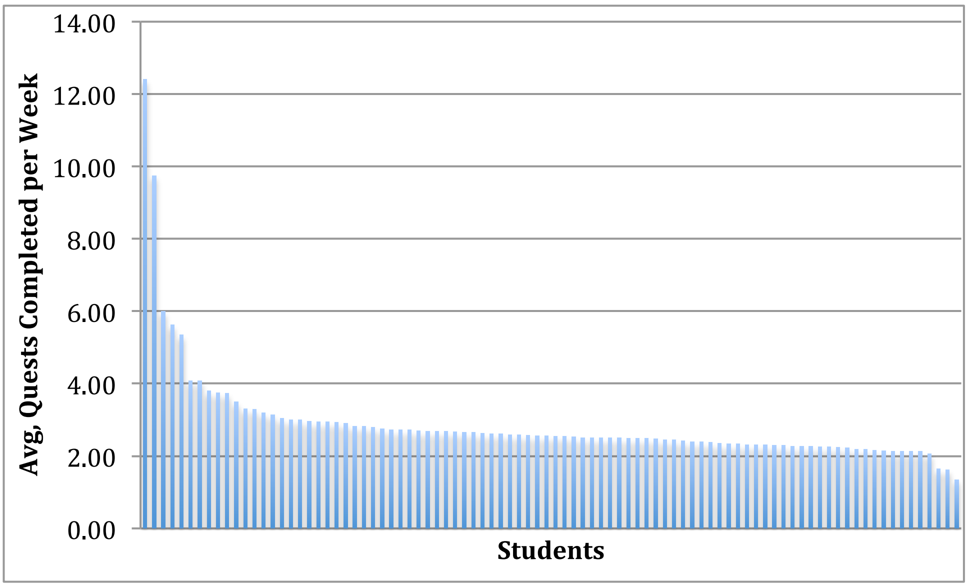

Figure 4-7. Distribution of quest completion. Each column represents the experience of an individual student. The figure shows the average number of quests completed by each individual participant in order to reach the winning condition. As stated in Fig. 4-4, 55% of participants completed more quests than required for achievement of the winning condition. The mean was just under three completed quests per week (μ=2.89, SD=1.45).

Quest Taxonomy

In order to identify characteristics common in quests most selected, completed, and highly rated by students, it was necessary to first identify, quantify, and categorize the characteristics of educational quests. As such, one of the goals of this research was to develope a quest taxonomy for the purpose of characteristics evaluation. These questions were investigated by looking at quests that are restricted to those characteristics that can be controlled. The following is a list of primary guiding questions related to the overarching research questions, as referenced in Chapter 1.

1. What are the characteristics of educational quests as they currently exist?
2. What is the taxonomy of quest characteristics currently used in the test group?
3. What different types of quest construction (goals, activities, context, deliverables, organization) exist?

Coding Characteristic for Taxonomy

Coding of characteristics within quests was performed to determine a quest taxonomy. This was done by coding and tagging these characteristics to create additional data points for analysis and data mining. The coding scheme was developed using elements of Redeker (2003), McGreal (2004), and/ Wiley (2000) classification schemes for educational and learning objects. Elements of Bateman and Nacke (2010) and Ashmore and Nitche (2007) game-based taxonomies were also considered and adapted. These were organized into five primary areas for identification and tagging.

1. *Knowledge Objects/Units* (McGreal, 2004; Redeker, 2003; Wiley, 2000).
2. *Organizational features* employed within the quest.
3. *Goal-based* vs. *task-based* (Sullivan et al., 2009)
4. *Digital tools*, used by students(McGreal, 2004)
5. *Deliverables* (Wiley, 2000).

After reviewing all quests in the system, it was determined that the identified characteristics were sufficient to proceed to tagging. It was not necessary to review additional educational and game-based taxonomies to round out this initial educational quest-based taxonomy and was sufficient to answer the research questions.

Once a comprehensive quest taxonomy was created, it was used to generate tags to the quests to assist in the data mining and analysis. Below, in Table 4-3, the coded variables and subsequent tags or identified.

Table 4-3. Quest Taxonomy Categories and Variables

Category	Coded variables/tags
Knowledge Objects	Text, image, table, hyperlinks, resource, example, video description, video content, video tutorial, embedded object-static, embedded object-interactive, narrative/role-play
Organizational Features	Headings, bullets, numbers, accents (bold, italics, underline, strike through), procedures, line/separator
Goal-based vs Task-Based	Goal-based: Activities that provide an outline of the deliverable with freedom to embellish or create Task-based: a detailed list of procedures that produce a uniform product.
Digital Tools	Apps store, ARIS, blogger, Camtasia, Cinch, email, games, Google document, Google Site, iPod touch, mobile device, none, presentation software, SmartBoard, spreadsheet, survey, twitter, Video camera, video production tools, video streaming, voicethread, Voki, Webquest, webquest, word processor, word processor, youtube
Deliverable	account creation, animated object, blog posts, choice, Cinch object, cooperative product, digital text, document-stylized, document-text, embed/link, embedded object, evaluation, none, participation, presentation, reflection, spreadsheet, video, video walk-through, VoiceThread participation, Webpage, wiki

Coding Results

Quests were viewed, inspected, and taxonomic variables were recorded to an external spreadsheet sorted by quest. Separate columns were created to separate the variables by category as listed above in Table 4-3. During the process of coding, additional variables were identified and added to the taxonomy. Quests that had already been coded were revisited to determine whether new variable(s) applied. If so, it was added to the coding of that quest. As such, the coding schema is consistent throughout the data set.

For accuracy, the process was repeated. The variables were reviewed and quests inspected a second time to ensure all characteristics of the taxonomy were consistent. All changes made during the review are reflected in the complete overall taxonomy.

Table 4-4 shows the frequency of occurrence of tags. They are not sorted by taxonomic category but rather holistically in descending order from most frequent to least frequent.

Table 4-4. Tags Frequencies

Row Labels	Total	Row Labels	Total
Text	65	video content	11
task-based	45	image	11
accents	40	blogger	11
headings	37	spreadsheets	9
hyperlinks	32	Portfolio	9
example	31	choice	9
bullets	31	word processing	8
procedures	30	Blog	8
Web Tools	23	Participation	7
Google Site	22	games	7
goal-based	21	embed/link	7
resources	19	tables	6
Context	18	presentation	6
numbers	17	Embedded object-interactive	6
reflection	16	document-text	6
none	13	Presentations	5
digital text	13	evaluation	5
video tutorial	12	cooperative	5
Wiki	11		

Note: Tags occurring fewer than five times were not included in this table.

Basic Taxonomy

Cluster analysis was performed to identify tags most commonly occurring together. The results show all 66 quests broken into 8 clusters. This represents the combined taxonomy of the quest group. These clusters are outlined in Table 4-5.

Table 4-5. Taxonomy Clusters

Clusters	Percentage	Freq.	Tags
1	15%	10	bullet, heading, +game, + blogger, blog
2	3%	2	hyperlinks, + image, + text ,+ accent, + task-based
3	5%	3	embedded object-interactive, Voicethread, evaluation
4	15%	10	wiki, portfolio, Google site, digital text
5	11%	7	Tutorial, + procedure, hyperlinks, spreadsheet, + task-based
6	27%	18	Content, + resources, video, + embed, context,
7	15%	10	word, processing, word processor, + goal-based, Google
8	9%	6	presentation software, + presentation, + goal-based, + accent

Note: Characteristic tags are not organized in any recognizable order.

The clusters depicted in Table 4-5 demonstrate basic combinations of characteristics within the larger taxonomy combinations of tags and characteristics are common. As seen in Table 4-5, cluster #1 typifies quests that

- utilized headings and bullets in the quest organization.
- asked the participants to play a game.
- and used a Blogger tool to create a blog post.

It also shows that 15% of the overall curriculum was typified by this type of quest design. Some of the quests identified in this grouping were “Games: Lesson,” “Changes in the ‘Intrawebs’," “Mobile Learning Game,” “Activity builder,” “Blogger”, “Games: Player,” and “App Explorer.”

The largest cluster of quests, cluster #6, contained 18 quests or 27% of those sampled (Table 4-5). Utilizing the quest tags, it is possible to describe the contents and construction of this cluster. Cluster #6 typifies quests that

- are in the category "Context", which deals less with specific digital toolsets and more with the "why" and/or "how" to employ them tools or knowledge in education.
- contain detailed written or video content.
- point the student to specific resources.
- include videos or other embedded content.

Some of the quests in this cluster were "Assistive Technology VoiceThread," "How to WIN EDTECH202," "Shock to the system!," "What is a WebQuest?," "Peer Review," "Annotated YouTube Video Playlist," and "Voki Builder."

Quest Characteristics and Attractiveness

The following section will highlight some of the descriptive characteristics of the data. This data is important because it demonstrates why quest dispositions alone (completed, dropped, active) do not serve as effective measures for attractiveness, interest, or successful design. Neither are their associated characteristics, classifications, or taxonomic implications intended to do more than shed light on the overall data. Specific attention to attractor and attractiveness is delivered in detail as results under the heading "attractiveness."

Quest Dispositions

Quests that were selected by students were limited to three possible dispositions at the end of the course. Quests *completed* by users were submitted for approval and accepted by the instructor because they satisfied the requirement. Some quests were submitted and approved automatically, without instructor oversight, based on the quest design. Participants could also selectively *drop* quests. Dropped quests were returned to the queue of available quests, allowing the student to reselect at a later time. Quests that were *active* (selected but never dropped or completed) at the conclusion of the course are also identified. For the purposes of this evaluation, those will be described as unfinished quests.

Completed Quests

During the course of the 16-week study, 3,598 quests were completed by the participants (N=98). More details are available at the beginning of Chapter 4 in the section titled "Participant Activity and Productivity." A total of 71 quests were available in the system and represented in overall quest completion numbers. However, only 66 were considered for evaluation. The remaining five quests were disqualified from the analysis of quest attractiveness due to one of the following:

- The quest was mandatory to all participants and thus not influenced by choice. This included the "Final Portfolio" quest and others required to complete the course.
- The quest was created by a student and not available to all participants. The quest, "Build a Website with Wix," was created by a student to satisfy the "Activity Builder" quest.
- The quest was part of a specially designed project not available to all participants.

While it does not directly suggest popularity or attractiveness, some quests were completed at a greater frequency than others. Quest completion averaged 51.86 (SD=32.46). The top 10 completed quests are listed in Table 4-6.

Table 4-6. Most Completed Quests

Quest Name	Completed	% of students
Blogger	97	99%
Tech Savvy	97	99%
How to WIN EDTECH202	97	99%
Portfolio: About Me	96	98%
Portfolio: Future Goals	96	98%
ADA Letter	91	93%
Fundraiser	90	92%
Back to the Future	87	89%
Reflection: Fundraiser	87	89%
Social Software Webpage	84	86%

Likewise, some quests were completed less often. Table 4-7 shows the 10 quests completed the least number of times. Again, it is not necessarily an indication of their attractiveness, but is descriptive.

Table 4-7. Least Completed Quests

Quest Name	**Completed**	**% of students**
Camtasia Walkthrough Video	4	4%
Presentation Resources Demo	9	9%
SMART Lesson	9	9%
VoiceThread Explorer	9	9%
Build a WebQuest	10	10%
App Explorer	18	18%
SMART Teacher	29	30%
Reflection: Standards Update	36	37%
WebQuest Review	39	40%
Voki Builder	42	43%

Unfinished Quests

Students collectively left 225 quests unfinished (recorded as “active”) despite completing the course (μ=3.41, SD=3.35). These quests could be among those that were selected but not necessary for course completion, selected as an alternate to a quest that they finished, or became less interesting or compelling upon further analysis. Interestingly, five quests accounted for nearly 25% of those quests left unfinished.

Table 4-8. Quests Most Often Left Unfinished

Quest title	XP	# left unfinished
Games: Learner	30	12
Presentation Resources Demo	50	12
Technology Grant Letter	100	10
Netiquette	75	9
Wildcard: ISTE 1	50	9

Note: Experience points are included in this table to highlight the range, as all but one were mid to high XP. The "Games: Learner" quest was available only during a specific date range and at the end of the semester and served as the second quest in a series of three quests about gaming and learning. The others available in Table 4-6 were available at different times throughout the semester.

Dropped Quests

An additional 617 quests were selectively dropped by participants (**μ**=6.43). The standard deviation of dropped quests (SD=8.1) is interesting because it shows a broad difference in behavior. As shown in Figure 4-8, 55 participants dropped five or fewer quests with 28 participants dropping no quests. For 20 of the participants, dropping quests was a more frequent behavior. Two participants dropped 36 quests each, which helps to explain a standard deviation higher than the mean. Dropped quests are also addressed and supported in the section on predictive modeling analysis referenced in the decision tree analysis.

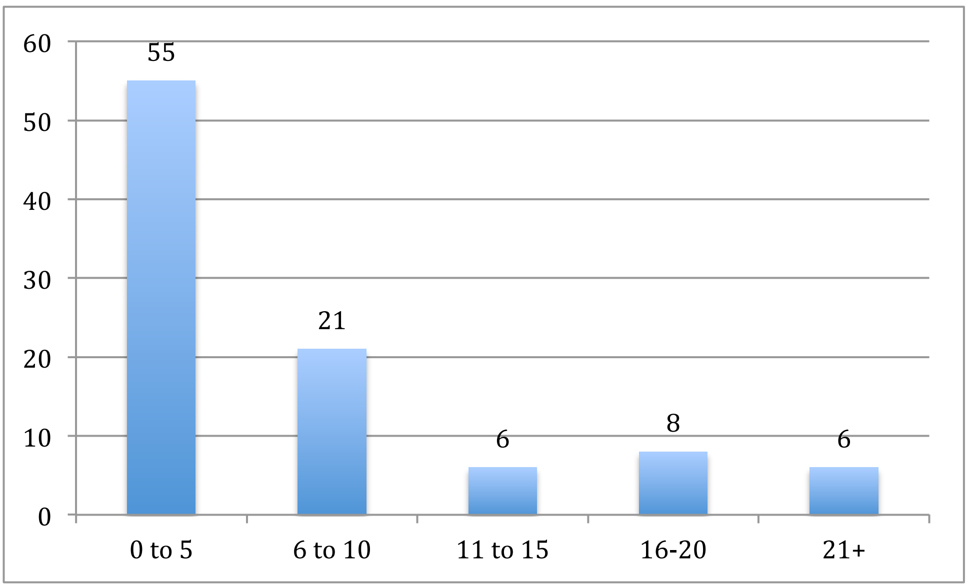

Figure 4-8. Distribution of Dropped Quests Totals by Student. Columns represent the number of participants who dropped quests within the labeled range. It highlights the broad range of behaviors within the group.

Attractiveness

While completion of quests is an interesting and compelling characteristic, it alone is not the measure of attractiveness. The characteristics of the attractive quests were measured three ways.

1. The user's interest as evidenced by selection of a quest from all possible activities. This specifically addresses research question 1), What characteristics are common in those quests most *selected* by students in a quest-based learning environment?
2. The user's persistence as evidenced by the completion of the quest. This answers research question 2), What characteristics are present in those quests that are *completed*?
3. The user's rating of the quest as a gauge of their desire for the quest and its characteristics. This answers research question 3), What characteristics exist in quests more highly *rated* by students?

It is important to note that the third and final consideration listed above, user rating, was found to be problematic as a tool for rating attractiveness. As the rating was given after any attraction to the quest would have occurred, it is not a reliable variable for consideration. It is possible that a student's experience with a quest would influence the likelihood that they would select a quest with similar characteristics. However, user navigational data was not available for this participant group to adequately run individualized decision tree analysis. This would be necessary to determine if a highly rated quest influenced the decision to select, attend, and complete quests with similar characteristics. As such, only the first two variables for rating attractiveness, user interest and completion, were included. User rating is discussed but not included in the analysis of characteristics.

<u>Quest Attraction: Interest</u>

User interest is operationally defined, for the purposes of this study, as the desire of students to select a quest from a list of possible quests. The navigational and decision-making data made it possible to record the number of times each quest was expanded vs. started. Quests that capture one's interest are selected, as opposed to simply being viewed (expanded). Because the 3D GameLab system recorded the specific behavior of expanding a quest, this data could be leveraged. An expanded quest was only recorded once per session, per quest, per user reducing the possibility of skew. Figure 4-9 shows the difference between a collapsed and expanded quest.

Quest Description: Collapsed | Quest Description: Expanded

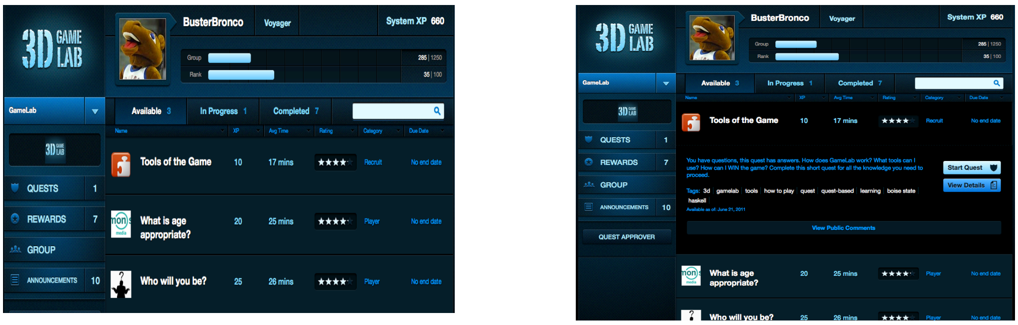

Figure 4-9. Collapsed and Expanded Quest Screenshots. Shows the quest menu (left) in its collapsed state as a list of possible choices showing only quest icon, name, experience points, average time to complete, user rating, category, and due date. Selecting and clicking the quest expands the selection (right) and includes a brief description, tags, prerequisites (not shown), access to public student comments, and the "start quest" button, which moves the quest from available to in progress.

During normal interaction with the quest menu, users would need to expand a quest to glean more information before starting it. A quest that was expanded, viewed, and started demonstrated student interest. As part of the chosen definition, this was deemed attractive to that student. Conversely, a quest that was expanded, viewed, and not started evidenced a lack of interest. After viewing the details of a quest, a student who elected not to start it translated as a lack of interest. This serves as the rationale behind the interest score.

<u>Interest score</u>

The interest score is shown as a ratio of selected quests over those that were just expanded and viewed. Rather than a ratio, a conversion percentage (of expanded to started) was generated expressed as a decimal value. As such, it can be calculated, compared, and more easily leveraged. The formula for calculating interest is found in Fig. 4-10.

$$Interest = \frac{Quest\ Started}{Quest\ Expanded\ View} = .454$$

Figure 4-10. Formula for quantifying quest "interest" or the initial attractiveness of the quest as evidenced by selection with the intention to complete.

The interest score is valuable for capturing quantitatively the initial interest and attractiveness of the quest. In essence, this binary decision to select or not select can be made multiple times by the same user and can influence the overall interest rating. It does not specifically identify characteristics that were highly influential in the attractiveness. Such evaluation of multiple characteristics independently can only be seen through data mining and evaluation after cluster analysis. These will be discussed more thoroughly in the section describing paired attraction clusters and taxonomy clusters.

Interest score does not align or appear to correlate with the movement of experience points, average time, or user rating. Specific relationships will be highlighted in future sections.

Quest Attraction: Completion

The attractiveness of a quest can also be quantified by its ability to hold the students interest. Thus, sustaining one's efforts can be quantified by quest *completion*. As a learning management system and educational approach fixed on the principle of student choice, participants were not required to complete quests once they had selected them. If a quest proved too difficult, time-consuming, or uninteresting, the student could "drop" it in favor of another, more attractive quest. It is also possible that students could select a quest and complete the winning condition of the course without completing quests that they had selected. As referenced at the beginning of this chapter, students left an average of 3.41 quest unfinished each.

Completion Score

The tool recorded each occurrence of quests being selected, dropped, or left unfinished. This allowed for the generation of a completion score. At course completion (or student "win"), the number of completed quests were divided by the sum of active, dropped, and completed quests to generate a conversion percentage. This is quantified using the formula in Fig. 4-11 and is expressed as a decimal value.

$$Completion = \frac{Quest\ Completed}{Active + Dropped + Completed\ Quests} = (i.e.).812$$

Figure 4-11. Formula for quantifying quest "completion" or the attractiveness of the quest as evidence by its completion.

Quest Attraction: User Rating

User rating could serve to quantify meaningful and personally relevant learning experiences. It could also be used as a means of characterizing the quality, ease, or brevity of a quest. The difficulty of using this rating as an indicator of overall attractiveness is evident. The rating that students give quests is not tied to any criteria or guidelines and thus is problematic to correlate to specific characteristics and comes at the end of the quest completion process. While a high user rating *may* be indicative of attractive characteristics, it is difficult to know if it will influence future decisions.

Rating Score

At the completion of a quest, students are asked to rate the quest using a five-star system (lowest = 1 star, highest = 5 stars). No additional information or rubric is offered. The primary purpose of this step is to provide an aggregate score, in stars, to other users. The students also report completion time for the purpose of an aggregated average completion time visible to other users and comments available to potential users.

As the rating was delivered after attraction to the quest would have occurred, it is not a reliable variable for consideration. It is possible that a student's experience with a quest would influence the likelihood that they would select a quest with similar characteristics. However, user navigational data was not available for this participant group to adequately run decision tree analysis. This would be necessary to determine if a highly rated quest influenced the decision to select, attend, and complete quests with similar characteristics. As such, only the first two variables, user interest and completion, for rating attractiveness were included. User rating is discussed but not included in the analysis of characteristics.

The user experience cannot be expressed in the same way as the interest score and completion score, as a conversion percentage. It is the **μ** of values selected between one and five. In order to express it similarly, as value between .001 and 1, it is necessary to divide the average user rating by the possible rating of 5 as seen in Fig. 4-12.

$$Experience = \frac{User\ Rating}{Rating\ Possible\ (5)} = .922$$

Figure 4-12. Formula for quantifying quest "experience" or attractiveness of the quest as evidenced by user rating.

<u>Cluster Analysis</u>

Cluster analysis was performed utilizing SAS Enterprise Miner version 6.2. As previously described, quests that were mandatory, created by students, and those that were part of a specially designed project were removed from the pool subject to the analysis. This removed five quests making the total number of quests subject to analysis 66.

The cluster analysis yielded three distinct cluster groupings represented by different types of data. Each informs the results in different ways. These unique cluster analyses are presented in the following order.

- **Interest and completion score clusters**: Quests were clustered into three equal groups using the interest and completion scores referenced in the previous section. When combined, they are described as "Paired Attraction" clusters.
- **Text-mining clusters**. Following the coding and tagging of quests by characteristics, analysis yielded 8 unique clusters. As they support

the creation of a taxonomy, they are referred to as “taxonomy clusters” when leveraged against other results.

- **Numerical data clusters**. These three clusters were created using a quest’s numerical averages including completion time, rating, interest score, completion score, comments, etc.

Interest and Completion Cluster Groupings

Interest score and completion scores were calculated and quests organized sequentially from high to low. Quests were then clustered into three groupings representing clusters of high, mid, and low in both areas of measured attractiveness. Each cluster contains 22 quests. Quests clustered by interest score are referenced as high interest (HI), mid interest (MI), and low interest (LI). Quests clustered by completion score are referenced as high completion (HC), mid completion (MC), and low completion (LC). Interest and completion clusters, the sample size, and score ranges of each are displayed in Table 4-9.

Table 4-9. Cluster Organization

Cluster Sizes and Ranges				
	Interest		Completion	
	N	Score Range	N	Score Range
High	22 (HI)	.86 to .52	22 (HC)	1 to .987
Mid	22 (MI)	.50 to .34	22 (MC)	.985 to .901
Low	22 (LI)	.33 to .02	22 (LC)	.893 to .428

Cluster Alignment Problems

The problem with a single variable is that it does not adequately describe the attractiveness and thus does not identify attractive characteristics. The following tables show the problems using one score or cluster to glean the characteristics of attractiveness of quests. Each of the tables corresponds with the top 10 requests identified in the sections above.

Focusing solely on the cluster of quests with a high interest (HI) score as they indicator of attractiveness could be simple and concise. However, when the same quests are viewed with completion cluster group and rating average, doubts emerge as to their validity as solely attractive to users. This is described in Table 4-10. While the quest “Social Software Links” was rated highest (HI), its completion score was rated in the mid cluster (MC). Focusing on the tags of the interest score indicator alone would not yield an understanding of attractive characteristics with any degree of confidence.

Table 4-10. Comparison of High Interest Score Cluster

Quest Name	Interest	Rating	Completion
Social Software Links	HI	4.62	MC
Tech Savvy	HI	4.14	HC
Social Software Presentation	HI	4.55	HC
Slidefest Presentation Videos	HI	4.48	HC
Voki Builder	HI	4.71	MC
M & M Spreadsheet	HI	4.59	MC
Social Software Webpage	HI	4.56	HC
How to WIN EDTECH202	HI	4.26	HC
Fundraiser	HI	4.39	MC
Portfolio: About Me	HI	4.48	HC

Note: Reflection quests were removed from consideration. The mean for user rating was just below 4.5 (**μ** = 4.48, SD= .29). With this standard deviation, *high* quest rating (highlighted in green) was defined at any rating above +1 SD above the mean or ≤ 4.77 and *low* quest rating (highlighted in red) at below -1 SD above the mean (≥ 4.19). Quests rated within this range (< 4.19 & > 4.77) were classified as Mid (highlighted in yellow) Quests with fewer than 10 completions were also removed.

When quests were sorted by completion score, the top quests look very different. When compared to interest score and user rating, the same concerns listed above are evident. The quest “Games: Lesson” is in the high cluster for completion (HC) but in the low cluster for interest (LI). Both Table 4-11 and Table 4-12 show the inconsistencies when compared to clustering.

Table 4-11. Comparison of High Completion Score Cluster

Quest Name	Completion	Interest	Rating
Video Producer	HC	HI	4.63
Games: Lesson	HC	LI	4.63
Social Software Presentation	HC	HI	4.55
Portfolio: About Me	HC	HI	4.48
Portfolio: Future Goals	HC	HI	4.33
Portfolio: Role of Technology	HC	HI	4.32
ADA Letter	HC	HI	4.28
Changes in the "Intrawebs"	HC	LI	3.8
Blogger	HC	MI	4.27
How to WIN EDTECH202	HC	HI	4.26

Table 4-12. Comparison of High User Rating against Score Cluster

Quest Name	Rating	Interest	Completion
Build a WebQuest	5	LI	MC
Camtasia Walkthrough Video	5	LI	LC
VoiceThread Explorer	5	MI	LC
Presentation Resources Demo	5	LI	LC
uStream Presentation	4.86	LI	LC
SMART Lesson	4.83	LI	HC
SMART Teacher	4.83	MI	MC
Games: Player	4.77	MI	LC
Games: Learner	4.75	MI	LC
Voki Builder	4.71	HI	MC

The comparisons, illustrated in Tables 4-10, 4-11, and 4-12, help to exemplify the need to focus on the characteristics of quests that are in high clusters for more than one attractor area. Because of the previously described inaccuracies or inconsistencies with user rating as a means of identifying attractiveness to participants, it was not considered in the clustering.

Paired Attraction Clusters

For the reasons listed above, using a single high cluster (HI or HC) to identify and data mine the characteristics of attractiveness was problematic. Combining the attraction clusters into pairs allowed the identification of quests, and their characteristics, that qualified as both HI and HC. Table 4-13 is a matrix of nine combinations of both interest and completion clusters. These paired attraction score clusters directly address guiding research question #4, "What design variables contribute to the attractiveness of a quest evidenced by user selection, completion, and user rating?" User rating was not included as previously stated. These paired attraction clusters were utilized for further data mining. Table 4-14 shows the distribution of the paired attraction clusters by the number of quests in each.

Table 4-13. Paired Attraction Clusters

		Completion		
	Cluster Pairs	High	Mid	Low
Interest	High	HI-HC	MI-HC	LI-HC
	Mid	HI-MC	MI-MC	LI-MC
	Low	HI-LC	MI-LC	LI-LC

Table 4-14. Distribution of Paired Attraction Clusters

		Completion		
	Cluster Pairs	High	Mid	Low
Interest	High	14	7	1
	Mid	3	11	4
	Low	5	4	13

Table 4-15. Taxonomy Clusters

Cluster	%	Freq.	Tags
1	15%	10	bullet, heading, +game, + blogger, blog
2	3%	2	hyperlinks, + image, + accent, + text, + task-based
3	5%	3	embedded object-interactive, Voicethread, evaluation
4	15%	10	wiki, portfolio, Google site, digital text
5	11%	7	Tutorial, + procedure, hyperlinks spreadsheet, + task-based
6	27%	18	Content, + resource, video, + embed, context,
7	15%	10	word, processing, word processor, + goal-based, Google
8	9%	6	presentation software, + presentation, + goal-base, + accent

Attractiveness of Task-Based vs. Goal-Based

With regards to goal-based versus task-based quest design, quest identified as task-based generated higher ratings over goal-based design in average interest score

(0.49, +.19), average completion score (.92, +.07), but remarkably a lower user rating (4.38, -.25). The inference is that task-based quests that identified and defined the steps to completion were more attractive to students as evidenced by their interest and completion. However, students rated the goal-based quests over those that were task-based. These details can be found in Table 4-16.

Table 4-16. Comparisons of Goal-based and Task-based Quest Attractiveness

	Values			
Row Labels	N	Avg. Interest Score	Avg. Completion Score	Avg. User Rating
Goal-based	21	0.30	0.85	4.63
Task-based	45	0.49	0.92	4.38
Grand Total	66	0.43	0.89	4.46

Text-mining Clusters (Taxonomy Clusters)

Text-mining clusters were created using the results of tagging of quests in the 5 characteristic categories listed previously. They did not, however, inform an understanding of which characteristics were either more or less attractive. Paired attraction clusters identified attractiveness of quests but did not identify characteristics within those quests. Individually, the different clusters are instructive. However, combining the paired attractiveness clusters and the taxonomy clusters in Table 4-17, it was possible to see patterns of distribution.

Table 4-17. Taxonomy Cluster Quest Distribution by Interest and Completion Paired Clusters

Clusters	HI-HC	HI-MC	HI-LC	MI-HC	MI-MC	MI-LC	LI-HC	LI-MC	LI-LC	Total
1				1	2	3	2		2	10
2	1			1						2
3	1					1		1		3

4	6	3			1					10
5	2	2			1			2		7
6	3	2	1	1	2	3			6	18
7					2	1	2	1	4	10
8	1				3		1		1	6
Total	14	7	1	3	11	8	5	4	13	66

Table 4-17 helps to identify quests and their distribution across both sets of clusters. A detailed investigation of these quests aids to isolate characteristics, and other additional considerations might be made about their attractiveness. For example, reviewing some of the LI-LC quests and Tag Cluster #6 revealed that several were a specialized quest (ISTE Wildcard #1-5) offered near the end of the course, which might not have been necessary for completion. These considerations including identification of attractive characteristics are detailed below. The primary findings are presented. Only those tag clusters identified as instructive are described.

Tag Cluster #4

Focusing on quests belonging to HI-HC, Tag Cluster #4 had the highest individual distribution. Notably, the same tag cluster identifies 3 HI-MC and 1 MI-MC quests totaling 10 quests. As such, Tag Cluster #4 represents the highest rated grouping and contains no low rated quests. This cluster was focused on quests identified as using a wiki, specifically Google sites, to create digital text for the student portfolio.

All quests in this cluster were associated with the completion of the portfolio, which was necessary to “win” the course, but not required. All required quests were removed from cluster analysis. Each represented a possible puzzle piece for the completion of this culminating project. Other quests contained digital text creation but only those in Tag Cluster #6 were specific to the culminating project.

Tag Cluster #6

Although Tag Cluster #6 did have 6 HI it had the same number of LI-LC quests. An additional six quests were spread across the distribution. This can be explained in the following way. The quests “Slidefest Presentation Videos,” “How to WIN EDTECH202,” and “Video Producer,” were attractive (HI-HC). However, “Peer Review,” “Shock to the System!,” and “uStream Presentation” were not (LI-LC). Three of the low rated LI-LC quests were from the set of five “Wildcard” quests, which rely on participants to find meaningful and relevant work created outside the class and connect it to existing standards. Both groups belonging to Tag Cluster #6 contained embedded video and resources, both thought to be more attractive than text alone. It is evident that other characteristics may influence the attractiveness of embedded video.

Quests focusing on word processing tools did not appear attractive to students. As evident when comparing Tag Cluster #7 with the pair attractor clusters, quests pertaining to word processing skills or tools had among the lowest attraction by way of interest score (LI). None of the quests in this cluster scored in the high interest grouping (HI). The two quests rated HC were associated with a specialty group, “Game Rules” and “Game Design Document,” of quests only attempted by 2 students. Removing these two quests from consideration, Tag Cluster #7 failed to demonstrate attractiveness scores of HI or HC.

Tag Cluster #7 and #8

Both clusters represented less attractive values in both interest and completion. Cluster #7 (N=7) included quests that utilized word processing tools while cluster #8 (N=10) focused on presentation software. Both clusters were mid to low interest and completion with one exception.

Attractiveness in Categories

Categories were a characteristic assigned to groups of quests to address their role in the course. Categories were preselected by the instructor when preparing the course materials. Often, quests in a category were delivered en mass to students at a predetermined XP or rank. Others were adaptively released through a "pearl chain" of prerequisite quests as a form of organization. Similar to sections or modules in a traditional course organizational structure, categories organized toolsets into related quests. Categories like word processing, spreadsheets, and presentation software were offset by less traditional, more emerging tools like Portfolio, Web Tools, and Context (the "how" and "why" of teaching with technology). Table 4-18 shows the distribution of paired attractiveness clusters by category.

Table 4-18. The Distribution of Paired Attractiveness Clusters by Category

Category	HI-HC	HI-MC	HI-LC	MI-HC	MI-MC	MI-LC	LI-HC	LI-MC	LI-LC	Total
Context	2	1			1	5	2	1	6	18
Portfolio	7	2								9
Presentations	2				2		1			5
Spreadsheets		2			1			1		4
Web Tools	3	2	1	3	5	3		1	5	23
Word Proc.					2		2	1	2	7
Grand Total	14	7	1	3	11	8	5	4	13	66

While the categories Word Processing, Spreadsheets, and Presentation utilized the Microsoft office suite including Word, Excel, and PowerPoint as primary productivity tools, other tools were available for students to select.

Quests featuring presentation software tools like PowerPoint, Prezi, and SmartBoard were the most attractive of these three categories of software tools to students as evidenced by interest and completion score clusters as seen in Table 4-15. Presentation software quests also offer the broadest range of tools, rather than the Microsoft and Google productivity suites alone.

The quests “Social Software Presentation” and “Slidefest Presentation Videos” both ranked HI-HC while ”Cyber Dangers PPT/Prezi” and “Back to School Presentation” both ranked MI-MC. Only the “SMART Lesson” quest received a LI-HC, which dealt with the use of the classroom smart board in view of the rest of the class. It was the highest user rating of any of the presentation category quests with 4.83. This may have influenced the initial interest of class participants because of the public nature of this quest.

Quests featuring spreadsheet tools were not as attractive as other characteristics to students. The category Web Tools were more likely to capture a student’s interest as evidenced by the interest score and showed 17 of 23 quests with being in the HI or MI clusters.

Numerical Data Clusters

The cluster analysis performed using the numerical scores of individual quests produced three clusters.

Table 4-19. Numerical Data Clusters

Clusters	Completion time	User Rating	Drops	Expansions	Comments	Completion Interval	XP	Interest score	Completi score
Cluster1	46.52	4.75	4.26	75.78	12.70	84.88	54.13	0.32	0.81
Cluster2	22.00	3.80	5.67	197.33	16.33	48.00	38.33	0.17	0.79
Cluster3	33.93	4.34	12.5	164.80	62.43	142.38	51.00	0.51	0.95
Total	37.77	4.46	9.35	135.26	43.00	118.05	51.52	0.43	0.89

While the cluster analysis of the numerical data did produce three distinct clusters, detailed analysis was not conducted due to time constraints.

Predictive Modeling

The goal of this study was to identify the characteristics of attractive quest-based learning, and results from data mining through cluster analysis were instructive.

As the research utilized large amounts of user behaviors, additional tools and techniques were employed to seek to further identify patterns otherwise invisible.

Predictive modeling is a data mining technique utilized in marketing, the sciences, and, most recently, education to determine the likelihood that subjects or conditions will influence outcomes (Fayyad, Piatetsky-Shapiro, & Smyth, 1996b). For the purposes of this study, decision tree analysis was run to develop predictive models based on key characteristics. These characteristics were numerical in nature and did not include results from text mining or clustering.

Analysis was run using multiple characteristics, including quest completions, quest comments, quest starts, interest score, quest expansions, quest rejections, completion interval (the amount of time from the selection of a quest to completion, not average time), quest drops, average time (time reported by users), user rating, and quests left active.

Each decision tree displays the point at which a specific data value is more or less likely to lead to the distribution. Figure 4-13, taken from the decision tree analysis for completion rate, demonstrates this. In this example, the "average" displayed in the branch box indicates the average completion score while the "count" indicates the number of quests in this branch of the distribution. Below, the thick line leads to the left branch showing quests with less than 4.5 quests left "active" (N=30) had an average completion rate of .98 while those greater than 4.5 quests left "active" (N=15) averaged a completion rate of .89.

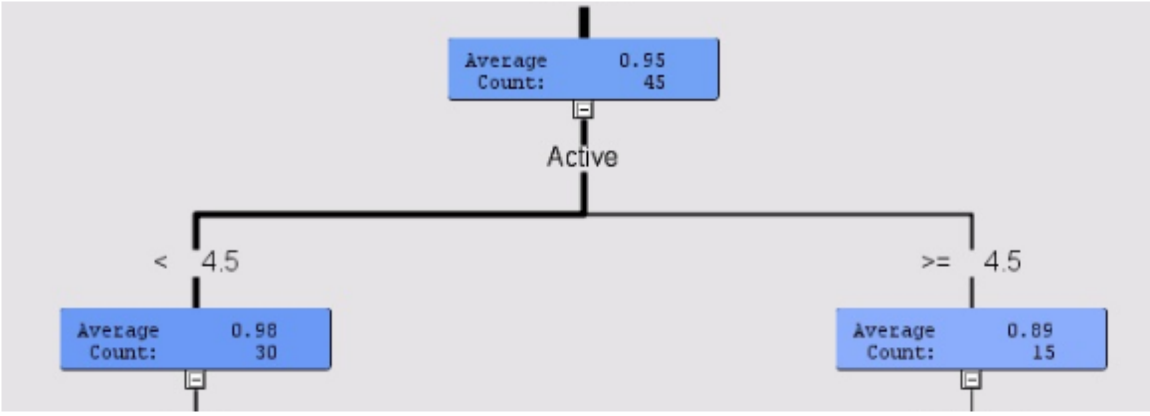

Figure 4-13. Decision Tree Analysis of Completion Score.

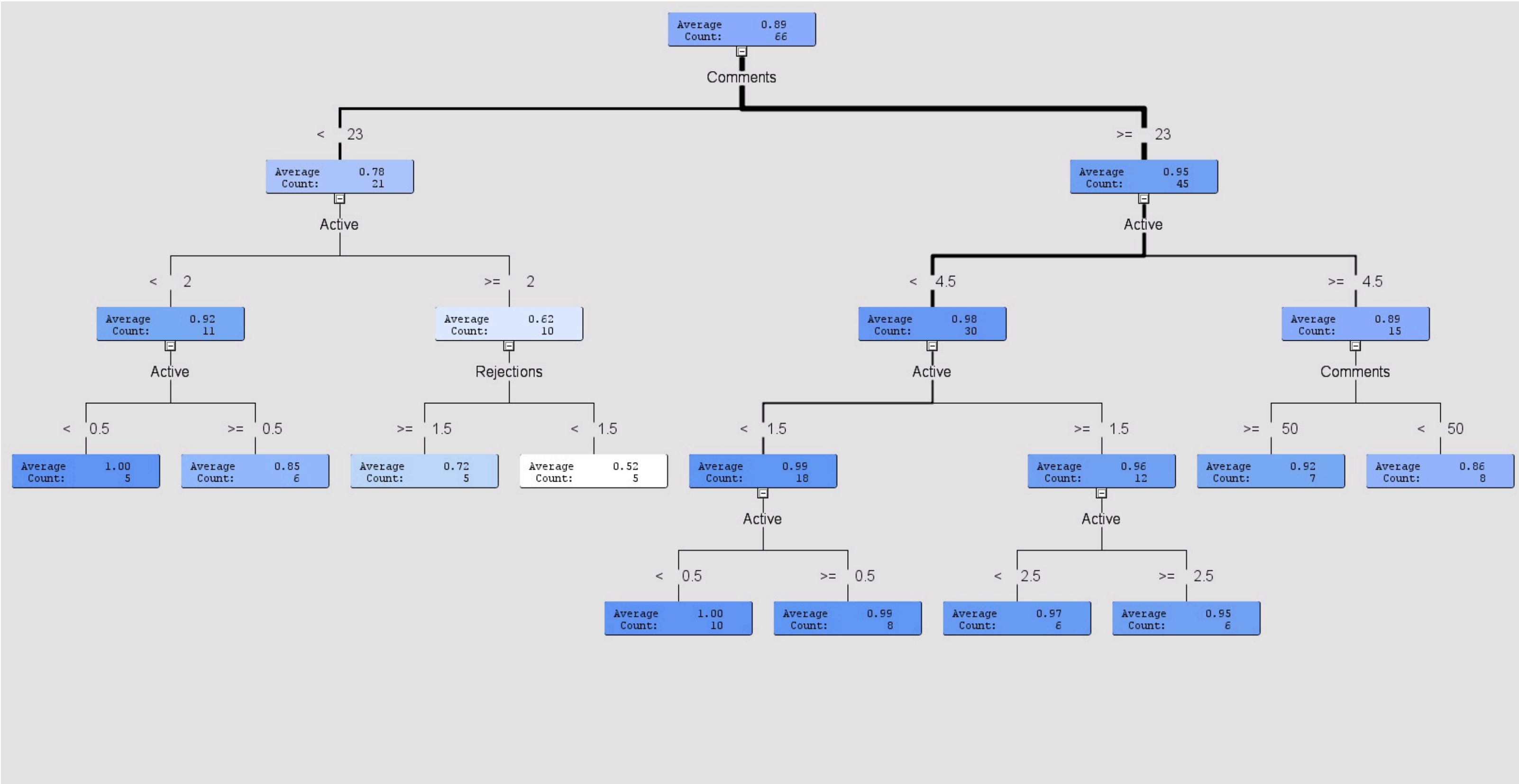

Figure 4-14. Decision Tree Analysis of Interest Score.

Decision Tree Analysis of Completion Score

The decision tree analysis in Figure 4-14 shows both the characteristic and point of leverage with which different factors influence the final outcome. In the first branch of the decision tree, it shows that comments (left by students at the completion of quests) greater than or equal to 23 represent an important characteristic in the high completion score, a measure of attractiveness. The higher completion rate of .95 (N=45) exemplifies this condition. The distribution of these 45 quests (with an average completion score of .95) continues down that branch of the decision tree.

Line thickness in the decision tree shows the path toward the highest predictable path. At the next point in the right branch, the defining characteristic becomes the number of quests that were left "active" at the completion of the course.

Predicting Completion

The decision tree shows high completion rate can be predicted by quests that have more user comments (>=23) and are less likely to be left active (<=4.5 avg.). In this circumstance, large numbers of user comments do not make a quest more attractive as the comments are left after quest completion. However, quests that elicit fewer comments may represent evidence that they will be less attractive. The opportunity to leave comments is available in all completed quests. Quests with low comments are less attractive. This predictive rule remains true as it continues down the tree. It can be possible to predict this based on the number of comments.

Decision Tree Analysis of Interest Score

Predictive modeling of attractiveness by interest score showed that expansions play a key role. Quests with the highest interest score (**μ**=.76, n=7) were expanded (clicked to see more details) fewer than a 123.5 times compared to those expanded more than 123.5 times (**μ**=.61, n=8). Additionally, quest's expanded more than 160.5 times by the participants demonstrated a lower interest score (**μ**=.44, n=17). Figure 4-15 shows the results of decision tree analysis of interest score.

Average completion time below 49 minutes (**μ**=.37, n=24) demonstrated a lower participant interest score. As such, some quests with an average completion time of 49 minutes or less were more attractive, as evidenced by interest score, than those over 49 minutes.

Predicting Interest

The decision tree shows high interest score can be predicted by average time reported. Quests with an average time less than 49 minutes had a higher average interest score (.37) than those greater than 49 minutes (.17). This was evident in quests completed by fewer than 61% of the students. It is possible, if expansions were not considered as a data point in the analysis, that average time might have also played a factor in quests completed more than 62 times.

Decision Tree Analysis of User Rating

An investigation of the decision tree analysis of user rating shows a strong relationship and predictability to user rating. As such, user rating is most likely to predict user rating. For this reason, further analysis is not warranted.

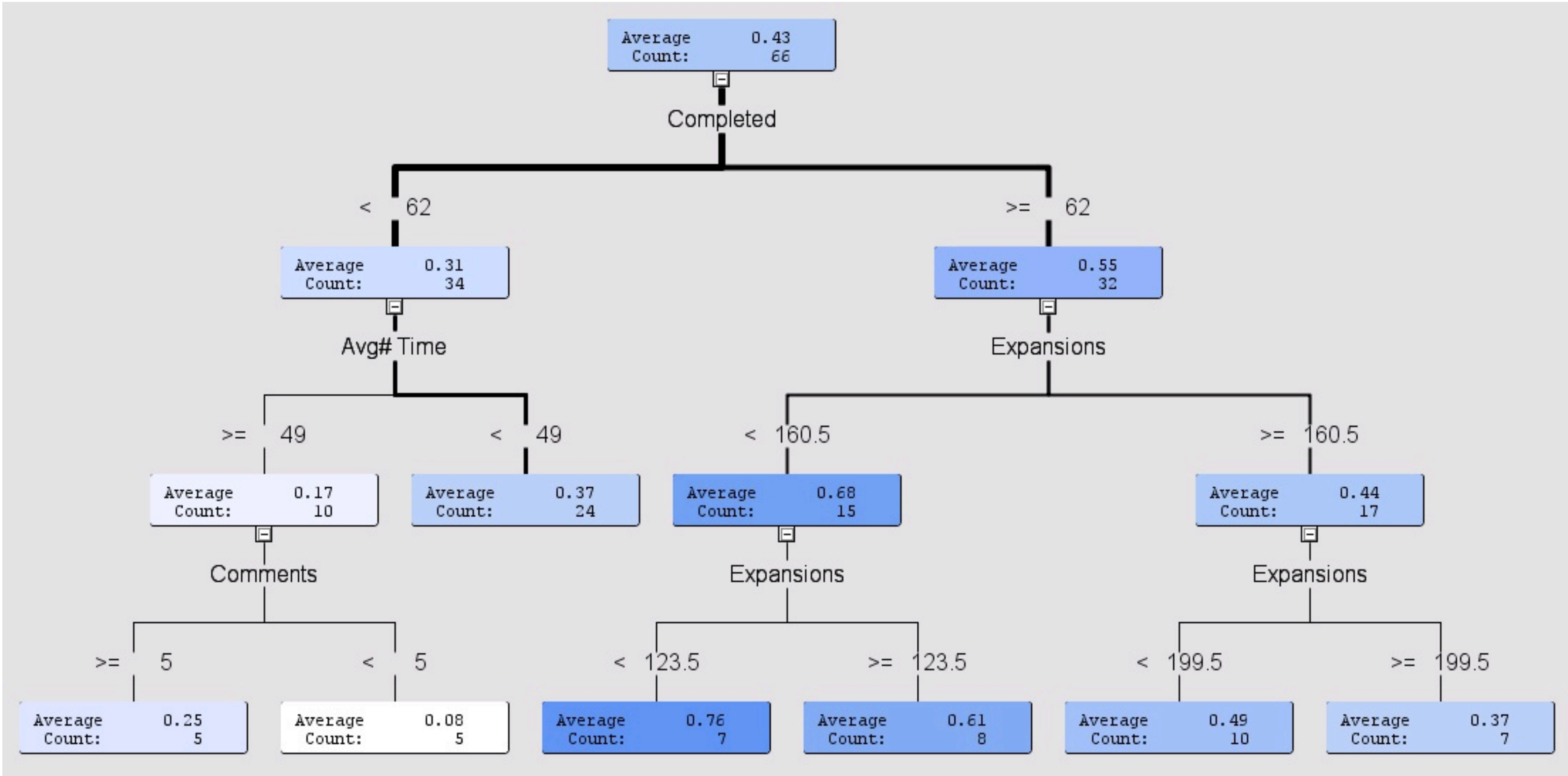

Figure 4-15. Decision Tree Analysis of Interest Score.

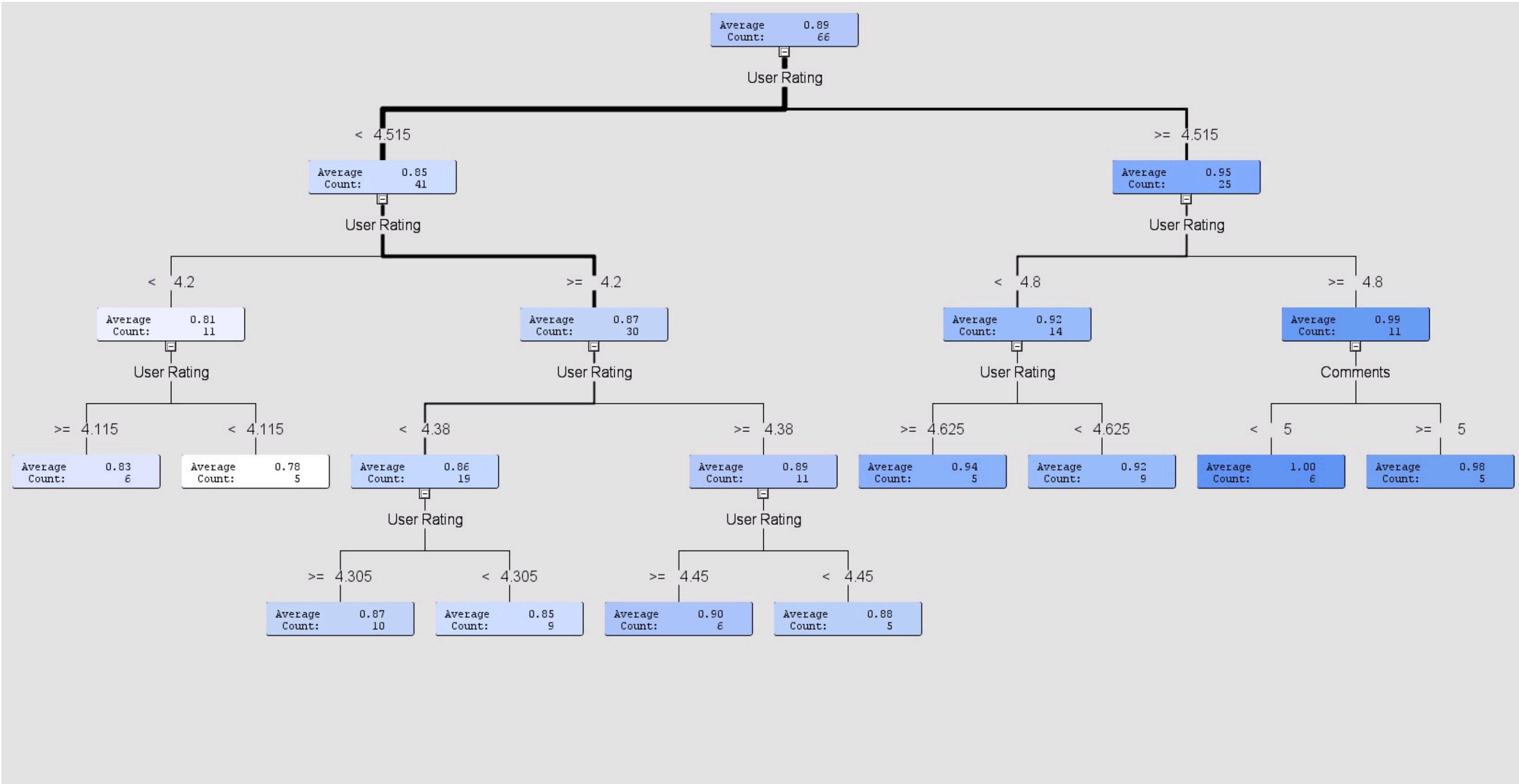

Figure 4-16. Decision Tree Analysis of Interest Score.

Conclusions

This chapter has attempted to answer the primary research question, “What are the design variables of attractive quest-based learning?” Results of data mining and analysis reveal that certain characteristics can influence the attractiveness of educational quests in the 3D GameLab environment to students. Specifically, quest attraction was measured in the areas of interest as evidenced by the students’ desire to select it, and completion as evidenced by the students’ desire to complete it. It also identified quest characteristics that were less attractive to participants. Chapter 5 discusses these results and their implications on future quest-based learning design.

CHAPTER 5

IMPLICATIONS

This chapter offers a summary of the research including conclusions drawn from Chapter 4 of the associated data analysis. It offers these results based on the three primary research questions. This chapter also discusses the direct and indirect implications of the findings on the development of educational quests and quest-based learning design. Finally, it suggests areas for further study and investigation.

Research Questions and Discussion

This section organizes and delivers the results of the data analysis explicitly while using the primary guiding research questions as a framework.

The research identified some design variables that contribute to the attractiveness of a quest evidenced by user selection and completion. This was shown through the motivation of students to select and complete them. User rating was referenced and considered as a descriptive variable but not as a tool for quantifying attractiveness for the purpose of identifying characteristics. The primary research questions that guided this study included: 1) What characteristics are common in those quests most selected by students in a quest-based learning environment?, 2) What characteristics are present in those quests that are completed?, and 3) What characteristics exist in quests more highly rated by students?

These questions were investigated by studying quests designed in the 3-D GameLab quest-based learning platform and were restricted to those characteristics that could be controlled and quantified. Primary guiding questions related to the overarching research question are listed below.

Guiding Question #1

The research was able to answer primary guiding question: 1) What are the characteristics of educational quests as they currently exist in the 3D GameLab? Quest analysis, that utilized new and a priori coding, produced 73 separate characteristics in 5 categories: Knowledge objects (14), organizational features (6), goal-based/task-based (2), digital tools (28), and deliverables (23).

The most common characteristics used in knowledge object construction included text (in 65 quests), hyperlinks (32), and video tutorials (12). Organizational characteristics of quests included accents like bold, italicized, or underlined text (40), section headings (37), and bullets and numbering (31). The combination of these two categories of characteristics created a uniform design, with many quests displaying a similar visual layout.

More than two thirds of the quests followed the task-based design principle, which focuses on a specific set of detailed procedural instructions to yield a specific product. 45 of the 66 quests selected for this analysis were task-based. The remaining 21 quests were identified as goal-based, which describe a general final product without explicit instructions (McGreal, 2004). Goal-based quests allow for student freedom and creativity (Charsky, 2010; Sullivan & Mateas, 2009).

A number of digital tools were employed in quest design that participants interacted with. The most commonly occurring of these tools were Google Sites (22), blogger (11), spreadsheets (9), word processors (8), and games (7). Participants also had the opportunity to interact with other web-based digital productivity and creativity tools including Voki, Voicethread, Youtube, Vimeo, Skype, uStream, Animoto, Cinch, and others.

Quests included a broad range of student deliverables, or product options. The most common were reflections (16), various forms of digital text including blog posts (13), embedded or linked objects (7), and other digital documents including spreadsheets, presentations, videos, etc. In all, 23 different deliverable types were available.

The implications of these findings show that the characteristics of quest-based learning design include a relatively broad set of variables. Rather than relatively minimal set of characteristics, the quests utilized in this study contained a variety of media, design, tools, and deliverables.

As such, it is possible for quest-based design to offer flexibility to both teacher and learner based on need, mandate, and/or preference. While the guiding question was to determine the breadth of these characteristics to identify variables for data mining, an unintended realization was that quest-based design can offer a wide variety of choices and combinations. This can contribute to the attractiveness.

Guiding Question #2

After identifying what characteristics existed, the research was able to identify commonly occurring characteristics to support the identification of a taxonomy. The research was able to address and answer question 2), What is the taxonomy of quest characteristics (including combinations) currently used in the test group? A total of eight taxonomic clusters were reported as a result of cluster analysis. These clusters are detailed below.

- Cluster #1 (N=10 quests, 15% of total quests) was comprised of quests where students interacted with the game and reflected on that experience using a blog. Quest designs and layouts consistently utilized headings and bullets, among other design elements.
- Cluster #2 (N=2, 3%) included only text, images, accents, and hyperlinks and asked the student to produce a text-based product.
- Cluster #3 (N=3, 5%) used VoiceThreads as a means of both interaction and deliverable.
- Cluster #4 (N=10, 15%) focused on the creation of portfolio elements utilizing digital text in their Google Site portfolio page.
- Cluster #5 (N=7, 11%) were tutorial and procedure-based quests to assist students in developing stylized spreadsheets.
- Cluster #6 (N=18, 27%) included text content, resources, videos, and other embedded objects to information didactically. These quests were all found in the Context category.
- Cluster #7 (N=10, 15%) was associated with the creation of word processor documents.
- Cluster #8 (N=6, 9%) utilized presentation software to both learn about and create presentations.

Although many quests contained unique characteristics, all fit into one of these taxonomic clusters. Analysis of these clusters show that #4 and #6 were the most attractive while #7 and #8 were the least attractive to students. The characteristics of these taxonomic clusters and their attractiveness based on detailed analysis will be discussed as they relate to guiding questions 4 and 5. All implications associated with these clusters and their attractiveness will be addressed in that section.

Guiding Question #3

Originally, the hope was to differentiate the taxonomies further with guiding question 3), What different types of quest construction (goals, activities, tools, deliverable, organization) exist? However, guiding question #1 and #2 provided the necessary data to understand the types of quests, characteristics, taxonomy, and quest construction that existed within the sample set. The research and subsequent data mining and analysis sufficiently rounded out the understanding in this area.

Guiding Questions #4 and #5

The final two guiding questions address the variables of attractive quests design. The research contributed to the answer of question 4), What combinations of variables produce more attractive quests visible through learner selection, completion, and rating? It also provided evidence for question 5), Based on qualitative and quantitative measures, which design variables are most likely to contribute to the attractiveness of a quest, and thus, learner selection, completion and rating? As they are related, answers to both guiding questions are paired below.

Task-Based Design Is More Attractive

Attractive quest design favors a task-based design approach in that students are more likely to select quests that offer a clear path to completion. The data showed that task-based quests were more attractive than the goal-based quests by being more likely to capture the students interest and sustain their efforts to completion. Task-based quests contained tutorial videos, step-by-step instruction, and utilized procedural content.

Students rated the goal-based quests more highly, however. Because of the nature of the 5-star rating system, it is unclear whether this score is indicative of quest design, tools used, deliverable type, goal-based/task-based design, or any number of other variables. A quest pool that contains both task-based and goal-based versions of quests might be a valuable future consideration.

Further text mining and decision tree analysis in this area might yield additional tags and characteristics of task-based and goal-based quest design worthy of investigation. The depth of this study did not allow for a more direct comparison or clustering by participant. The possibility exists that certain participants might favor goal-based over task-based quests. These patterns were not available in this research design.

<u>Quests Contributing to the Final Product are Attractive</u>

Interactions suggest that participants were attracted to quests related to portfolio creation, which served as the final product of the course. These quests were built around the creation of pages for a personal learning portfolio utilizing Google Sites. Each quest asked students to produce digital texts and reflections using the wiki features of the site.

Quests associated with the portfolio were clustered with those of high interest (HI) and high completion (HC). These HI-HC pair clusters containing quests include "Reflection: Fundraiser Spreadsheet," "Reflection: Standards Update," "Portfolio: Future Goals," "Portfolio: Role of Technology," "Social Software Webpage," "Reflection: M&M Spreadsheet," and "Portfolio: About Me." In fact, all quests in the "Portfolio" category were presented in the HI cluster and all but 2 in the HC cluster.

The remaining two were in the MC cluster, both were reflection quests. None of the Portfolio category quests were included in either the LI or LC clusters.

The implications are that educational quests that are connected directly to a final product are attractive both in high initial interest and high completion scores. Quests that might be viewed by students as clearly representing progress toward the winning condition, as “jewels in a crown,” may be more attractive.

Embedded Video Doesn’t Automatically Make Quests Attractive

While some of the most attractive quests did contain embedded video, even more quests with mid to low attraction scores also contained embedded video. The characteristic of embedded video alone did not lead to quantifiable student attraction. While embedded video may support attractive quest design, other characteristics related to the video may also impact attractiveness.

The study had no way to identify or catalogue the quality, length, or number of video elements embedded in a single quest. It is possible that a single, high impact, professionally produced video would be more attractive than a number of variable combinations of video design and implementation. It is also possible that different types of video content might be attractive to different students. This could be a compelling area of future research in quest-based learning design.

Web Tools are Attractive

Students selected quests that utilized unique web tools like VoiceThread, Cinch, Prezi, Voki, iPod touch, uStream, Blogging, Aris, and other web-based and app-based productivity and creativity tools. However, not all of the quests that were quickly and easily selected were completed with the same regularity. Many continued to be attractive after selection while others were not. The study showed the use of

Web-based tools including those that are novel, interactive, embedded, or visually appealing can influence the initial attractiveness of an educational quest. But utilizing web tools does not assure the quest will remain attractive and compelling to students through completion.

Although the study design did not allow for differentiation of Web-based tool characteristics beyond tags, possible explanations for why some web tools lacked attractiveness through completion exist. It is possible that some participants found the Web-based tools initially attractive but difficult to use or understand. Experience with these types of web-based applications may also impact their attractiveness through completion as students may have a schema that can support their implementation and use.

Word Processing and Spreadsheet Quests May Be Less Attractive

Completion scores for word processing and spreadsheet related quests were lower than other categories. Tag cluster analysis showed other tools were more attractive to users. Independent of other quests, it is possible that these tools and their related quests would be attractive. However, in a learning environment where students may choose between activities, these were less attractive.

Other tools deemed more attractive by this comparison include video games, wikis, blogs, web-based presentation software, and web-based animation tools. Although these tools were not individually identified or clustered as part of the cluster analysis, they were present in many of the quests identified as more attractive through the analysis.

Comments Predict Attractiveness

Quest with higher numbers of user comments were more attractive by completion score. One implication is that attractive quest activities elicit more positive feedback and those that were less attractive did not. This information can be valuable to teachers and designers as formative evaluation in addition to user rating and comments. One implication is that it may be possible to utilize this information and data value in an algorithm, which draws attention to the quest beyond simple performance. Teachers and designers may benefit from an early warning to potential attractiveness of a quest. If necessary, an intervention could be put in place to increase the attractiveness of the quest.

Shorter Quests Garner More Interest

Decision tree analysis demonstrated that quests with a lower student reported completion time were more attractive in terms of initial interest. Quests averaging lower than 49 minutes in average completion time were more attractive than those that took longer. As a predictor of interest score, these results are instructive and offer meaningful inferences.

First, implications of these results offer a pedagogical consideration useful in the design of new curriculum. Designing quests that can be completed in shorter amounts of time are more attractive. Higher initial attractiveness is beneficial to students by increasing motivation. Teachers and designers who focus on shorter, more compact quests should see higher learner interest.

Second, these implications extend beyond the development of new curriculum. These findings also suggest one possible approach to revamping existing, possibly lower performing, quest-based curriculum. Quests that are larger could be broken into smaller, calibrated slices. These quests could then be organized in a short "pearl-chain." In this way, existing curriculum could be slightly modified to make it more attractive in terms of initial interest. Layered with other considerations, this initial interest could support overall attractiveness and effectiveness of an educational quest.

Importance of Findings

These findings are important for the advancement of our understanding of quest-based learning design. As previously referenced, student engagement is critical in the successful implementation of a curriculum (Ames, 1992; Boekaerts, 1997; Bronack et al., 2006; Dede, 2009; Eccles & Wingfield, 2002; Papert, 1998; Vaughn & Horner, 1997). Failure to attract a learner impacts student motivation and performance negatively. This section outlines the importance of these findings in terms of a student-centered focus, pedagogical considerations, and development potential of algorithms and other computer-based feedback systems.

Focuses design on learner attraction

A thorough review of this research should highlight to readers the importance of a student-centered approach to quest-based curriculum design. The ways in which learners interact with quests and learning activities has a direct effect on their likeliness to select and complete them. As such, student success is influenced by an individual students attraction to learning activities.

Although there is much that can still be gleaned from this and future research, savvy teachers and designers of quest-based curriculum would do well to consider how it will be received by their students. One of the broad important findings of this research is that quest attraction influences student success in varying degrees. Designing curriculum predicated on student choice, using a quest-based approach, requires the consideration of student experience and learner attraction to quests.

Pedagogical considerations

This research identifies the first known set of pedagogical considerations specific to quest-based learning. While not complete, these suggestions, recommendations, and approaches served to inform a growing community of quest-based learning teachers and designers. These pedagogical considerations inform the types of tools that may be more attractive to users. They identify types of media that may be effective in the construction of attractive quests including suggestions for methods to prevent it from becoming unattractive. This research provides descriptions of quest design as it exists in an active, successful curriculum. These details can be useful to designers in the development or modification of their own coursework.

Development potential of algorithms

As the system used to deliver quest-based learning is digital, these findings could serve to inform and instruct the development of algorithms to provide meaningful feedback in several areas.

Utilizing the results of the study, algorithms could be developed to predict student success based on the types of quests they individually find more attractive. Based on these results, algorithms could be designed to suggest quests to students based on their characteristics and various profiles created by student interactions. An individual student's interest score, completion score, and quest characteristics could be used to tailor quest content to create an approach to computer-mediated, differentiated instruction.

Algorithms could also be developed to monitor and influence quest success. Using results of this research, it would be possible to develop processes that would look for low performing characteristics. A quest-based system could then identify at-risk quests and possibly suggest pedagogical interventions to teachers and designers.

Potential Areas of Future Study

Characteristics of students who frequently drop quests might be a valuable area of future investigation. As referenced in Chapter 4, an average numbers of dropped quests indicate relative satisfaction. However, a number of outliers demonstrated a different experience. Investigating the behaviors, attitudes, dispositions, and outcomes of students who drop a high volume of quests may contribute to the understanding of effective quest-based learning design. Detailed user decision records would be necessary to conduct this research. Understanding this outlier behavior could be instructive and benefit all students.

Utilization of organizational characteristics like accents, section headings, and bullets and numbering may decrease the completion time of the quest by providing students a quest-based learning object that is less confusing. This research was not designed to answer this question but implications from other areas of attractive quest design suggest this possibility. A comparative study with several instructional message design principles applied to quest design could yield more knowledge in this area. As such, researchers could consider organizational elements and its effect on completion time and user rating in the future.

Text mining of user comments could also be a potential direction for future research related to user experience. While possible in the study, specific focus was paid to the quantitative results of user experience while the qualitative was set aside. Combining these in a mixed methods approach, utilizing text-mining strategies, may be a consideration for future investigation.

Goal-based vs. task-based Quests

One of the more intriguing areas for potential future research revolves around the results of goal-based and task-based quests. Task-based quests were identified as more attractive based on their combined interest and completion scores. These quests directed participants to complete a highly specific task, often with detailed step-by-step instructions, to produce an explicit product. Although these quests allowed for some personalization of the product, the outcomes were predetermined. Task-based quests yielded a higher interest and completion score compared to goal-based quests.

Despite the high quantifiable attractiveness of task-based quests, goal-based quests yielded a higher average user rating (4.63, +.25). Although user decision data indicated higher attractiveness for task-based quests, user rating fails to support this conclusion. A possible reason for this difference could include that quests that outlined a specific path to completion were initially more attractive but those that allowed for more creativity, choice, or less restrictive completion guidelines were, in the final analysis, more compelling or perhaps personally relevant and meaningful.

Another possible explanation is that a clear path to a specific outcome appears "easier" and thus less restrictive. Although an open, goal-based, outcome might be offer fewer restrictions, it does implicitly mandate creativity. It is possible that students viewed the need to be creative as "harder" than activities that mandated the steps. As previously stated, this may be a valuable area for future consideration.

It is important to note that user rating is not specifically an indication of popularity, preference, or quality. Users were not provided a rubric of how to rate request. Thus, reasons associated with rating are determined by the user. Future research could look at user rating more explicitly. Rather than an open ended, nondescript user rating, the system could direct students to rate specific characteristics of quests to help differentiate or explain these findings.

After the Winning Condition

As previously stated, the winning condition of the course being studied was 2,000 XP and a completed portfolio. Despite a clear and finite course completion, more than half of all students continued to complete quests. In fact, 55% of students who reached the winning condition submitted 200 XP or more worth of quests.

Several questions emerge about this phenomenon. Future research would do well to investigate the characteristics of quests selected by participants after they have reached the winning condition. Do students continue to complete quest because they are selecting activities they are interested in? Do they continue for competitive reasons? Understanding why students continue to complete quests when no longer compelled by the requirements of the curriculum could lead to more attractive and meaningful quest and curriculum design.

Differences by Demographics

Because demographic data was only used to describe the participants and not leveraged against the decision data, results of data mining were not differentiated by individual users. As such, the research design did not enable organization of findings by individual, gender, age, race, or other distinguishing participant characteristics. Future research would do well to include participant demographics for consideration in the data mining and analysis.

Continued research in the attractiveness of educational quest design could explore potential differences based on these demographic details. Do participants in different age groups find certain quests more or less attractive? Are the characteristics of attractive quest design different for men and women? As data mining and analysis is a powerful tool for identifying patterns not otherwise visible, utilizing demographic data as part of the process could serve to improve our understanding.

Differences by technology proficiency

Participants completed a technology proficiency survey at the beginning of the course for demographic description and course improvement. It may be possible to leverage this data to create a unique user technology proficiency profile. Individual preferences, tendencies, and aversions may influence the attractiveness of certain types of quests. Future research could consider a student's technology proficiency profile in the data mining and analysis.

This line of research could give way to the development of unique and meaningful algorithms leveraging student interest, quest attractiveness (by learner), and proficiency to direct or recommend quests and learning activities ideally suited to the individual. Similar algorithms could also serve to provide the instructor or designer with information about the alignment, or goodness of fit, between curriculum and learner.

Quest Load

Another potential area of future research could delve into the area of quest load. In the current quest-based delivery structure, it is possible for students to have large numbers of quests available to choose from. While the design attempted to make no more than 5 to 10 quests available at any one time, based on a user's individual path it was possible for as many as 21 quest to be available at a given time.

Natural questions arise: do large numbers of quests affect the attractiveness? Do too many quests results in loss of novelty? Future research could consider comparisons of available quests in attractiveness. For example, of the seven quests that were available, which characteristics were evident in those selected versus not selected?

As the results of decision tree analysis showed, user comments left at quest completion lead to positive outcomes. High completion score is predicted by high numbers of student comments. One potential implication of this finding is that the system could prompt users of low performing quests, as evidenced by low comments, to answer the question "How could this quest be improved?" Identifying quests early by their low performing characteristics could serve to inform instructors and designers of curriculum. Acting on this knowledge, curriculum could be modified, enhanced, improved, or removed to improve the overall quest-based educational experience.

Using the results of this analysis, algorithms could be constructed within the system to allow it to look for and identify low-performing quests as evidenced by these predictors. Automated messages, in the form of a pop-up comment box, could collect information from the user and deliver it anonymously to the teacher or designer. This formative evaluation could serve as a real-time intervention to low performing or at risk quests.

Learning analytics

This research may serve to inform designers of quest-based learning analytics by developing profiles of both the user and quest characteristics. Identifying an individual's experience, preferences, tendencies, and gaps in knowledge and ability represents an exciting potential area of future research. Developing learning analytics and subsequent algorithms would be a valuable next step.

This could indicate a number of broadly different things including either dissatisfaction with quest options or use of the drop feature as a means of organizing ones workload. The data does not offer a clear explanation for this difference nor suggest inferences to cause. For this reason, dropped quests will not be specifically characterized as less attractive on this data alone.

Other Considerations

This section addresses the possible explanations of the research design and explores possible alternate explanations for some findings. Similar to previously identified limitations, the following could influence the direction of future research.

Although the age of the participants varied, the majority of students were near 20 years of age. The characteristics of this group may have limited or focused the results. Attributes, habits, and attitudes of young adult students may not be consistent with that of other age groups.

The participant group was composed primarily of college education majors, a unique group of individuals. As these students had completed more than 12 years of school, the expectations, interests, and motivations may be different from other users of quest-based course materials and design. Different subjects my have yielded different results. If the study had been conducted using middle school students, high school students, or other college majors, those groups may have identified with different attractive variables, although the diversity of teaching disciplines (English, Science, Music, etc.) may have had the same effect.

Depending on the progress and path of each individual, it is possible to have between 1-20+ quests available for selection at any one time. If the quest load is larger, it's possible that students may inspect large numbers of quests to select the most attractive. The larger the number of available quests, the more previewing or expanding of available quests may take place. This creates more quest expansions recorded by the system influencing the quest attractiveness score. Attractiveness scores, specifically for interest, for quests at certain high quest load points during the course may be influenced.

Certain points may also exist within the course where the quest load is higher for all participants, thus increasing the possibility that quests that appear within a certain XP or rank range are more likely to register a higher number of quests expansions, a critical variable for calculating quest interest. For example, when students reach the rank "Learner 3" an additional 10 quests are made available and visible. If a student has 10 or more available quests before this point, the number of possible quests to select from doubles.

In the same way quest interest score may be influenced by quest load and other factors, quest completion may be influenced by factors within the organization of the course. As students approach and reach the winning condition, quests that were attractive at the point of selection are no longer needed to complete the course. While some students may complete these previously selected quests, others may not. The decision to abandon or drop selected quests would have less to do with their overall attractiveness and more to do with need. Attractiveness scores, specifically for completion, for quests that become available near the end of the course may be influenced.

Finally, future research should consider the experience of individual students rather than just that of the whole group when possible. This research focused on the mean without consideration of standard deviation as a method for looking at diversity of experience. Future research designs would do well to consider and prepare to report the possibility of outlier experiences.

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APPENDIX

Technology Use and Proficiency Survey

1. Introduction

Your participation in this survey is strictly voluntary, and you must be 18 years or older to participate. You may skip any item or stop at any time. By completing the survey, you are consenting to participate.

For this research project, we are requesting demographic information. Due to the make-up of Idaho’s population, the combined answers to these questions may make an individual person identifiable. We will make every effort to protect participants’ confidentiality. However, if you are uncomfortable answering any of these questions, you may leave them blank.

2. Background

1. Please indicate the section/teacher/time of your EDTECH202 course.

- ◯ EDTECH 202 001 Haskell,Chris MW 10:40AM
- ◯ EDTECH 202 002 Haskell,Chris MW 2:40PM
- ◯ EDTECH 202 003 Haskell,Chris TuTh 12:15PM
- ◯ EDTECH 202 004 Haskell,Chris TuTh 1:40PM
- ◯ EDTECH 202 005 Seideman,Christine W 6:00PM
- ◯ EDTECH 202 006 Seideman,Christine Th
- ◯ EDTECH 202 4036 Wessel,Terrie Lynn
- ◯ EDTECH 202 4037 Slocum,Melissa Sue
- ◯ EDTECH 202 4038 Abrahams,Michelle Linda
- ◯ EDTECH 202 4039 Hampton,Brandon Wayne
- ◯ EDTECH 202 4040 Wessel,Terrie Lynn

*2. Select details that best describe you.

	Gender	Years out of HS	Program are you pursuing	Teaching emphasis	Computer usage
You...					

If you are a daily computer user, how many hours a day would you estimate you are on the computer?

3. Please list the city and state in which your high school was located.

4. High School Technology Use:

Please indicate the level of educational use IN HIGH SCHOOL of each of the following applications.

	Often(daily)	Seldom(weekly)	Occasionally	Never
Word Processing	◯	◯	◯	◯
Spreadsheet	◯	◯	◯	◯
Presentation Software	◯	◯	◯	◯
Database	◯	◯	◯	◯
Educational Software (Math Blaster, Wolf, Oregon Trail, etc)	◯	◯	◯	◯
Other	◯	◯	◯	◯

Other (please specify)

3. Usage

1. Communications:
How many hours a week do you spend in the following activities?

	Hours
Writing or reading email	
Social Networking (Myspace, Facebook, etc.)	
Photo Sharing (Flickr, Piccasa, etc.)	
Blogging (either reading or writing)	
Discussion Boards (reading or writing)	
Computer Text Chat (AIM, MSN or Yahoo Messenger, etc)	
Computer Audio Chat	
Computer Video Chat	
Mobile Phone Text Chat (SMS, MMS)	
Multi-user Online Meetings (video conferencing)	

Other (please specify)

2. Gaming:
How many hours a week do you spend in the following activities?

	Hours
Playing Computer Games (not online)	
Playing Computer Games (Online)	
Playing Console or Handheld Games/ Wii, Xbox, PS, DS etc (not online)	
Playing Console or Handheld Games/ Wii, Xbox, PS, DS etc (online)	
Virtual Worlds (Second Life, Club Penguin, VMK, etc)	
Mobile Phone Games	

Other (please specify)

3. Entertainment and leisure:

How many hours a week do you spend in the following activities?

	Hours
Surfing the Internet	
YouTube (Google Video, myspace video, or other video sharing sites)	
Internet-based Radio	
Listening to or Watching Podcasts	
Music (online or just through player)	

Other (please specify)

4. Proficiency

1. Please rate you skill using the following technologies.

	Very Strong	Strong	Average	Poor	No experience
File Management	◯	◯	◯	◯	◯
Word Processing (Word, Notes,etc.)	◯	◯	◯	◯	◯
Presentation software (Powerpoint, keynote, etc.)	◯	◯	◯	◯	◯
Spreadsheet software (Excel, Numbers, etc.)	◯	◯	◯	◯	◯
Database Software	◯	◯	◯	◯	◯
Internet	◯	◯	◯	◯	◯
YouTube	◯	◯	◯	◯	◯
Blogging/Discussion Boards	◯	◯	◯	◯	◯
Text Chat, Phone Chat, SMS, AIM, etc	◯	◯	◯	◯	◯
Email	◯	◯	◯	◯	◯
Social Networking (Myspace, etc.)	◯	◯	◯	◯	◯
Computer Gaming	◯	◯	◯	◯	◯
Console Gaming	◯	◯	◯	◯	◯
Downloading Music	◯	◯	◯	◯	◯