SIMTEACHER: SIMULATION-BASED LEARNING IN TEACHER EDUCATION

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To my mother,

Shari Faith Fischler

(1942 - 1995).

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Abstract

The use of educational simulations may help bridge the divide between contemporary learning theories and traditional practices of instruction. The research literature suggests that successful simulation-based learning largely depends on the instructional design principles behind the simulations. How instructors effectively use well-designed simulations with students, however, is less clear. An original simulation for teacher education (SimTeacher) was created based on contemporary learning theories. Three instructors at a major southwestern university used the simulation in their teacher education courses within a span of four semesters. Qualitative data was collected through interviews and observation. Instructors decided on their extent of involvement based on their teaching style, objectives, technology skills, and available time. The study provides a detailed look at the issues, concerns, failures, and triumphs of instructors using SimTeacher in their courses. In addition, a unique perspective was provided from student feedback after simulation use. The study results suggest that adding an advanced technological tool like an educational simulation will have little effect on learning unless it is integrated well into the curriculum. Specifically, instructors who facilitated "social practice" by (a) using structurally rich storylines and by (b) blending simulation use with classroom discussions reported the most success with simulation-based learning in teacher education.

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Chapter 1: Introduction

Most college classrooms provide safe learning spaces where students develop abstract understandings of a subject. Unfortunately, a dearth of opportunities exists for students to apply these abstract concepts in real-world settings (Roschelle et al., 2000). As a result, students tend to learn concepts for the sake of classroom exams rather than for real-world application (National Science Foundation, 2003). Even worse is that most exams consist only of multiple-choice questions and occasional open-ended or short-answer essay questions. These standardized tests have become so routine that many students find comfort in their ubiquity. Sadly, these exams are often the only vessels available for students to apply newly learned concepts (Jonassen, 2002).

Although such exams may tell instructors how well their students memorized information on a short-term basis (Cheaney & Ingebritsen, 2005), they are poor indicators of how well students internalized the material for practical use (Sternberg, 1997). Educational simulations could help college students practice theory while providing instructors with a better means of authentic assessment.

Potential for Educational Simulations

Educational simulations allow students to learn by acting within virtual environments, immediately applying theory to practice in realistic yet controlled settings. Simulations may easily be added as a complement to standard pedagogical practice, *not* as a replacement. For instance, a simulation could be the *hands-on* activity for a lesson in the same way a lab section may supplement a lecture.

A new generation of simulations, capitalizing on advanced Internet and multimedia technologies, makes simulation-based learning (SBL) more economical and feasible than ever before (Lane, 2005; Sun & Lin, 2001). The adoption of SBL is predicted to grow at an epidemic rate within the next five to ten years (Bonk, Kim, and Zeng, 2005; Brennan & Kao, 2004).

Problem Statement

Despite its potential as an instructional tool, the academic merit of simulations for teaching and learning remains inconclusive (Rieber & Parmley, 1995; Swaak, Jong, & van Joolingen, 2004). The lack of empirical evidence may be related to the scarceness of good simulations themselves. Although there are many relevant pedagogical perspectives that legitimize simulation use (e.g., situated learning, constructivism, authentic assessment, problem-based learning, case-based learning, and computer-assisted instruction), few educational simulations are available.

The education market has yet to determine whether instructors would use them if a rich variety of pedagogically supported simulations were provided. The research is sparse on how these tools might be used in practice (Asal, 2005; Trotter, 2004). Specifically, research on instructors' experiences with SBL would help educators better understand and prepare for successful simulation use.

Research Study and Questions

This study documents instructor use of SBL. Instructors' experiences before, during, and after simulation use were investigated. Sets of research questions were devised to particularly consider instructors' perspective, procedural, technical, and outcome issues of simulation use.

Perspective issues

What were key factors instructors considered in their decision to use the simulation? For example, what were their expectations, goals, and motives before using the simulation? What prior experience and knowledge did they have regarding simulation-based learning and was that a factor for success? How was success determined?

Procedural issues

How was the simulation used? Was it an in-class or out-of-class activity? How did it accompany the course material? Was the simulation used primarily as a learning tool or an assessment tool?

Technical issues

What resources of the simulation were most or least used, and why? For example, why did instructors choose particular activities, how did they use them with their students, and how effective were they? Were there aspects of the simulation's design or feature-set that helped or hurt its efficacy as a learning tool?

Outcome issues

Was SBL effective? How so? Did instructors feel it was more advantageous than (or complementary to) other methods of instruction? What could instructors point to or look at to suggest that their students learned anything from using the simulation?

These areas will be addressed in this dissertation by examining instructor experiences individually as well as collectively.

Study Overview

The purpose of this study was to examine how instructors used educational simulations in their courses. First, the related research literature is reviewed. Contemporary learning theories are described that support the use of simulation-based learning. A sample of simulations currently available is also provided. Second, the research methodology is described, including the study's rationale, participants, and assessments. There is a comprehensive description of the simulation tool developed for the study. Third, the results are discussed in light of related research. Fourth, implications are suggested for future educational simulation use and research.

Chapter 2: Literature Review

The literature review will examine four areas: (1) how contemporary learning theories relate to simulation-based learning, (2) how instructional video games differ from educational simulations, (3) examples of educational simulations, and (4) the Tigerlake Project as a precursor to SimTeacher.

Contemporary Learning Theories

Many traditional instructional strategies, such as the heavy reliance on textbook materials or canned lectures, encourage inert knowledge at best (Bransford, Franks, Vye, & Sherwood, 1989). These antiquated modes of instruction, with their corollary dependence on standardized testing, provide students with minimal conceptual transfer to real world scenarios and deprive them of spontaneous problem-solving opportunities (Bransford, Franks, Vye, & Sherwood, 1989). This section will explain how simulation-based learning offers an alternative strategy of instruction that is supported by many contemporary learning theories.

Traditional practices of instruction

The old-fashioned conception of education defined teaching as an act of knowledge *transmission* and learning as an act of knowledge *acquisition*. Professor David Jonassen at the University of Missouri is perhaps one of the most outspoken challengers of this outdated view. Jonassen believes that learning is activity-based rather than content-based. Teaching practices that overvalue the memorization of information, Jonassen (2002) claims, is preventing learners from developing the practical knowledge and problem-solving skills needed to excel in the world.

Many educators purport that a deep intellectual comprehension can only be built upon an experimental foundation (Kolb, 1984; Lane, 2005). According to Windschitl (1999), students learn best when they solve real problems, critically discuss issues with peers, and see the big picture rather than assemble a collection of facts. Without an opportunity to apply theory to practice, students accumulate book-knowledge without acquiring the skills to utilize it. Knowledge without application lacks depth. Many concepts have theoretical and practical sides to them that need to be explored simultaneously to develop a more complete, deeper comprehension (Roschelle et al., 2000). Educational simulations value active learning, problem solving, and many other pedagogies endorsed by modern educational researchers.

Research on simulation-based learning

Most studies on the effectiveness of simulation-based learning (SBL) compared SBL to expository instruction (de Jong & van Joolingen, 1998). Furthermore, many of those studies could be described as a comparison between expository instruction with a simulation component and expository instruction without a simulation component. Some studies found that a simulation component produced favorable results (Grimes & Willey, 1990), whereas other studies found no difference when using a simulation (Carlsen & Andre, 1992; Chambers et al., 1994). A third set of findings projected mixed results (Rieber & Parmley, 1995).

A meta-analysis of research studies on simulation use may appear incoherent since simulations may have varied in features, been poorly developed, utilized different technologies or media formats, and had unclear goals for pedagogical outcomes. Salomon (2000) reminded educators that different technological means, if powerful enough, would produce a diversity of outcomes rather than varied results of attaining the same end. Therefore, it may not be constructive to measure SBL outcomes using the assessments designed for more traditional modes of instruction.

Lainema and Nurmi (2006) assert that simulation use may encourage tacit knowledge, which is qualitatively different than factual knowledge. The knowledge distinction has been referred to as having the "know what" (or being book-smart) versus having the "know how" (or being street-smart) (Zibit & Gibson, 2005). Tacit knowledge may be best measured by tests that require learners to apply their knowledge in new situations -- in other words, tests of knowledge application and transfer (Sternberg, 1997). Studies that have solely relied on factual knowledge tests to measure simulation results have likely contributed to the inconclusive research findings on SBL.

<u>Learning theories related to SBL</u>

There are a number of contemporary learning theories that offer additional insight to the application and results of simulation-based learning. Depending on the simulation’s design and use, an SBL approach may incorporate a number of pedagogical strategies, including:

1. *Authentic assessment (Lainema & Nurmi, 2006)*.
2. *Situated learning* (Harley, 1993; McLeelan, 1993; Young, 1993).
3. *Discovery learning* (de Jong & Van Joolingen, 1998).
4. *Constructivism* (Bonk & Cunningham, 1998; Duffy & Cunningham, 1996).
5. *Cognitive apprenticeships* and expert-novice relationships (Rogoff, 1990).
6. *Learner-centered principles* (APA, 1997).
7. *Case-based learning* (Barnett, 1991; Byrick, 1998; Williams, 1992).
8. *Problem-based learning* (Albanese & Mitchell, 1993; Lloyd-Jones, Margetson, & Bligh, 1998; Schauble, Klopfer, & Raghavan, 1991).
9. *Computer-assisted instruction* (Taylor, 1980).

All of these approaches advocate placing learners within authentic settings (whether simulated or actual), in order to (a) explore their surroundings, (b) pursue inspired lines of inquiry, (c) identify and define problems, (d) research using additional resources, and (e) provide justified solutions. While simulation-based learning appears most closely related to *problem-based learning, case-based learning,* and *computer-assisted instruction*, all of the contemporary theories reviewed in this dissertation individually support simulation-based learning to some degree.

Authentic assessment

In authentic assessment, students perform a task under realistic conditions and their performance is evaluated. Authentic assessment provides not only an indication of what a student knows, but also insight into the student's ability to apply that knowledge.

Since using computers for assessment is generally not a disadvantage for students (Stephens, 2001), computer-based simulations may easily be adapted to allow students to demonstrate their proficiencies. While simulations provide real-world scenarios, students may be assessed by how well they solve typical problems in the field. Even though the scenarios are simulated, the narrative complexity still encourages students to react using higher-order thought processes and fosters an expert grasp of material (Lainema & Nurmi, 2006). If needed, computer-based educational simulations may include more traditional methods of assessment (e.g., multiple-choice quizzes) in addition to realistic scenarios.

Lainema and Nurmi (2006) described how authenticity can be applied to e-learning environments by (a) using tools that provide realistic and complex models of reality, (b) offering continuous problem solving and meaningful learning, and (c) embedding social experience in the learning process. They developed an authentic learning environment, called "Realgame" (see http://www.realgame.fi/index2_eng.php), for business students. With authenticity as a guiding principal, Realgame provided training sessions rich in detail and realistic in how transactions were processed. The sessions also necessitated collaborative efforts of small groups working as business teams. Performance was evaluated by video taping the students' decision-making and through post-game interviews. Realgame is one example of how authentic assessment can be incorporated into SBL.

Situated learning

The concept of "situated learning" fundamentally assumes that knowledge derives from experience (Harley, 1993; McLeelan, 1993; Young, 1993). In other words, theories and methods should be taught in the context of the real world if we want students to internalize them and apply them after graduation. Research on situated learning supports this theoretical basis for student participation in a professional environment (Kneebone et al., 2005).

A core principle of the American Distance Education Consortium (ADEC, 2002) is that learners need to be actively engaged through hands-on, concrete experiences. Students learn by doing as well as through analogy and assimilation. Simulation may be used to relate lessons to real-life experiences (ADEC, 2002). Educational simulations can provide a realistic context in which students can practice solving meaningful problems. If learners participate in authentic tasks, situated learning can occur in realistic simulations (Thomas & Milligan, 2004). Knowledge gained from such simulations may offer much more transference to real-world situations than traditional textbook learning (Lane, 2005).

Discovery learning

Jerome Bruner noticed in the 1960s that much of classroom instruction was prepackaged and merely guided students through a series of procedures for learning activities. Bruner argued that learning is more meaningful to students if they are able to discover and solve problems on their own as they learn about a topic. Not only would this foster problem-solving skills and reasoning abilities, but students would also become better self-learners. Swaak, Jong, and van Joolingen (2004) hypothesized that discovery learning through simulation use could be a better approach for fostering intuitive knowledge, while expository instruction may be a better approach for acquiring definitional knowledge.

De Jong and van Joolingen (1998) reviewed the effectiveness and efficiency of discovery learning in computer simulations. Specifically, they asked: "What are the problems learners have in discovery learning, and how can we design simulation environments that support learners in overcoming these problems?" (p. 180). They found that learners encounter challenges at various steps of the discovery learning process, including hypothesis generation, experimental design, and the interpretation of data.

De Jong and Van Joolingen (1998) suggested instructional support to overcome these problems. Learners may generate better hypotheses if asked to list a number of plausible hypotheses before experimenting. The learner could receive hints during the design phase of experiments. Additionally, providing visual graphing software would dramatically help learners better understand their data. These suggestions would assist students during discovery learning, regardless of simulation use. At the same time, the suggestions could easily be implemented into simulation design as well.

Constructivism

Constructivist principles suggest that learning occurs when a student builds on his or her own knowledge about a topic. Students become authors of knowledge as they actively construct new ideas or expand on old ones (Bonk & Cunningham, 1998). Shepherd (2003) claimed that from a 100 years of research on adult learning, we know learners (a) want to be in control of the learning process, (b) prefer content that is relevant to their lives, (c) benefit when learning is enjoyable, and (d) like to learn through experience whenever possible. Therefore, classroom activities and schoolwork should be meaningful and motivating to the student; curriculum should not be inert or focused on the memorization of isolated facts.

According to constructivism, teachers should not try to be classroom controllers, but rather classroom facilitators of student learning. By facilitating, teachers assure that students are making progress and have the necessary resources to become self-learners (Duffy & Cunningham, 1996). Educational simulations can be designed to lead students through scaffolded instruction with realistic yet open-ended tasks. Furthermore, constructivists believe understanding comes from interacting with an environment that may challenge a previous understanding (Cheaney & Ingebritsen, 2005). Similarly, SBL activities may be designed to challenge students' understanding in this way.

Cognitive apprenticeships and expert-novice mentoring

Barbara Rogoff (1990) advocated cognitive apprenticeships, building on the idea of social constructivism. Social constructivism purports that learning is a social event; knowledge is constructed and exists within social interactions. During cognitive apprenticeships, two or more people work together to solve a problem or *think together* about a situation. In most cases, a novice learns from interacting with an expert.

If designed correctly, a simulation can provide both challenging situations and expert advice on how to react to those situations. Zibit and Gibson (2005) referred to this as "simulated apprenticeship." For example, a simulation can mimic a mentor and, congruent with the concept of scaffolded learning, gradually diminish its computerized support structures over time.

Apprenticeships in real-world situations are highly valuable since the best predictor of job performance is proficiency in tactical or practical knowledge (Sternberg, 1995). The praxis of apprenticeship in teacher education currently includes early field experience, pre-teacher practicum, and student teaching. Unfortunately, many of these apprenticeship systems have been criticized for their lack of structure, organization, or clear goals (O'Sullivan, 1990; Placek & Silverman, 1983; Taggart, 1988). Although most students perceive field experiences with their cooperating teacher as the most important part of their training, a poorly supervised experience can leave a student unprepared or uninterested in teaching after graduation (Dodds, 1985; Placek & Silverman, 1983).

Too often, cooperating teachers are solicited over the phone and are simply the first teachers who agree to participate (O'Sullivan, 1990; Strand & Johnson, 1991). Some students may observe questionable values and esoteric tricks of the trade from mediocre practitioners. However, the cooperating teachers are not necessarily at fault; colleges and universities must be held accountable for their teacher-education programs. In particular, college supervisors ought to visit prospective sites, meet with potential cooperating teachers, maintain a list of good candidates, spend time overseeing students in the field, and produce a field guide manual documenting common procedures with explicit expectations and objectives (Strand & Johnson, 1991).

Educational simulations of field experiences can offer unparalleled supervision. For example, simulated teachers may be programmed to model expert behavior. Bell (2001) acknowledged that the time is ripe to combine the powerful experience of role-playing to online environments. Furthermore, Hunt and Brent (1996) and Nicaise and Barnes (1996) point out that computer-based simulations for teacher preparation could not only help students apply concepts, but could also expose students to educational technology in action.

Learner-centered principles

The American Psychological Association published 14 principles for a Learner-Centered Approach (APA, 1997). As noted in Table 1, the principles focus on learners and the learning process, rather than on teachers, curriculum and instruction, or school administration.

COGNITIVE AND METACOGNITIVE FACTORS
1. **Nature of the learning process.** The learning of complex subject matter is most effective when it is an intentional process of constructing meaning from information and experience.
2. **Goals of the learning process.** The successful learner, over time and with support and instructional guidance, can create meaningful, coherent representations of knowledge.
3. **Construction of knowledge.** The successful learner can link new information with existing knowledge in meaningful ways.
4. **Strategic thinking.** The successful learner can create and use a repertoire of thinking and reasoning strategies to achieve complex learning goals.
5. **Thinking about thinking.** Higher order strategies for selecting and monitoring mental operations facilitate creative and critical thinking.
6. **Context of learning.** Learning is influenced by environmental factors, including culture, technology, and instructional practices.
MOTIVATIONAL AND AFFECTIVE FACTORS
7. **Motivational and emotional influences on learning.** What and how much is learned is influenced by the learner's motivation. Motivation to learn, in turn, is influenced by the individual's emotional states, beliefs, interests and goals, and habits of thinking.
8. **Intrinsic motivation to learn.** The learner's creativity, higher order thinking, and natural curiosity all contribute to motivation to learn. Intrinsic motivation is stimulated by tasks

of optimal novelty and difficulty, relevant to personal interests, and providing for personal choice and control.

9. **Effects of motivation on effort.** Acquisition of complex knowledge and skills requires extended learner effort and guided practice. Without learners' motivation to learn, the willingness to exert this effort is unlikely without coercion.

DEVELOPMENTAL AND SOCIAL

10. **Developmental influences on learning.** As individuals develop, there are different opportunities and constraints for learning. Learning is most effective when differential development within and across physical, intellectual, emotional, and social domains is taken into account.

11. **Social influences on learning.** Learning is influenced by social interactions, interpersonal relations, and communication with others.

INDIVIDUAL DIFFERENCES

12. **Individual differences in learning.** Learners have different strategies, approaches, and capabilities for learning that are a function of prior experience and heredity.

13. **Learning and diversity.** Learning is most effective when differences in learners' linguistic, cultural, and social backgrounds are taken into account.

14. **Standards and assessment.** Setting appropriately high and challenging standards and assessing the learner as well as learning progress -- including diagnostic, process, and outcome assessment -- are integral parts of the learning process.

Table 1: Learner-Centered Psychological Principles from the American Psychological Association (APA, 1997)

With applied theory in mind, the principles emphasize psychological aspects of the learner and the contextual factors that may interact with those aspects. There are cognitive and metacognitive principles, motivational and affective principles, developmental and social principles, and principles related to individual differences. All principles should be viewed together to represent the learner holistically; no principle stands in isolation. The learner-centered psychological principles were intended to be used by anyone designing or implementing instruction, including those who develop educational simulations.

Case-based learning

Case-based learning (CBL) and SBL both allow students to learn about the practical side of turning knowledge into action. The case-based method used in teacher education, for example, familiarizes preservice teachers with the dilemmas and challenges that practicing teachers deal with every day (Williams, 1992). Well-written cases can involve students in complex, authentic situations that encourage them to think like practitioners (Bennett, Harper, & Hedberg, 2002).

Cases can promote knowledge transfer and cognitive flexibility to better prepare students for service after graduation (Barnett, 1991). However, narrative vignettes with linear storylines may not be enough to engage students. Asal (2005) notes that simulations are like case scenerios with the addition of "active doing." While case scenarios allow students to briefly identify with the main character, the text is not interactive.

In educational simulations, though, role-playing activity is interactive and can be extended over time, making it a more intimate experience than cases (Burke, 2004; Roschelle et al, 2000). Extended simulations (i.e., over a series of weeks) may encourage personally meaningful problem solving. Also, a simulation can be restarted with a new strategy whereas a case study cannot (Baset & Scott, 2004).

Despite the similar aspects of role-playing and simulation-based learning, Bell (2001) identified ways they differ. In role-playing activities, participants often improvise facts or events and receive only sketchy information about their role. They may also be encouraged to think in ways that vary significantly from their normal selves in order to adopt the perspectives of the characters they are playing. Role-play may be understood, at best, as a subset of simulation. It is less complex and not as involved. Whereas role-play may allow participants to 'act out' *their* idea of reality, a simulation takes it a step further by providing a virtual reality system for participants to operate within (Bell, 2001).

Simulation-based learning could immerse participants within an environment for weeks or months. During this time, participants themselves become the main characters. (Note: Examples of these environments are provided in the section entitled "Educational Simulations Today.") In such settings, learners are more likely to remember and apply new knowledge as compared to text-based cases alone (Williams, 1992). With cases, students study a problem from the outside in, whereas, with simulations, they study a problem from the inside out (Asal, 2005).

Although most educational simulations place students within a somewhat controlled and predetermined environment, unexpected problems and confrontations could still surprise learners. SBL, therefore, can breathe new life into CBL content by adding interactivity and a more immersive environment.

Problem-based learning

If case-based learning (CBL) critically examines *past* solutions to a situation, problem-based learning (PBL) explores *new* solutions (Bennett, Harper, & Hedberg, 2002). As with CBL, research findings in PBL have much to offer educational simulation developers. See Table 2 for common characteristics of PBL from Lloyd-Jones, Margetson, and Bligh's (1998) revisit of Barrows' (1986) taxonomy of PBL methods.

Four educational objectives: • The development of clinical reasoning • The development of self-directed learning skills • The importance of learning to structure knowledge for use in clinical contexts • The increased motivation dependent upon the first three objectives
The most significant variables upon outcome are: • The type of problem • The learning sequence • The degree of self-directed learning • The assessment procedures
To achieve the stated objectives of the strongest variant (namely, closed-looped or reiterative PBL): • Problems should be functionally appropriate • Problems should be delivered before any other learning materials • Teacher direction should be minimized • The full range of objectives rather than only factual content must be assessed
The degree of teacher or student direction is judged by: • The timing and availability of ancillary information • The freedom with which students are allowed to pursue their own lines of inquiry

Table 2: Common characteristics of problem-based learning (Barrows, 1986; Lloyd-Jones, Margetson, and Bligh, 1998)

For example, embedding realistic problems within simulated scenarios can provide excellent opportunities for student learning. Carefully placed problems, or *triggers*, can initiate or direct meaningful exploration by students.

The two types of PBL triggers are at opposite ends of a continuum (Lloyd-Jones, Margetson, & Bligh, 1998). A "problem-solving trigger" is an ill-defined problem placing students in a decision-making, action-oriented situation. It relies on everyday problem solving using heuristic guidelines. Clinical reasoning is emphasized. "Narrative triggers," according to Lloyd-Jones, Margetson, and Bligh (1998), rely neither on problem solving nor role-playing. Like the Socratic method, learning occurs through inquiry as students encounter carefully placed *clues* that indicate what should be learned. Either by trial-and-error manipulation or by reacting to an urgent and unresolved situation, learners become actively engaged in an educational simulation when triggers are embedded within the design.

Simulation developers may also find PBL research on hypotheses generation useful. Before solving problems, students need to hone their ability to problem-find and ask the right questions to generate sound hypotheses. The level of problem-finding detail is important as well. Detailed problem identification indicates a deeper understanding of the field of study, which may lead to successful hypotheses addressing the multiple facets of problem-laden situations. Many students intentionally underdevelop their hypotheses to reduce the chances of being proven wrong (Klahr, Fay, & Dunbar, 1993; Klayman & Ha, 1987; van Joolingen & de Jong, 1993).

Furthermore, when confronted with a problem, students too eagerly focus on creating a desirable outcome, bypassing the necessary time to fully understand the problem. Schauble, Klopfer, and Raghavan (1991) have called this phenomenon “the engineering approach,” when learners overly concentrate on aspects of the problem that are likely to be resolved promptly. When ill-defined factors and anomalies do not fit into a tidy equation, students either ignore them or demote their importance when trying to solve problems.

One possible reason that many students offer low-level solutions to problems is that they lack prior knowledge. Providing students with relevant information at the right time can be critical to their success (Berry & Broadbent, 1987). Furthermore, Leutner (1993) found that relevant information provided only before a problem occurrence was not as effective as having the information permanently available. Other studies (Chambers et al., 1994; Dunbar, 1993; Klahr & Dunbar, 1988) show that most students fail to change their hypothesis after their experimentation leads to disconfirming evidence. Chinn and Brewer (1993) found that learners ignore or incorrectly interpret anomalous data in an effort to retain original hypotheses. On these occasions, the hypothesis drives the interpretation of data.

Simulations may prompt learners to avoid these pitfalls. Learners could be asked to explicitly identify existing problems (or the remaining facets of a problem) at any given point. Learners could also be asked to reconsider their hypotheses when problems are not being solved or when new information surfaces. PBL has been widely acknowledged as a powerful approach to teaching and learning. However, instructors were probably hard pressed to find a way to use PBL in their courses before simulation tools matured and became so widely accessible (Begg et al., 2005).

Computer-assisted instruction

Computer-assisted instruction (CAI) is, essentially, the use of educational technology. CAI previously let learners navigate through computer screens with graphics and text in a non-linear manner at their own pace. CAI now offers learners the ability to create content, collaborate through social interaction, and practice their understanding of a discipline within a simulated environment.

Taylor (1980) classified instructional technologies into three categories: tutor, tool, and tutee. *Tutor* programs are designed to teach subject matter to the user. Computer *tools* allow the user to run analysis, organize information, or create quality products with ease. In *tutee* environments, the user “teaches” (i.e., programs) the computer to behave in a defined way. Though it was helpful to utilize these categorical distinctions a quarter century ago, it is not unusual for current educational software to embed elements of all three technologies. Today's CAI takes many forms (e.g., Web-based learning, distance education, e-learning, instructional technology, etc.) and affords more non-linear, dynamic, and learner-centered possibilities than ever before.

Sonwalkar (2001) proposed a "learning cube" framework for understanding how multimedia assets could correlate with learning styles. A cube, naturally, is three-dimensional. On one dimension, Sonwalker placed six different media: (1) text, (2) graphics, (3) audio, (4) video, (5) animation, and (6) simulation. Text was the lowest form of media and simulation was the highest form of media. On a second dimension, there were five learning styles: (1) apprenticeship, (2) incidental, (3) inductive, (4) deductive, and (5) discovery. Apprenticeship was listed as the most basic learning style, requiring a step-by-step procedural model of instruction, whereas discovery was the most complex learning style, necessitating interactive exercises or simulations where students learn by doing. Lastly, the third dimension was a scale of student-centeredness to teacher-centeredness. The cube as a whole displays the multidimensional nature of designing educational media to accommodate both the different learning styles of students and the different instructional approaches of teachers (Sonwalkar, 2001).

Until recently, bandwidth and programming language limitations restricted high-quality educational software to CD delivery. Web-based systems are now beginning to show CD quality results while adding the community aspect of the Web. For example, SecondLife.com shows the potential of highly immersive, Web-based systems. At SecondLife.com, users (called residents) vicariously live a second (i.e., alternative, fantasy) life through their identity in a 3D virtual world created by its (over 130,000) residents. Residents own their digital creations, and can therefore buy, sell, or trade with other residents using the Linden dollar, which can be converted to US dollars. Although this product was not built for educational purposes, it previews a possible direction of advanced technologies for teaching and learning.

The American Distance Education Consortium (ADEC, 2002) offered the following ten characteristics for Web-based teaching and learning.

1. Fosters meaning-making discourse;
2. Moves from knowledge transmission to learner-controlled systems;
3. Provides for reciprocal teaching;
4. Is learner-centered;
5. Encourages active participation in knowledge construction;
6. Based on higher-level thinking skills – analysis, synthesis, and evaluation;
7. Promotes active learning;
8. Allows group collaboration and cooperative learning;
9. Provides multiple levels of interaction;
10. Focuses on real-world problem solving.

Unfortunately, many of the popular Web-based courseware platforms do not support authentic forms of assessment nor do they support many of the other ADEC recommendations (Jonassen, 2002). As Bonk et al. (2005) pointed out, course management systems primarily provide ways to "manage" the administrative tasks of courses rather than provide tools for learners. Thus, these systems have been more teacher-centered than learner-centered.

However, well-designed online educational simulations can meet all of the ADEC recommendations. Simulations could not only facilitate classroom instruction, but can potentially assist self-learners in skill development or businesses with group strategic thinking as well (Lane, 2005).

Roschelle et al. (2000) identified four fundamental characteristics of computer-based applications that best enable children to learn: (a) active engagement, (b) participation in groups, (c) frequent interaction and feedback, and (d) connections to real-world contexts. When students play a passive role of receiving information, they often find it difficult to apply their learning outside the classroom (Roschelle et al., 2000).

Nonetheless, even with well-designed software, teachers cannot just position students in front of it, walk away, and expect students to learn (Begg et al., 2005; Thomas & Milligan, 2004). The educational value of many technology tools comes from not just the instructional design, but also how it is used in practice (Squire, 2002). In other words, it takes the marriage of instructional technology and effective pedagogy to produce triumphant results.

CBL + PBL + CAI = SBL

The instructional approaches described above share values and suggest practices that are not necessarily exclusive. Of all the approaches, SBL is most congruent to problem-based learning (PBL). Both SBL and PBL feature authentic tasks, ill-defined problems, multiple solutions, active learning, and seamless assessment as their most prized offerings. SBL and PBL emphasize participation followed by reflection (Byrick, 1998).

The affinity of SBL to case-based learning (CBL) and computer-assisted instruction (CAI) is also important. In fact, as diagramed in Figure 1, SBL might be best understood as interactive CBL narratives, adhering to a PBL model, delivered via CAI methods.

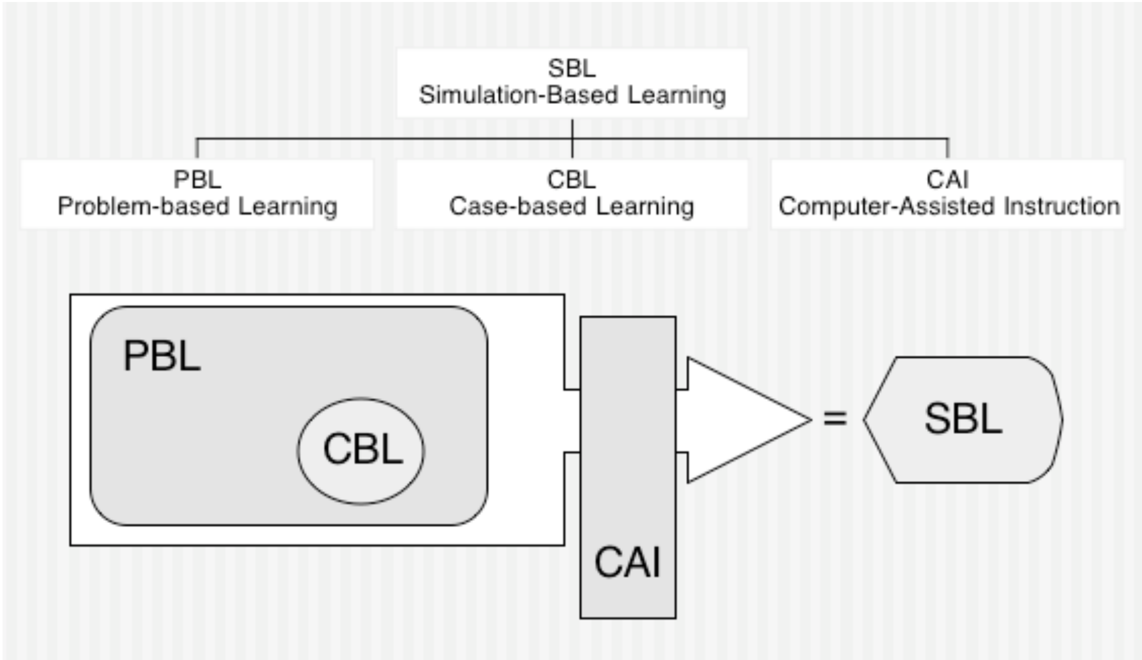

Figure 1: Online simulations conceptualized as interactive case-based narratives embedded within a problem-solving model and delivered through computer-assisted instruction.

The central difference between CBL and SBL is that SBL is interactive. This is no small detail. Interactivity allows students to assume ownership of the problem, adding meaning and responsibility to their participation. The result is superior performance and higher-level learning (Burke, 2004; Jonassen, 2002; Roschelle et al, 2000). An online simulation that only lets learners react to situations, but not act in them or interact with them, is no different than Web-delivered case studies.

Instructional Video Games

Many of today's simulations, especially commercially available ones, are targeted at the "gamer" audience. The player assumes the role of a professional athlete, vigilante with weapons, opponent in a fighting match, explorer in a fantasy world, or community controller. The "community controller" games (e.g., SimCity®, Civilization®, RollerCoaster Tycoon®) show the most educational promise, though still they often fall short of being well-designed instructional tools.

Many in academia advocate game-based learning (GBL) as a promising instructional approach (Gros, 2003; Kindley, 2002; Squire, 2002). This section will describe GBL as it related to SBL. Although the research literature frequently groups the two approaches together, a case is made here that they are distinctly different instructional approaches.

<u>Game-based learning</u>

Kindley (2002) distinguished between four levels of e-learning complexity. At the *Traditional* level, learning is deductive and amounts to nothing more than electronic page-turning. The next level is *Scenario-Based* and is designed to improve performance. Rather than simply displaying correct answers after a lesson, it supplies relevant information to learners during a lesson. Additionally, scenario-based e-learning utilizes images and sounds to engage users. Kindley described *Simulation-Based* as the third level of e-learning, where realistic modeling and decision making occurs. The fourth level is *Game-Based* and the most complex, requiring artificial yet elaborate environments with reward systems for making good choices or for quick motor skills.

It is true that good instructional technology uses interactive multimedia and that today's popular video games contain some of the most impressive displays of interactive multimedia (Prensky, 2001). It does not follow, though, that game-based learning must be inherently good. The so-called "gamer generation" does not need "edutainment" (Trotter, 2004) in higher education to keep interested and to learn. In fact, a dependency on games may actually conflict with learning.

Games versus simulations

The central difference between good educational simulations and good video games come down to their primary objectives (Gros, 2003). The objective of educational simulations is learning in a realistic setting, while the objective of video games is entertainment in a fantasy setting (Tapscott, 1998). Some products may blend qualities of both tools, but they are distinct products if they are good products. Many games are engaging because of their thrill factor, but schools can do without the pedagogy of thrill-based learning. Adding animation and multimedia to class lessons might provide more fun than education (Baset & Scott, 2004). Adding gameplay elements to a lesson may distract from or compete with the learning objectives (Aldrich, 2004; Asal, 2005).

Gros (2003) points out that gameplay changes when repurposed from an informal context to a formal one. When games are adapted to formal contexts for learning, new rules are applied to maximize the game's educational benefit. These rules often conflict with the game designer's intent. Educational simulation developer, Clark Aldrich, mentioned a problem often encountered when making existing games educational (Morrison & Aldrich, 2003).

> Many people who have tried to build educational simulations have used existing game genres as their starting point. But the more they got into the project and tried to change the game, the more they realized that the genre did not lend itself to educationally relevant content. [...] Designers will need to invent new, educationally oriented simulation genres. These new genres will be both similar to and different from computer game genres. (Morrison & Aldrich, 2003, p. 2)

In "serious games" for educational purposes, the learner does not have superpowers, realism preempts fun, and the experience could be perceived as boring if evaluated solely on its entertainment value (Dixon, 2006). A game designed to enhance one's thinking is not a game one plays for pleasure (Shaffer, 2005; Trotter, 2004). If a serious game or educational simulation is enjoyable, it is not because of its immediate goal but rather because the player identifies, understands, or is interested in its content (Shaffer, 2005).

Gros (2003) compared the differences between the top ten multimedia educational products (for primary and secondary school) to the top ten favorite games (of children and adolescents). The top ten educational products in 2000 were Multimedia world atlas, Clic Sinera 2000, Euroaventura, History of the World, The Adventures of Ulysses, Living in a Castle, Egypt, Rome, The Louvre, and The Time Machine. The top ten video games in 2000 were PC Futbol, PC Basket, Golf, Age of Empires, Sims, Harry Potter, The Pink Panther, SimCity 3000, Doom, and Racing Championship.

Gros (2003) concluded that these multimedia educational products were primarily designed on the basis of subject matter whereas the video games were designed around the players. Accordingly, Gros (2003) noticed the mismatch between game content and curriculum content to be a major obstacle for schools. Furthermore, the top multimedia programs encouraged reflection about what had been learned, while the top video games did not. Reflection, needless to say, is vital to learning in any context.

Extracting gameplay principles

Begg et al. (2005) made a distinction between game-based learning (GBL) and game-informed learning (GIL). While GBL uses a gaming format for the purpose of making curricular content fun, GIL applies only a few gameplay principles that could promote learning. Gameplay principles include (a) providing an engaging context, (b) eliciting a feeling of agency, (c) removing risk of serious consequences, and (d) offering a variety of role-playing identities (Begg et al., 2005). Some educators (Gros, 2003; Salomon, 2000) have also noted the widely applicable skills children may learn from gameplay: problem solving, sequence learning, deductive reasoning, memorizing, parallel processing, digital literacy, and fine motor skills.

Game and simulation similarities

Both educational simulations and video games share characteristics that are valued by both, such as being immersive and encouraging group communication. These characteristics are valuable to instructional technology and can be applied to a variety of professional fields. Both educational simulations and video games have design features that require more visual information processing than verbal; both emphasize spatial, dynamic imagery, and iconic representation; and both usually demand attention across different locations on the screen (Gros, 2003). However, since only a limited number of professions require a high level of these skills, the characteristics that simulations and games do share may not necessarily have explicit educational value.

The high cost of game development

Another distinction between educational simulations and video games is the cost of development. With an emphasis placed on creating high-quality 3D visual effects and multi-user experiences, video game budgets are exuberant. The budget for most computer-based training applications is typically in the $50,000 - $500,000 range, but the average video game costs $3 million to $6 million to develop, with high-end games in the $5 million to $20 million range (Dixon, 2006; Lane, 2005).

Serious games are no exception. The US Army recently spent $45 million to develop the educational simulation game Full Spectrum Warrior (see http://www.fullspectrumwarrior.com) and $12 million to develop the training application Americas Army (see http://www.americasarmy.com) (Lane, 2005). These are seemingly large sums, yet they are only a fraction of the $18 billion combined training budget for the armed services, excluding trainees' salaries (Prensky, 2001).

The exception of war games

Gee (2005) contends Full Spectrum Warrior has legitimate educational merit because it asks the player to think, value, and act like a soldier to win the game. However, such an argument based on "war games" is misleading because the war activities (a) are inherently engaging by their life-threatening situations, (b) often involve quick maneuvering within accelerated timeframes, (c) rely heavily on the use of technical equipment and digitized data to interpret the immediate situation, and (d) typically produce immediate results. Although players of most war game software act independently without the need to collaborate with others, Full Spectrum Warrior is an exception; the player must coordinate with virtual players while giving orders to others.

When compared to the genre of teacher education, however, the game's features have little relevance and its educational merit is all but lost. On-the-job teachers seldom find themselves in life or death situations, do not rely on quick physical movements to get them through the day, use little to a fair amount of technology, and the consequences of actions are rarely immediate.

Video gaming in adulthood

Another problem with using video games in higher education is that while gaming is especially relevant to some adults, it is irrelevant to the majority of adult learners (Henry, 1997). Most video game players are between the ages of 8 and 14 (Gros, 2003). Children today are indeed growing up with impressive and widespread games that are at the edge of technology, but similar comparisons can be made for any generation. The games in the 1980's were equally impressive to the children growing up during that time. Were those children unreachable unless their higher learning involved games? What about the telephone generation or the television generation? Does the way to reach children change with the technology that defined their era?

Some children continue their gamer activities into adolescence and young adulthood, but it is often not a primary part of their lives. While boys are much more likely to play video games than girls (Newsweek, 1997) – especially after 14 years of age (Henry, 1997) – more women are attending college than men in the new millennium (Fonda, 2000; Marklein, 2005). It is puzzling, then, that some educators want college pedagogy to reflect a boys' preference for video games when the majority of college students are adult females. Schools of education, for instance, may not find the GBL approach germane for their students.

Gibson, Zibit, and Reidel (2005) surveyed 245 preservice students from six schools of education, including those at large universities as well as small colleges. Respondents under 34 years old reported playing approximately two games in the past whereas those over 34 reported playing approximately one game. Approximately 20 percent of respondents did not report playing any games at all. The game Oregon Trail accounted for nearly half of all games mentioned. Furthermore, preservice students reported playing fewer games after college and those games were not classified as educational (e.g., card games like Solitaire). The majority of respondents said they did not see video games as having deep educational value, but rather as a peripheral activity to learning. The survey's results clearly show that preservice students are not gamers.

Game over

If our learning activities are oriented toward gamers' preferences, when do students stop playing around and start functioning in an authentic work environment? The research on learning transfer from games to reality is inconclusive at best (Gros, 2003). Even with the celebrated use of military video games, do we really want the commander of a squadron depending on his or her video game expertise during an operation?

SimCity provides another example of questionable authenticity. In this gmae, urban planning has no relation to politics or ethnic demographics. As Squire (2002) points out, "most people would not want to live in a real city designed by someone who has only played SimCity" (p. 4). Furthermore, one of the greatest benefits of games and simulations is that there are minimal risks for the learner. In the real world, however, real risks exist and this affects how people act as professionals.

Educators may envy the level of attention and dedication school-aged children give to video games, but this “if you can’t beat them, join them” approach is not a viable solution. There is a common notion that video games adversely affect children’s behavior by increasing violent tendencies and sedentary habits (Freedman, 2001; Funk, 2001; Marshall, 2004; Onion, 2005; Oon, 2004). These are outcomes that educational simulations should seek to avoid. War games may be an effective way to attract and train young Army recruits (Prensky, 2001), but is not a helpful model for other fields of study.

Educational Simulations Today

A computerized flight simulator – developed in 1950 at MIT to train pilots – is usually referred to as one of the first instructional simulations (Roblyer & Edwards, 2000). Since then, many simulations have been created within numerous fields of study. Despite the diversity among disciplines, there are commonalities across almost all simulations.

Types of simulations

Alessi and Trollip (1991) classified simulations into two main groups: “About” simulations teach users about something, while “how to” simulations teach users how to do something. “About” simulations include (a) *physical* simulations, where users manipulate objects or phenomena on the screen; and (b) *process* simulations that either speed up or slow down a process so students can observe events unfolding in a way that is not readily possible in the real world. "How to" simulations include (a) *procedural* simulations that teach a sequence of steps (e.g., diagnostic programs), and (b) *situational* simulations that present hypothetical problems that students are asked to explore and solve.

De Jong and van Joolingen (1998) also described two broad types of computer simulations: conceptual and operational. *Conceptual* models are used for learning facts, principles, and concepts. *Operational* models emphasize procedural knowledge. For example, a conceptual-focused computer simulation on archeology may show users how principles apply to a specific exhibition, whereas an operational-focused simulation may allow the user to plan an exhibition.

Defining simulation

Simulation categories are becoming less useful as technologies develop and programs encompass a multitude of features and capabilities. According to Whitehouse (2005), everything from multimedia scenarios with branching storylines to immersive systems of virtual reality is considered simulation.

Thomas and Milligan (2004) specified two key features of simulation: (a) there is a model of behavior based on a real or theoretical system and (b) the user can experiment by observing the consequences of actions. Furthermore, the model and actions are purposefully limited to focus attention of the important issues of study (Aldrich, 2004). Ironically, too “real” of a simulation may distract users from attending to the educational lesson at hand. For this reason, Thomas and Milligan (2004) suggested giving the educator control of the fidelity of a simulation.

Characteristics of simulations

Rather than attempting to define simulations by categories or by a vague summarizing statement, a richer understanding can be acquired by looking at the common characteristics across all educational simulations. This section offers a comprehensive listing of 21 characteristics found across all educational simulations. Many of the concepts from the pedagogical approaches described above are embedded in these simulation characteristics.

1. Learn By Doing

Students learn through active participation. In a simulation, students perform tasks and act in situations that they are likely to encounter on the job.

2. Learn From Mistakes

The examined results of mistake-making may lead to insight for a solution. In a simulation, students can repeatedly react to a situation and fail, learning a little more each time until they are able to succeed.

3. Surprises

As challenging situations befall, the learner must be able to rise to the occasion. Learning how to perform at critical moments that often require immediate action is difficult to learn from a textbook, yet it is a vital part of the complexity in real world settings.

4. Risk Free

Mistakes can be costly. Risks are minimized during simulations, which is why flight simulators and simulated prototyping have been so beneficial.

5. Time Compression

In real life, it could take years to become skilled in a profession, largely because it may take years to encounter most of the situations that could arise in the field. It may also take a significantly long time to see the results and ramifications of prior decisions and actions. Sometimes it is simply too late to fix things after acknowledging that earlier actions or decisions were ineffective or harmful. Simulations can compress time so that a broad array of situations is encountered in a short amount of time and the results of actions and decisions can be viewed almost instantly.

6. High Fidelity

Realistic scenarios do not need to be idealistic ones. Simulated worlds could strive toward nirvana, but an educational simulation ought to have intentional errors that mirror the real world. Sometimes information is inaccurate, advice is unwise, and things do not always work as they should. Learners should become competent performing in an imperfect world, become comfortable with inconsistencies, and evaluate subtle tradeoffs.

7. Interaction Effect

To be interactive, the simulation environment should be somewhat contingent on student performance. In other words, decisions made and actions taken should affect future events in the simulation. If not, the student is merely a passive observer in a one-dimensional world. Without a two-way exchange, things merely happen "to" the student and the student has no effect (i.e., responsibility) in his or her simulated world. In reality, a participant's mere involvement in a situation could in itself complicate the problem at hand.

8. Meaningful Learning

Simulations can be very meaningful to learners if they are given the chance to act like professionals in the field. The more realistic and interactive the simulation, the more relevant the learner will perceive the simulated exercise. When students view learning as meaningful, they are more likely to retain knowledge. Also with meaningful learning, the learner "pulls" content in when motivated to achieve a specific goal, rather than having content "pushed" at the learner at inappropriate times.

9. Applied Learning

Simulations, like the case-based method, allow learners to apply concepts immediately. Beyond the typical case-based method, however, simulated environments may also let learners witness the implications of their applied concepts. As with delivering a punch line of a joke, the timing and context are essential for success. New concepts need quick and appropriate application to stick to memory.

10. Learner-Centered

The student is the center of a simulation, an active participant in an interactive world. Often the student can drive the pace of the simulation and, especially with online simulations, can engage in it at almost any convenient time and place. (See APA, 1997, for more learner-centered principles.)

11. Permeate Reality

A simulation is more realistic if the learner cannot "stop time" at will. Timelines are an important part of real world performance and learners need to be able to function within set periods of time. If learners can control the timing of all events in a simulation, they may become dependent on this power. Furthermore, the simulation would be more realistic if it "breaks into" the learner's normal state of reality and pulls the learner back into the simulated world. For example, a simulation might email a learner a message or leave a voice mail about events that have unfolded since the learner last participated in the simulation.

12. Post Analysis

Computer-based simulations have the added benefit of archiving information for post analysis. A user and his or her instructor (or supervisor) can review responses to pinpoint the user’s strengths and weaknesses. Progress can be viewed over time. Data could be graphically displayed, saved for a future analysis, compared to peer performance, or printed.

13. Authentic Assessment

Simulations allow instructors to move toward an authentic assessment methodology when testing student performance within the field is not feasible. Students need to be assessed on how they are likely to act on the job after they graduate.

14. Dynamic Database

The quality and quantity of scenarios are quintessential to a simulation's design. If the scenarios are too easy or hard, uninteresting or not interactive enough, outdated, or superficial, the simulation will have minimal educational value. If there are too few scenarios for learners to engage in, once again, the simulation will appear trivial. Versatile simulations allow for more scenarios to be added at later times. Online simulations can be updated almost instantly and professional educators can collaborate at an international level to further develop a simulation's database of scenarios.

15. Progressive Complexity

More sophisticated simulations become increasingly complicated over time. The learner may start with basic situations where only passive involvement is required. Then the learner may need to actively participate as the simulated environment becomes richer in context and more personalized for the learner. At more advanced levels, the learner may become deeply immersed within a simulated world, interacting on multiple levels, and performing as an expert in the field.

16. Diminishing Assistance

A good teacher offers students assistance on activities that may be too difficult for students to perform themselves. Over time, the scaffold of help is gradually removed as students become competent to perform the activities themselves. This form of diminishing assistance can be built into the design of simulations, making sure new participants get much more assistance than experienced ones.

17. Cognitive Mentoring

The naturally objective, non-judgmental feedback of computers can aid the regulatory thought processes of learners. Regulatory thought processes include metacognitive thinking, planning, and reflecting about an activity during the activity. The computer can prompt the learner to explicitly articulate ideas or decisions and provide tools like a digital journal to take notes at relevant times during the simulation.

18. Expert Advice

Characters within a simulation can embody the advice of experts. The content of online simulations can be updated instantly to reflect new theories and current events in the discipline. A cast of characters in the simulation may offer the learner multiple perspectives. Artificially intelligent agents may someday watch the learner and offer timely feedback, foster understanding, and motivate the learner based on the learner's history and profile.

19. Resource Library

A library of resources could be available at all times for learners to investigate and conduct research. Content would reflect information in the field as well as course material.

20. Active Participation

The progression of an interactive simulation is contingent on a participant’s action. Learners should always be doing something when inside the simulated environment. Information should not be plainly presented, especially in a text-only format, to passive receivers. Multimedia should engross the learner and tasks should always be available for the learner to do if motivation strikes.

21. Visualizing Impossibilities

By slowing down or speeding up natural processes, users may be able to observe phenomena from a unique perspective. Also, simulations with this characteristic may allow users to explore in ways that would either be too costly, not socially acceptable, or impossible otherwise.

Sample of educational simulations

Simulations typically do not include each of the 21 characteristics described above. Nonetheless, most simulations display a number of the characteristics. This section offers a sample of current educational simulations with examples taken from both higher education and corporate markets. Each simulations featured here has a website or publication noted that contains further information about the product.

The Virtual U Game

The Stanford University researcher William F. Massy (Blumenstyk, 2000) developed a game entitled Virtual U (see http://www.virtual-u.org). It was a commercial product modeled after the popular SimCity games (see http://www.maxis.com). Virtual U, funded primarily by the Alfred P. Sloan Foundation, provided a sophisticated financial and managerial model of how universities operate. Figure 2 displays two screenshots of the Virtual U interface with annotated descriptions of its features.

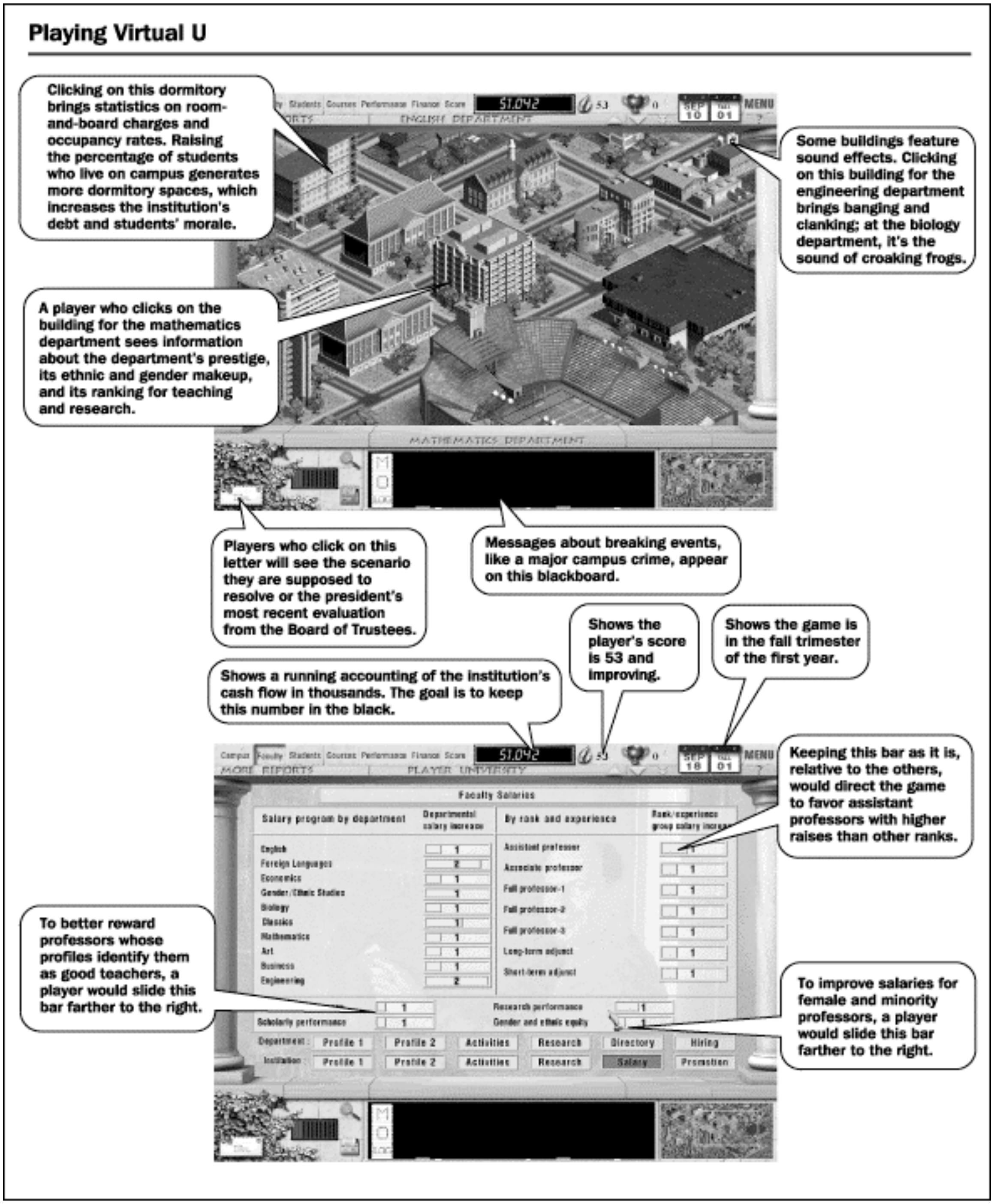

Figure 2: Screenshots of Virtual U with descriptive quotes (Source: The Chronicle of Higher Education. Retrieved January 9, 2005, from http://chronicle.com/free/v46/i18/4618virtual.htm.)

Massy hoped graduate students and administrators could use Virtual U as a teaching tool on matters of university governance

(Blumenstyk, 2000). Although this simulation may be fun to play, its educational application is specific to learning about financial administration in higher education.

Bricks Or Clicks Project

Two MBA candidates at the Northwestern University business school, Scott Mencken and Shailu Verma, created an online simulation for business students at BricksOrClicks.com (Industry Standard, 2000). The Kellogg Case Simulation Team, under the sponsorship of Professor Mohan Sawhney, further developed it (see http://www.clicksorbricks.com). BricksOrClicks.com users were placed in the role of CEO at a fictitious toy manufacturer. The legacy toy company called ToyBlocks, Inc. had to rework their business strategy to include an online sales channel.

CADETT

Virtual Reality Modeling Language (VRML, pronounced "vermul") is a programming language that some consider outdated (Dixon, 2006). Nonetheless, it let Web developers employ three-dimensional imagery that users could navigate through. The Consortium for Advanced Education and Training Technologies (CADETT) – a research arm of the Franklin Institute – used VRML to create a virtual reality simulation to teach team-building (Stamps, 1998). During the multi-user simulation, participants traveled with others on a cross-country road trip. As if that does not present a challenging enough opportunity to build team skills, the road trip ends at the bridge construction site where participants needed to collaborate with local residents, environmentalists, and business interests. Participants had to consider multiple viewpoints to arrive at an acceptable solution about how and where the bridge should be built. The simulation was run on a high-speed local area network (LAN).

SimSchool

SimSchool is a classroom simulation (see http://www.simschool.org) funded by the Preparing Tomorrow’s Teachers to Teach with Technology program of the U.S. Department of Education (Zibit & Gibson, 2005). SimSchool, like SimTeacher that was developed for the study, situates novice teachers in a virtual classroom to support the development of teaching skills. SimSchool users (i.e., players) design “tasks” for simulated students. Simulated students respond to the tasks and, based on the response, players make decisions about how to help the simulated students complete the tasks.

Players interact with students through a click-and-select method. Specifically, players click on students to access a controller that lets the players select a phrase, like “Do you understand?” Simulated students respond to phrases based on their personality setting. A personality setting is the combination of a programmed trait, learning preferences, and social expectation for the character.

If a task slightly exceeds a student’s abilities, the student will “learn.” The student will not learn and become bored if the task is too easy, and the student will not learn and become frustrated if the task is too difficult. SimSchool, therefore, lets future teachers practice designing tasks that match the individual differences of students.

StarTrainer

Simtrex (see http://www.simtrex.com) offered StarTrainer to help train customer service personnel. The simulation combines a computerized interface with telephone use for realistic, on-the-job training. Simtrex marketed StarTrainer using educational catch phrases like "experience transfer" and "progressive mentoring" (Simtrex, 2000).

At first, the novice StarTrainer user observed models of expert performance by shadowing an experienced person and taking notes on overheard conversations and computer use. The user then interacted with prerecorded human speech (via a phone) as if he or she was in a discussion with a real customer. The system recorded the user's speech responses for later review. At this level, computer applications were automated on the screen as the user simply observed them during the mock conversation. Next, the user practiced only the computer applications as the keystrokes and mouse movements were recorded. In the final stage, the user interacted with the virtual customer over the phone while working the computer at the same time. The user could restart any session as often as needed before mastering it. A supervisor could replay any session as well.

Simtrex promoted StarTrainer as not only “voice interactive” but also as “data realistic" (Simtrex, 2000). Users worked with the same phone system and computer applications during the simulation as they would in real life. The initial set up was the only barrier for using this simulation: audio and courseware servers needed to be installed, and sessions needed to be developed using Simtrex's authoring tools. Additionally, the cost of licensing their software would likely exceed modest budgets.

Virtual Leader

Clark Aldrich (Aldrich, 2004; Morrison & Aldrich, 2003) at SimuLearn (see http://www.simulearn.net) developed Virtual Leader. The simulation was designed to help users understand and improve their leadership skills in a business setting. Figure 3 displays a screenshot of Virtual Leader’s interface with annotated descriptions of its features.

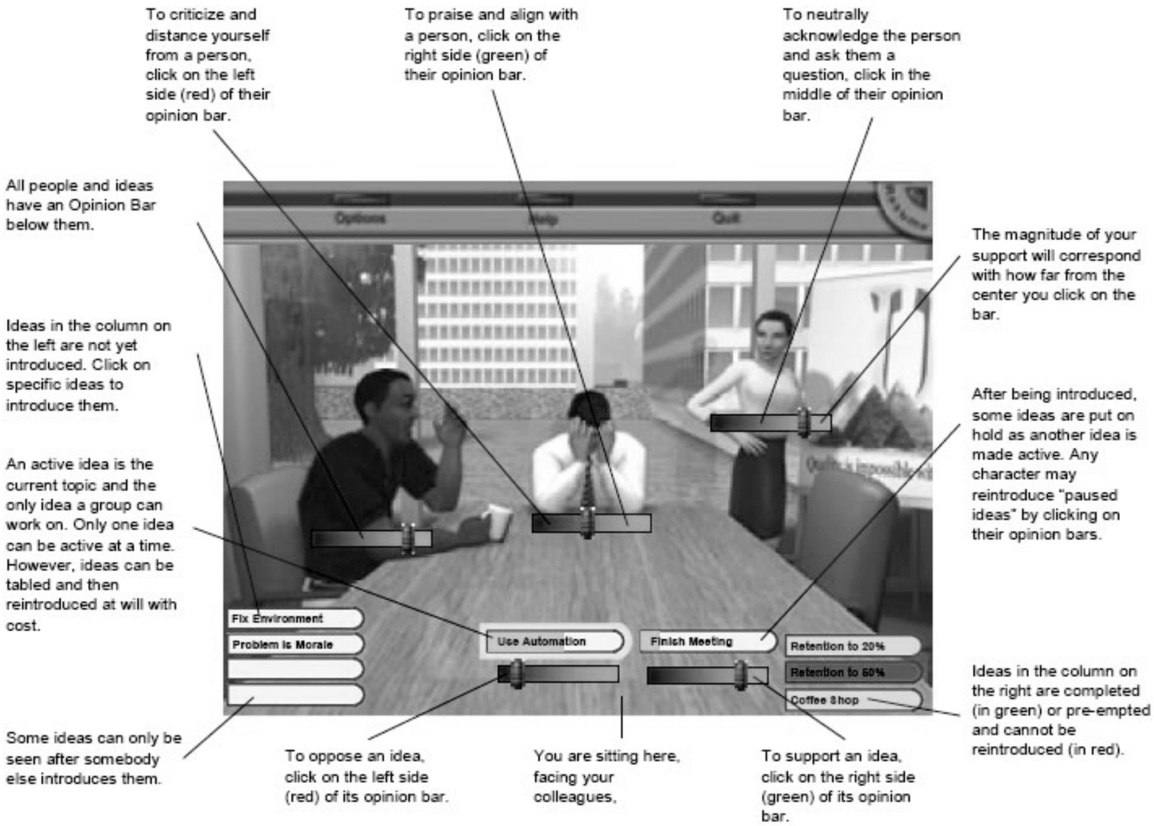

Figure 3: Screenshot of Virtual Leader with descriptive quotes (Aldrich, 2004)

Virtual Leader also included game elements in its design. Users receive online scores that can be used for competition. There are quotes from simulated characters for entertainment purposes. The user’s role becomes increasingly more important as the identity moves from basement employee to boardroom executive.

Virtual Dig

Carr (2000) acknowledged Barbara J. Roth (Oregon State University), Harold L. Dibble (University of Pennsylvania), and Shannon P. McPherron (Bishop Museum of Hawaii) as the co-creators of an educational simulation called Virtual Dig for archeology students. Virtual Dig (see http://www.mhhe.com/catalogs/

007282476x.mhtml) was a CD-ROM and 128-page workbook that let students practice organizing an archaeological dig, including how they would measure artifacts to how they would deal with uncooperative co-workers.

Students learned the basics of an excavation project as they planned the event, used the mouse button to dig on-screen, and analyzed the data they collected. The data were real measurements directly extracted from archived field notes taken at the Middle Paleolithic site of Combe-Capelle in France. Real life situations (including unexpected happenstance) were segmented into a number of chronological modules. Instructors could choose which modules to use depending on their needs, the course content, and the activity's objectives.

IT Project Management E-Challenge

Gartner Institute's (see http://www.gartnerinstitute.com) IT Project Management E-Challenge was a Web-based simulation training course (Barbian, 2000). Users that successfully completed all four modules and passed the comprehensive examination would be recognized as Gartner Certified Professionals in IT Project Management. The certification signified a mastery of project management in IT – instructional technology (i.e., it is not a learning tool for inexperienced project managers nor anyone outside the field of IT).

The IT Project Management E-Challenge offered virtual job experience by managing a fictitious yet realistic IT project. The mentored environment let users develop skills as they would normally, but without the risk. The Web-based simulation must have been completed in three months as the user drives the complex project from start to finish.

In the simulation, what started as a two year, $10 million-dollar project (before going over budget) ended up requiring a reinvention of the company. The virtual project manager had to successfully implement a new technology within a mid-sized computer company. If unsuccessful, the company went bankrupt.

According to the Gartner Institute's own research findings published on its website, even the best project managers often lack up to 20 percent of the skills and knowledge necessary for very large projects. The Gartner Institute believed the successful completion of its E-Challenge experience would improve a project manager's performance and decision making by at least 30 percent. However, the source of the Institute’s statistics is unknown.

Wharton’s Learning Lab

The Learning Lab at the Wharton School of Business (see http://www.wharton.upenn.edu/learning/) in the University of Pennsylvania was founded in the fall of 2000. Four years later, it had developed 18 applications with deployment in local classrooms and elsewhere. Many of its applications were online simulations that challenged students to think strategically in a business setting. Whitehouse (2005) described six of these simulations: OTIS, OPEQ, VIBE, Fare Game, FutureView, and Rules of Engagement.

Students act as fund managers using the Online Trading and Investment Simulator (OTIS) as they buy and sell equities in the current market (see http://www.aw-bc.com/wharton/). They run competing companies in the Oil Pricing Equilibrium (OPEQ) to learn about negotiations and decision making when there is incomplete or ambiguous information. Students build and manage bond portfolios with the Virtual Interactive Bond Engine (VIBE). They compete and cooperate in “fare warfare” in the airline industry using Fare Game to learn about price-setting and resource allocation. Students use information acceleration in FutureView to uncover quantitative market data for radically new technologies (e.g., futuristic auto-piloted vechicles). And lastly, students try different competitive strategies for marketing and advertising in Rules of Engagement to measure their possible long-term effects.

Medical Simulations

Medical simulations are among the most advanced educational simulations offered today (Benowitz, 1997; Rendas et al., 1999). Physicians-in-training use computer simulated surgical procedures to learn their trade. In some medical education facilities, trainees operate in immersive and mediated environments.

Vinay Kumar, Professor of Pathology at the University of Texas (UT) Southwestern Medical Center at Dallas, said traditional lectures failed to contextualize medicine within the milieu of patient care (Benowitz, 1997). His medical school integrated computers into the curriculum in 1994 using both traditional lectures and problem-based learning. Students explored clinical problems to learn the fundamentals of medicine while developing their clinical reasoning sensibilities. By 1997, the UT Medical School had developed 100 simulated scenarios for students to learn independently, reducing their pathology lectures by 60 percent. Instead of preparing for lectures, professors had more time to facilitate group discussions and serve as content experts for software-development specialists.

The Faculty of Medical Sciences of Lisbon, Portugal used a computer simulation designed for problem-based learning (Rendas et al., 1999). The trainee progressed through six sequential phases to gather clinical information about a patient: (a) patient encounter, (b) present illness, (c) review of body systems, (d) personal and social background, (e) physical examination, and (f) laboratory findings and other diagnostic procedures. While moving from phase to phase, the user may be prompted to explain and support a working hypothesis, identify learning issues raised during the analysis, and specify the resources that were helpful. These prompts served as *gates* that users must pass through before moving on to the next phase. Gates sometimes contained triggers to assist users in recalling or applying relevant knowledge or to think about the problem in a different way.

The Problem-Based Learning System (PBLS) at Lisbon's medical school was normally used with groups of two or three students per computer; sessions lasted around two hours (Rendas et al., 1999). It took four to five sessions and the occasional assistance of a tutor to work through each case. Computer input was reviewed by supervisors more quickly, easily, and consistently than the previously used videotaped sessions. An exit questionnaire showed that students found the PBLS user-friendly and highly motivating (Rendas et al., 1999).

MyPatient.com (see http://www.mypatient.com) and MedCases.com (see http://www.medcases.com) were additional online simulations for medical education. Virtual cases within MyPatient.com allowed the user to investigate patient symptoms and medical history, run physical exams, produce lab results, and diagnose and treat patients. MyPatient.com, which was jointly sponsored by the University of Virginia School of Medicine, claimed that its virtual cases were written and peer-reviewed by a national network of medical professionals. MyPatient.com cases were delivered entirely over the Web at a subscription rate of $480 a year. Medical students earned AMA Category 1 CME credits. Figure 4 shows two screenshots of MyPatient.com.

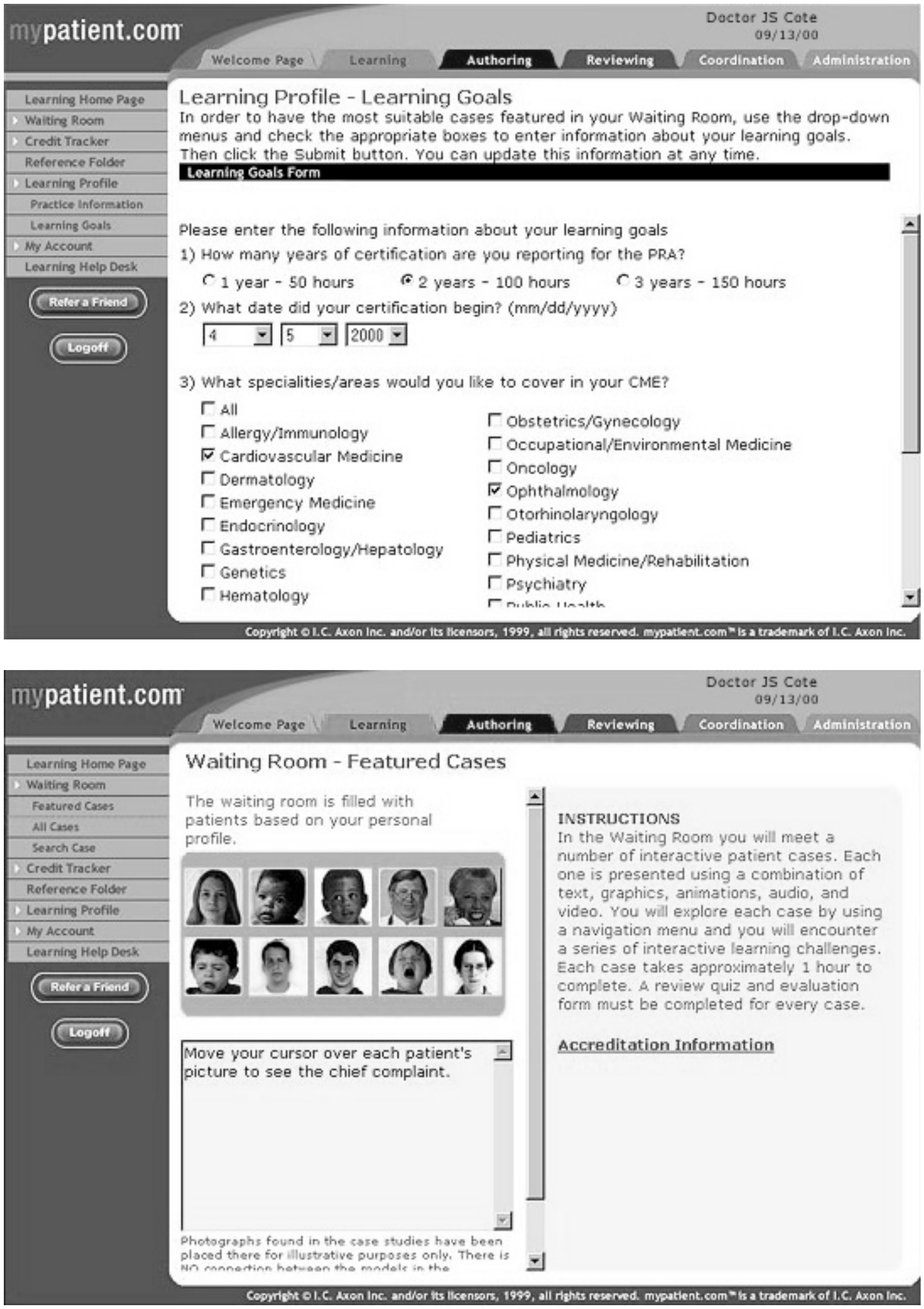

Figure 4: Screenshots from MyPatient.com

On the first screen of Figure 4, users completed *learning profiles* to specify their interest areas and prior experience. On the second screen, users were presented with a *waiting room* of patients (i.e., virtual cases) that matched the users' learning profiles.

Medcases.com operated similarly to MyPatient.com, except the fictitious patients may have refused treatment as real patients sometimes do. Also with Medcases.com, users could request evaluations of their performances on cases. Medcases.com, like MyPatient.com, also offered virtual cases online for CME credits.

The Tigerlake Project

The Tigerlake Project was the precursor to SimTeacher – the SBL tool used in the study. This section describes its development and use.

Inner-City Simulation Laboratory

Donald Cruickshank created an elaborate simulation for preservice teachers – The Inner-City Simulation Laboratory (Cruickshank, 1969) – composed of filmstrips, audiotapes, fictitious student records, and administrative papers. There are several hindrances precluding its use today: (a) the scenarios were no longer available for purchase yet they were still protected by copyright laws, (b) the case scenarios do not accurately represent today's societal issues, (c) the cases were restricted to situations involving sixth graders, (d) each simulation contained 32 students which may overwhelm new preservice teachers, and (e) the focus on inner-city children limits the applicability to rural and suburban districts.

The lack of simulation tools for preservice educators inspired the author to develop the Tigerlake Project (TP) in 1996 (see http://www.indiana.edu/~tiger). Tigerlake offered preservice teachers an opportunity to apply course material to *real-life* scenarios using computer-mediated technologies (Egbert, Thomas, & Fischler, 2000; Fischler & Matuga, 1998). Tigerlake Web assignments also served as a platform for authentic assessment of student learning.

In addition to eliminating the five major restrictions of Cruickshank's simulation, there were four additional benefits of the Tigerlake website: (a) reduction of required materials (e.g., paper, audiotapes, etc.); (b) the characters and scenarios were specifically tailored to the course content, grade level, and social context by instructors; (c) the system provided preservice teachers with a manageable number of students — 12 instead of an overwhelming 32 — in their virtual classrooms; and (d) the Web content could be maintained much more efficiently than older forms of media.

Instructional design considerations

In line with the movement to replace traditional *teacher*-centered instructional approaches with constructivist *learner*-centered pedagogy (Alexander & Murray, 1994; American Psychological Association, 1993; Bonk, Oyer, & Medury, 1995), the TP attempted to provide situated learning environments – even if only artificially. The TP was also congruent with APA Learner-Centered Psychological Principles (APA, 1997) and situated cognition literature (Brown, Collins, & Duguid, 1989; Hay, 1993). Three additional elements embedded in Tigerlake's design were (a) meaningful learning situations; (b) a viable means for authentic, formative assessment; and (c) tools for learner support (Brown, Collins, & Duguid, 1989; Harley, 1993; Young, 1993).

Tigerlake features

The Tigerlake website infrastructure consisted of a database of student records, a set of scenarios, questions, tasks, and tools that emphasized real-life problem solving situations. In other words, the Tigerlake website was a *virtual classroom* providing preservice teachers with their own class of students and problem-solving situations in which they could apply their newly acquired knowledge over the course of a semester.

The Tigerlake website specifically consisted of:

1. Situations (i.e., narrative vignettes) provided by the instructors of preservice teacher education courses. The situations emulated life-like events that teachers in the field may experience.
2. A Teachers' Lounge (i.e., an informal online forum to interact with peers).
3. A system to communicate with the course instructor disguised as the *school principal*.
4. Letters to virtual parents of Tigerlake students.
5. Student Records, including a sociogram, cumulative school records, *expert* teacher comments, comments about

the students by the School Counselor, test scores, and examples of student work.

The TP relied on course instructors to generate situated learning scenarios and methods of assessing student progress, focusing on domain-specific and procedural knowledge as well as metacognitive and higher-order processes (e.g., analysis, diagnosis, evaluation, etc.). See Appendix A for an example.

Preservice teachers also had an online forum for social interaction. The Teachers’ Lounge and the Principal's Office served as a means of support and scaffolding within the Tigerlake environment. In conjunction with the Student Records, these forums afforded preservice teachers opportunities to become acculturated within the Tigerlake environment, making the experience more personal. In effect, the information, strategies, and tactics emulated real-life problem-solving situations.

A set of pseudo student records and fictitious scenarios were created for 1st, 4th, 8th, and 11th grade classrooms. In terms of the typical sequence of events, each preservice teacher (a) applied and interviewed for a teaching position at the Tigerlake Public School System, (b) chose a grade level and subject matter, (c) read about situations (i.e., problem-solving scenarios starring some of the pseudo students), (d) viewed the set of questions or directions that followed each scenario, (e) accessed the appropriate student records and any other information needed (e.g., class notes, course text, or online material), and (f) submitted a hard copy of his or her answers to the instructor. Each scenario was followed by a set of questions that asked preservice teachers to recognize key educational concepts in action and to react to the situations using information and techniques discussed in their classrooms and textbooks.

Tigerlake research

Fischler and Matuga (1998) conducted a pilot study using the Tigerlake website in the teacher education program of a major midwestern university. Two educational psychology courses (Spring of 1996 and 1997) and one language education course (Spring of 1997) utilized the Tigerlake website. At the end of each course, the preservice teachers were asked to complete questionnaires that addressed the quality and utility of the website as well as solicited suggestions for future development of the cases and assignments utilized in the project. Of the 55 students who completed questionnaires, 48 were undergraduate education students. Most students were female and approximately 20 years old. Teaching philosophies were also obtained from approximately half of the undergraduates at the beginning and end of their Tigerlake experience. Seven graduate level education students critiqued the system as well.

Preservice teachers unanimously agreed that:

1. The Tigerlake assignments were *relevant* to the course material;
2. The assignments were a *fair* and *authentic* way to assess the knowledge they were constructing in the course;

3. Although the Tigerlake website was originally conceived as an assessment tool, there were instances where course material was *internalized* while completing the assignments (i.e., students felt that the technology helped them learn and remember the material);
4. The website *motivated* students to learn the course material; and
5. The project succeeded in providing them with an opportunity to *apply* concepts they were learning in the course to a simulated reality.

In general, preservice teachers found the semester-long simulation educational, motivating, and enjoyable (Fischler & Matuga, 1998). However, course-related knowledge gains could not be attributed to the Tigerlake simulation use alone due to extraneous factors (e.g., other course activities, the course readings, classroom interaction and atmosphere, instructor influence, etc.). For these reasons, course-related knowledge gains were not assessed in relation to simulation use. Nonetheless, anecdotal comments from participants, the entrance and exit interviews, and questionnaire results all suggested a positive relation between simulation use and concept learning.

Egbert, Thomas, and Fischler (2000) also used the Tigerlake software as a supplement to a language education course in a midwestern preservice teacher program. The course goals focused on student understanding of current concepts and issues of literacy while developing strategies to improve learners' reading and writing skills. A secondary goal was to show students, by example, an effective integration of technology in instruction.

As with Fischler and Matuga (1998), Egbert et al. (2000) first had students apply and interview for virtual teaching positions in the Tigerlake online environment. The scenarios then featured key concepts from a language education course. Students applied theory to practice by responding to questions within each scenario. The instructor evaluated answers based on their thoughtfulness and professionalism.

A 30-minute Content Diagnostic (CD) assessment was given at the beginning and end of the course to measure students' improved ability to realize significant problems and solutions in scenarios. Two neutral coders used three criteria for CD analysis: (a) the identification of substantive problems rather than trivial ones, (b) the offering of several in-depth and diversified solutions rather than a few overly simplified ones, and (c) the use of specific strategies for improvement. Results are shown in Figure 5.

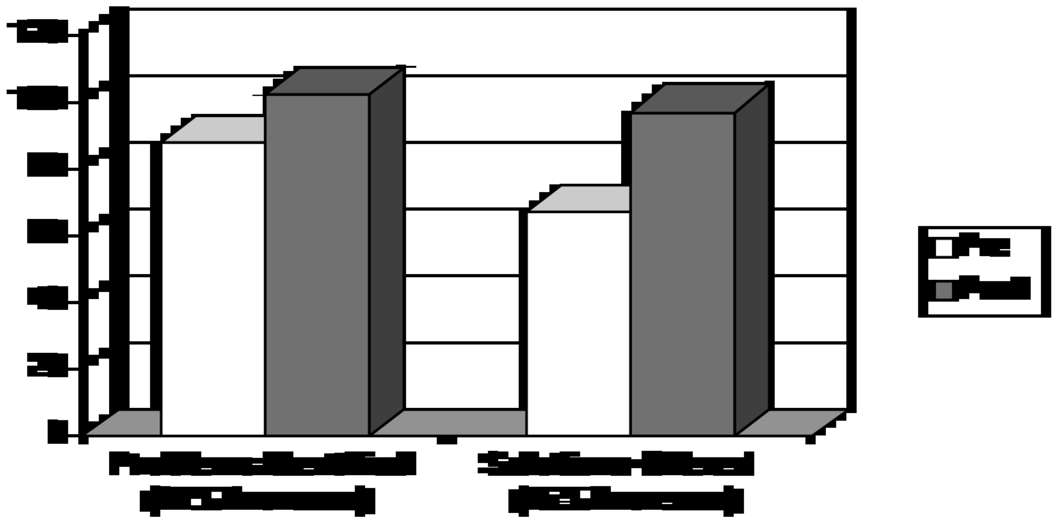

Figure 5: Comparison of problem identification and in-depth solutions before and after Tigerlake use

The CD analysis found that after using Tigerlake (see Figure 5), students discovered 27 percent more problems (from 88 to 102 instances) and posited 45 percent more solutions (from 67 to 97 instances) than they did before using Tigerlake. In addition to an increase in *quantity* of identified problems and solutions, almost all students showed an increase in the *quality* of their CD answers (e.g., moving from trivial to substantial problem identifications). Clearly, not all improvements can be attributed to the use of the TP; factors such as the course textbook and instructor confound any cause-and-effect conclusions. Therefore, a primary objective of this study on SimTeacher was not to assess the educational impact of the tool (like in the previous Tigerlake studies), but rather to examine how instructors use such a tool.

Chapter 3: Methodology

The first half of this section on methodology describes the study's purpose, research questions, approach, participants, and assessments. The second half details the simulation that was developed for this study. An emphasis is placed on how SimTeacher incorporated the contemporary theories described in the literature review.

Purpose

As the literature review indicates, simulations can be some of the most effective tools for the education community. Their potential is anchored in current learning strategies, such as situated learning, authentic assessment, case-based learning (CBL), and problem-based learning (PBL). While well-developed educational simulations can be pedagogically sound, they do not teach students by themselves. It is evident that instructors must play an important role in simulation use.

So how do instructors make the best use of simulations? This study specifically examined this question by observing how instructors used an educational simulation (SimTeacher) built for higher education. It explored instructors' motives for using the simulation, the preparation involved, the time and energy spent during their students' use, and the result of their efforts. In short, it tells their stories through a detailed narrative of each instructor's experience. The results are intended to help educators better understand and prepare for successful simulation use.

Research Questions

To encompass the multiple facets of each instructor's experience, the study posed four sets of research questions: perspective, procedural, technical, and outcome issues.

Perspective issues

Perspective issues were concerned with instructors' expectations and prior experience using SBL. Answers to these questions would reveal instructors' perspectives on and understanding of simulations before using SimTeacher in the study:

- What were key factors instructors considered in their decision to use the simulation? For example, what were their expectations, goals, and motives before using the simulation?
- What prior experience and knowledge did they have regarding simulation-based learning and was that a factor for success?
- How was success determined?

Procedural issues

Procedural issues involved how instructors specifically used the simulation. Answers to these questions would show what worked and what did not:

- How was the simulation used?

- Was it an in-class or out-of-class activity?
- How did it accompany the course material?
- Was the simulation used primarily as a learning tool or an assessment tool?

Technical issues

As with all instructional technology, technical issues arise about the tool's design and features. Answers to these questions would indicate which simulation components were used and how:

- What resources of the simulation were most or least used, and why? For example, why did instructors choose particular activities, how did they use them with their students, and how effective were they?
- Were there aspects of the simulation's design or feature-set that helped or hurt its efficacy as a learning tool?

Outcome issues

Outcome issues implicated the results of SBL. Answers to these questions would suggest the efficacy of (a) SimTeacher as an instructional tool in particular and (b) SBL in general:

- Was SBL effective? How so?
- Did instructors feel it was more advantageous than (or complementary to) other methods of instruction?
- What could instructors point to or look at to suggest that their students learned anything from using the simulation?

Approach

A qualitative research approach to data collection and analysis was determined from the nature of the research questions. In other words, qualitative research techniques were essential to capturing and describing the multiple facets of instructors’ experiences with SBL.

Data collection

Wolcott (1995) explained that qualitative research studies, for the most part, rely on three strategies for collecting data: (a) observation, (b) interviews, and (c) data recorders. The latter refers to the use of computers and recording equipment. These strategies were applied by (a) observing instructors using the simulation with students; (b) interviewing instructors before, during, and after simulation use; and (c) archiving email correspondence and SimTeacher log files throughout the study.

It was also important to examine these instructors in a naturalistic context to maintain the integrity of the participant observation data (Wolcott, 1995). Therefore, research methods relied heavily on the researcher observing and, if at all possible, not intervening. Instructors used the simulation as it became of interest to them and applicable to their teaching goals, therefore “simulating” realistic usage. The simulation was not customized for each instructor’s needs nor were instructors specifically trained on SBL. In other words, the motivation for instructor participation stemmed directly from what the simulation could apparently offer.

The researcher was there to facilitate the application of the simulation, assist when problems occurred, offer suggestions and ask questions when appropriate, and mainly observe and take note of instructors' experiences.

Data analysis

As data collection captured instructors' experiences (e.g., their expectations, actions, and outcomes), the qualitative analysis constructed meaning out of those experiences. The result is a documentation of instructors' overall stories in narrative form, rather than a purely statistical account as with quantitative methods. Likewise, instead of seeking statistically valid samples of participants, only three instructors were examined closely in this study.

Wolcott (1995) suggested that qualitative researchers distinguish between data *analysis* and data *interpretation*. That is, an analysis of qualitative data essentially describes what, where, when, and how something happened. Data interpretation, however, gets at *why* it happened. Therefore, this study will provide an analysis of data on instructor's experiences in the Data Analysis chapter and an interpretation of data, including links to the literature, in the Conclusion chapter. Research questions will be addressed in both chapters by examining instructor experiences individually as well as collectively.

Participants

Three instructors from a major southwestern university participated in the study. Instructors decided on their extent of simulation use based on their teaching style, objectives, technology skills, and available time. Within a four-semester span, each instructor incorporated SimTeacher in at least one course and participated in a minimum of two academic semesters. Overall, 11 undergraduate teacher education courses used SimTeacher with an average of 24 students each, totaling 265 students (see Appendix B). While the focus was on the instructors, many students also provided feedback after simulation use for an additional source of data.

Instructors' participation depended on their comfort level of integrating technology in their teaching rather than on simply volunteering in a study. Since the instructors were affiliated with a different university than the researcher, they were free to use the simulation as much or as little as they wanted and however they saw fit to meet their goals.

Assessment

The main source of data for this study came from instructors. Instructors' use of the simulation was assessed using interviews and observation. Instructors were interviewed on a number of occasions before, during, and after their use of the simulation in their courses. The interview questions are listed in Appendix C. Another source of data came from direct observation. The researcher observed instructors at three stages: (a) preparing the simulation, (b) using the simulation with their students, and (c) assessing student learning based on simulation use. In addition, email correspondence was archived during the study for further insight into each instructor's style, approach, and "story."

To collect another type of data, instructors were asked to take journal notes. Appendix D shows the instructions printed on the first page of the blank notebook given to each instructor. Notebooks also had date and time fields, intended to detail ideas or problems at the time they occurred. Although instructors were regularly reminded about this resource, they did not make good use of it. Fortunately, SimTeacher logged instructors' use of the tool and this provided an adequate source of additional data.

Since the focus of this study was on instructors' use of SimTeacher, the *content* of student data from SimTeacher assignments was not analyzed. It was more important to know whether or not instructors perceived their students as benefiting from simulation use. However, the *pattern* of student data, including average practices and logs, were reviewed to ascertain the level of student involvement. Additionally, all students were asked a number of questions (see Appendix E) within two weeks of the end of simulation use. The questions were designed to capture their opinions and thoughts about SBL as well as to assess SimTeacher's educational merit from a student's perspective.

Lastly, some students were observed as they worked on SimTeacher in a classroom setting.

SimTeacher

As educational tools evolve, there is an increased need to implement these advancements and to evaluate their effectiveness (Riel, 1993). SimTeacher picks up where the TP left off, utilizing the latest relevant technologies and basing its design and functionality on current educational theory. This section will describe the origin, development, and status of SimTeacher.com – a simulation-creation tool for teacher education.

In the spirit of Tigerlake

Copeland (1989) proposed that cases online might provide cheaper, faster, and more extensive opportunities for preservice teacher apprenticeships than the currently used technology-mediated laboratory experiences. Although Tigerlake did not contain the level of interactivity and multimedia that online simulations do today, it did offer instructor-customized case studies online for students along with relevant questions, fictional student files, and other resources. With some imagination, preservice teachers acted as real teachers in their own virtual classrooms, applying newly learned theories to realistic scenarios. In effect, they practiced using the course material in a context that clearly related to how they would use the information in the future.

The preservice teachers involved in the Tigerlake project were not only exposed to technologies during training that they were likely to encounter in service; they also directly experienced constructivist and apprenticeship learning environments fostered by technology (Confrey, 1995). An added value for preservice teachers was the exposure to the Web as an instructional tool. The Web still is an enormously expanding and vital resource for teachers. ISTE (the International Society for Technology in Education) acknowledged the Web as an invaluable teaching tool and formed the NETS (National Educational Technology Standards) to develop standards for PK-12 students and teachers (Wiebe, Taylor, & Thomas, 2000).

While Tigerlake was still under development, there were a number of “wish list” items that were never implemented. For example, preservice teachers could focus on either 1st, 4th, 8th or 11th grade levels. One request was to extend the options to encompass Kindergarten through 12th grade. Consequently, student records needed to be developed for each grade level. Another desire was to have access to scenarios that were more content area specific. Lastly, further development would have made the virtual classrooms more *situated* and interactive (Harasim, 1993; Roschelle et al, 2000). For instance, preservice teachers should be able to take a tour of the school, learn its specific policies, hold teacher/parent conferences using digital video technology, and electronically submit work via the Web. Using online technologies, all of this is now possible.

Using new technology

In the late 1990's, the Tigerlake website might have been considered cutting-edge educational technology. Tigerlake took advantage of the emerging Web technologies of its time, as does SimTeacher today. Fortunately, many emergent Web technologies as well as entire learning systems are available for free (Downes, 2005). SimTeacher used the free and open source software of PHP and MySQL (described below) to build its core simulation-creation engine. Also, considering that the researcher wrote the programming code and the instructors created their own content, overall development costs were exceptionally low. Simulations, as shown in this case, could reduce the costs of developing and distributing education content (Lane, 2005).

PHP (see http://www.php.net) is a Web development programming language that became popular after the initial development of the TP. Since PHP was central in the creation of SimTeacher, it is valuable to have a basic understanding of it. PHP can help a site become more dynamic and functional (Meloni, 2000). However, many elements need to be in place for the development of a functional tool, such as (a) PHP scripts that can be incorporated into HTML documents, (b) a PHP parsing engine located on the website's host server, and (c) a database platform, like MySQL (see http://www.mysql.com).

The database platform is not mandatory but highly recommended if a website will collect and store data as well as retrieve data to display in a Web browser. A moderately dynamic site will require a database of some kind, but PHP can still be used without a database for simple functionality (e.g., emailing Web form data without archiving it). MySQL is a relational database offering a much more efficient and scalable platform as compared to a flat-file method of data manipulation. The PHP parsing engine and MySQL database system have evolved as “open source” software (see http://www.osdn.com/history.shtml or Gasperson, 2000).

One reason SimTeacher was built and used with this study was so the researcher could log and later access both student and instructor activity in the backend database. PHP5, the latest version of PHP at the time of this report, also supports Java, XSLT, SOAP, and other popular technologies to ensure scalability, compatibility, and longevity of Website functionality (Zandstra, 2000).

Putting instructors in charge

A major shift occurred in the design and approach from Tigerlake to SimTeacher. Tigerlake, like most educational simulations today, provided instructors with inflexible content and a rigid delivery method. Thomas and Milligan (2004) warned that such simulations could only complement a few styles of teaching and learning. SimTeacher, however, allowed instructors to create their own simulations. From content-creation to the choice and flow of assignments, SimTeacher put instructors in charge of creating simulation experiences for their students. Currently, this innovation sets SimTeacher apart from any other educational simulation available in teacher education.

The purpose of letting instructors create their own online simulations was twofold. First, it allowed instructors to tailor the simulation content to the specific material they were emphasizing in their courses. The openness of the platform meant that the researcher did not need to be a content expert (or hire one). Consequently, this openness made SimTeacher applicable to more content areas as well as to more instructors. Second, it was important to let instructors decide how much to use SimTeacher to meet their teaching goals, based on their amount of available time and their comfort level using new technology. By putting instructors in charge, they were able to choose the number, frequency, duration, and content of simulation assignments.

Definitions

The following terms used in SimTeacher are defined: SimTeachers, assignments, activities, situations, classrooms, schools, and courses.

SimTeachers

Undergraduate (or less often, graduate) students enrolled in a teacher education course using SimTeacher.com were called SimTeachers. They were assigned their own fictional students. Aside from the SimTeachers and their fictional students, there were also fictional teachers in this simulation. Once again, the real college students (i.e., the SimTeachers) should not be confused with the fictional teacher characters or the fictional students. Fictional teachers and SimTeachers were intended to be "colleagues." Real students controlled SimTeachers' actions as each played the role of a teacher in a make-believe school. SimTeachers dealt with situations and activities at these schools.

Assignments

Assignments were either situations or activities (described separately below). A SimTeacher's main task in the simulation was to complete the assignments. Assignments were created by instructors and, ideally, allowed SimTeachers to apply what they were learning in their real college courses to the virtual school setting. Assignments were also time-dependent, becoming available in the simulation on certain dates and then being unavailable after certain dates. Instructors determined the dates. Students were allowed to redo an assignment at any time if they first completed it within its availability dates. Redone assignments did *not* overwrite previous attempts. The history of student work was archived for later review.

Activities

Activities were the daily tasks that went along with the teaching job. For SimTeachers, these included taking attendance, responding to parents' emails, calculating grades, etc. Instructors may have also assigned more involved activities such as filling out an IEP (individualized education plan) or creating a lesson plan on a specific topic. (For an example of a completed IEP in SimTeacher, see Appendix F.) Activities differed from situations in that activities were usually not interactive and may not have involved any specific characters.

Situations

Jonassen and Hernandez-Serrano (2002) believed that the most effective way to prepare professionals for the complexity of the workplace is to expose them to stories from the workplace. The interactive stories within SimTeacher were called *situations* and contained narratives, multimedia, and question and answer sessions. The instructor created the content for all the storyline branches or repurposed content another instructor had previously created.

The narratives would stop at pivotal points and ask SimTeachers to take action – as well as to provide justification for that action – before proceeding. The narrative would branch into a unique direction depending on the action taken by the SimTeacher. Figure 6 depicts the structure of an interactive story with multiple storyline branching.

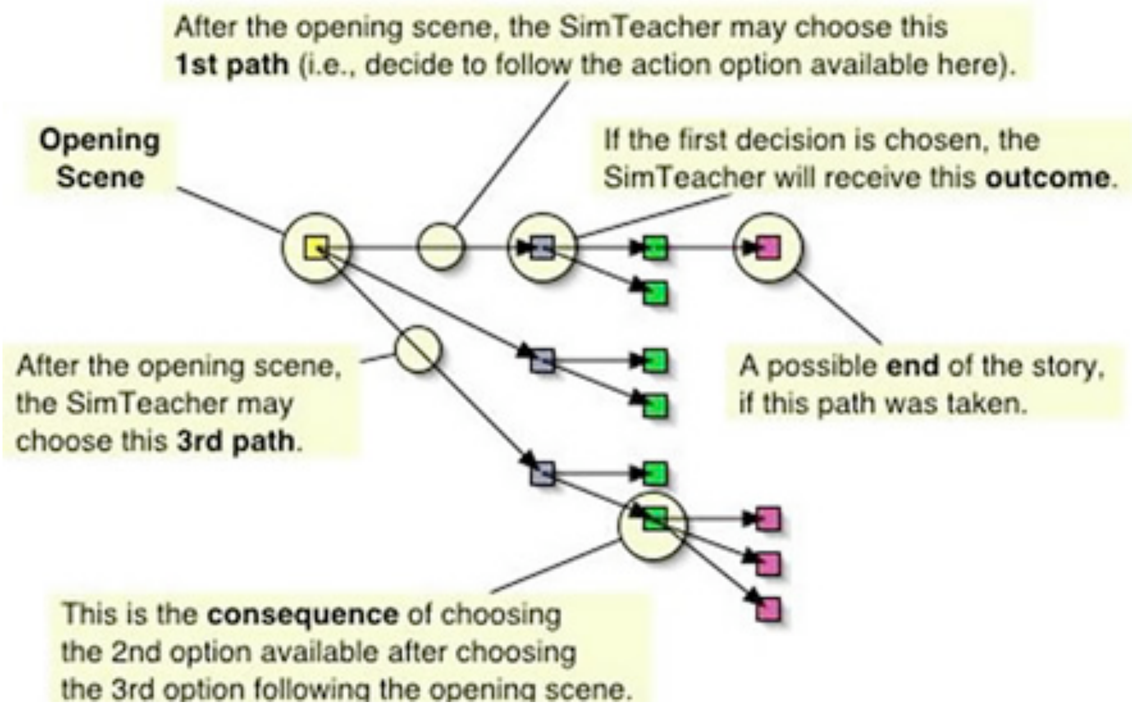

Figure 6: The structure of an interactive story in SimTeacher

A good way to help conceptualize “situations” is to recall the “make your own adventure” paperback novels. In these novels, readers were given the choice to, for example, turn to page 102 if they wanted the protagonist to drive to Jersey to look for his twin brother, or turn to page 78 if they wanted him to stay in Missouri and marry his high school sweetheart. In effect, the reader had some control over the plot when given choices at pivotal points in the storyline.

The same was true for situations in the SimTeacher simulation. However, SimTeachers had to justify their actions and perhaps answer additional questions before proceeding. By making justified decisions and then experiencing their consequences, SimTeachers engaged in problem-based learning. According to ADEC (2002), PBL fosters analysis, synthesis, and evaluation skills.

Similarly, SimTeachers were presented with situations in which they had to analyze the problem, synthesize relevant course concepts to formulate solutions, and evaluate their chosen solutions by observing the consequences. Having SimTeachers answer content-related questions within the storyline provided an opportunity for knowledge-based learning as well. Knowledge-based learning "involves recall, comprehension and application" (ADEC, 2002). It was the instructor's prerogative when designing the assignment whether or not to include content-related questions.

The point of situations was to give SimTeachers a chance to apply the academic concepts they were currently learning. Ideal situations featured content-rich scenarios incorporating the theories and concepts from course lectures and/or the textbook. For example, an educational psychology student using the simulation ought to encounter *situations* that emphasize classroom management, cognitive learning styles, student motivation, child development issues, and related topics. Segments of the narrative were enhanced by multimedia (e.g., a picture of the 5^{th} grade girl who was mentioned in the storyline). Media rich stories have been shown to stimulate and engage students (Cameron, 2001). Also, the more SimTeachers could identify with the situations and picture themselves acting within a virtual setting, the greater the probability of meaningful learning and abstract knowledge transfer.

Classrooms and Schools

SimTeachers acted as teachers in the classrooms that their instructors created for them. Classrooms usually had a number of fictional students enrolled. Instructors were able to create fictional students on their own, adopt students other instructors had already created, or instantly add a pre-defined classroom of students. SimTeachers were able to view their classroom at any time as well as access any of their students' records. Classrooms were subsumed within schools. Each school created in SimTeacher was automatically populated with a principal, teaching mentor, counselor, nurse, librarian, security officer, technician, and receptionist. If SimTeachers were signed up for more than one course, they may work at a number of virtual schools.

Courses

SimTeacher courses allowed instructors to organize a number of assignments for their SimTeachers. Each SimTeacher course was associated with a school and required a certain number of assignments with specific start and end dates. If desired, an instructor could create more than one SimTeacher course (i.e., more than one school) for each university course. For instance, an instructor may want half of her university students working on assignments different from the other half (or may have wanted different due dates). Each SimTeacher course had a unique *token* code that distinguished it from other courses. University students needed a course's token before enrolling in a SimTeacher course. When SimTeachers enrolled in SimTeacher courses, they became employed as teachers at the appropriate virtual schools and received all the associated assignments that the instructor set up for them.

Features and capabilities

SimTeacher incorporated many of the standard features of an educational simulation, yet it also broke new ground with exclusive capabilities. Some of its more innovative features and capabilities are described.

Themes

SimTeacher's backend engine was run by a series of integrated PHP scripts and a MySQL relational database. Multiple front-end customizations, called "themes," could be applied. Themes could accommodate the simulation for target audiences: a law professor can use the "law theme" to accommodate her course, a medical professor can use the "medical theme," etc. The backend engine drives all content regardless of semantics.

Blended learning

Distance learning might be criticized for being *too distant*. Students can quickly become detached from online activity if they lose interest or if the media does not engage them. Blended learning seeks to find the most effective mix of communication technologies to fit the educational situation (Graham, 2005; McGarvey, 2002). Depending on the topic, the level of the students, afforded time, departmental budget, and other factors, instructors could design a specialized blend of media and delivery methods (Bersin, 2003). For example, a corporate training program may use CD-ROMs, conference calls, Webinars (i.e., Web-based seminars), and mentors to most effectively educate employees about a new line of company services.

SimTeacher provided instructors with numerous ways to interact with their learners (e.g., by passing notes under the guise of simulated characters, using the online discussion board, or email) and a variety of tools and resources (e.g., resource library, theorybase, interactive stories, and activities). SimTeacher may also complement more traditional methods of instruction, such as textbooks and lectures. A tool like SimTeacher may, therefore, be a resourceful asset to an instructor’s blended learning strategy.

Resource Library

A collection of Web resources was available to help SimTeachers complete their daily activities and situations. For example, a searchable dictionary of theories and a space for online lecture notes were available. SimTeachers were able to look up student records, ask simulated characters for advice, and keep notes in an embedded online journal. An important attribute of the PBL model is to have additional resources like these readily available for learners.

Instructor controls

Instructors had privileged access to SimTeacher.com. Instructors could view the progress of all of their SimTeachers, determine the situations their group will experience, add new situations to the database, or add items to the resource library.

Instructors could also see which SimTeachers were currently online and had the option to receive email notices when certain actions occurred (e.g., if a SimTeacher tried a second attempt at a situation).

Instructional support for regulative learning processes

De Jong and van Joolingen (1998) suggested providing support for students to manage their own learning process during educational simulations. Specifically, they suggested instructional support for model progression, planning, monitoring, and structuring. In *model progression*, the complexities of the simulation are gradually introduced so the new user is not overwhelmed. Support for *planning* involves using questions, games, and various assignments to help learners manage their learning process. Using a notebook for storing data from experiments facilitates *monitoring*. And by *structuring* the discovery process using prompts that direct activity, learners may be more successful. SimTeacher incorporated these suggestions into the design of the activities, situations, and the resource library.

Permeate reality

Via email, SimTeacher could send messages to users regarding school events and student-related issues. For example, a user could receive an e-newsletter from the school or a note from a student's parent at any time. Having the simulation permeate into the normal lives of users may have made the simulation appear more real and, as a result, more motivating. As a preference, instructors were able to choose not to have SimTeacher email their SimTeachers, and SimTeachers were able to choose not to receive email related to their courses. Advanced educational technology may soon utilize new forms of digital media (ADEC, 2002). For example, SMS messages (a text messaging system compatible with most U.S. mobile phones) may become an option for future simulations to permeate reality for students.

Character-laded environment

The characters within SimTeacher drove most of the activity. The simulation came alive with seemingly real yet fictional characters. The daily tasks and story-like situations involved an animated and diverse crew, including students, a school counselor, nurse, secretary, parents of students, the principal, other teachers at the virtual school, and more. The instructor of a course occasionally played the role of the school principal or a parent of a student (though the instructor's students were usually not aware of this). Furthermore, some simulated characters made remarks and held opinions about other characters. Lastly, SimTeachers interacted with other SimTeachers with the semblance of being fellow teachers in the simulated environment.

Mastery learning

The simulation applied some principles of mastery learning as well. SimTeachers did not complete the simulation with a grade or quantitative scorecard. Rather, they completed the simulation by successfully doing their job in the virtual environment. The daily tasks and situations could be designed to become increasingly difficult. For example, Table 3 lists the general activities that instructors may have placed at each level. As the SimTeacher progressed, the amount of scaffolded assistance would diminish over time.

Level One	A new visitor to a simulated world may first… • Take a passive, public tour. • Go through a job hiring process before becoming a participant. • Take a more active, private tour after becoming a participant. • Meet the other characters and participants. • Become familiar with his or her personalized space (e.g., an office desk or classroom within the simulation). • Understand the available resources within reach.
Level Two	A new participant in the simulation may… • Perform daily job functions in the field. • Be coached by either expert advice or by cognitive mentoring. • Experience a "Permeating Reality" feature of the simulation that reaches out to the participant in his or her reality and calls the participant back into the simulated world.
Level Three	The seasoned participant in the simulation may… • Have to act accordingly to unexpected events and unpredictable incidences. • Not have expert advice and cognitive mentoring available. • Have to mentor or coach a new participant in the simulation. • Deal with complex situations that have multiple and/or messy solutions that are mostly driven by the participants' own justifications. • Interact in real time to unfolding events.

Table 3: An example of Progressive Complexity within a simulated environment

Process

Although their specific actions differed, all SimTeachers and their instructors followed a general process when using the simulation.

Instructors registered for a new account at SimTeacher.com if it was their first time using the system, or logged in and chose to create a new course if they had previously registered. In both cases, they submitted information about their courses via online forms. Next, instructors created or repurposed assignments for their courses and populated the associated virtual schools with fictional characters. When the course assignments were completely set up, instructors invited their real students to become SimTeachers in the simulation by giving them a token code that corresponded to their course at SimTeacher.com.

The students went to SimTeacher.com and registered if they were new to SimTeacher or just added a course if they had previously registered. Based on instructors' preferences, all students were interviewed for available SimTeacher positions at virtual schools. Questions about prior teaching experiences, current teaching philosophy, and other areas were asked through the SimTeacher website, where their responses were saved. The instructor could then choose to accept all or only certain students. Accepted students received email notices that they were hired and could then log on to attend work.

SimTeachers completed the assignments their instructors designated, and all work was saved in their portfolios.

SimTeachers were able to repeat assignments they had already completed. Repeated work was appended to their portfolios and did not overwrite prior work. Instructors could see which SimTeachers were working on which assignments at any time. Instructors could also view their SimTeachers' completed work, learn how long it took a particular SimTeacher to complete an assignment, and find out the last time a SimTeacher logged on. Instructors could change due dates or assignments whenever necessary and the changes took effect immediately. SimTeachers and their instructors could review the portfolios after each assignment or after all assignments. Portfolios were printable as well.

Reliability and validity

Testing was necessary prior to the study to confirm: (a) the reliability of the software and (b) the validity of SimTeacher as a tool to support SBL. An instructor at a major southwestern university tested the simulation during its final stage of development using two undergraduate teacher education courses. The courses were held during the same semester and consisted of 45 students total. SimTeacher's reliability was confirmed when the website did not produce any software or hardware errors while performing its functions. Validity was confirmed when the tester was able to create interactive storylines and use them in a course setting with students.

Chapter 4: Data Analysis

First, this section will describe the analysis of instructor data. Second, similarities and differences across all instructors' data will be examined. Third, each instructor's data will be examined separately in order to compare instructors' unique experiences to the relative experiences of the group. Lastly, a summary of student observations and the results of a student questionnaire are provided.

Instructor Data

Instructor M was the first of three instructors to participate. Subsequently, through their professional relationship with Instructor M, Instructor D and lastly Instructor L became interested and involved. Instructor data were accumulated using interviews and observations. Interviews were conducted both in person and over email on numerous occasions. Observations included viewing classrooms during simulation use, cataloging email correspondence, and accessing the simulation's computerized log files. The interviews and observations are described below.

Interviews

There were three sets of interview questions (see Appendix C): before simulation use, during simulation use, and after simulation use. Questions asked before the simulation assessed how instructors planned to use SimTeacher, their prior experience using simulations, and why they decided to become participants.

During the simulation, instructors were asked how their students were doing as well as their thoughts regarding the design and capabilities of the simulation software. Questions asked after using the simulation were designed to gauge how involved they became in its application and how simulation was used in the context of their overall course agenda.

Email correspondence

Every interaction with instructors helped provide a more complete picture of their experiences. Since email was a primary means of communication, all email correspondence regarding the simulation study was saved and indexed. A total of 95 messages from instructors to the researcher were flagged as relevant to the study. Messages sent to instructors or messages deemed irrelevant to the study were not analyzed. Each instructor sent approximately 32 messages. There were six categories of messages based on the themes that arose from the data (see Appendix G).

The most popular type of message was about timing, including setting a time to meet with the researcher or arranging a time to use SimTeacher with their class. Roughly one-third of all messages fell into this category. The least frequent category, comprising approximately one message per instructor, included suggestions to use SimTeacher to do something else for which it was not initially developed. Messages that fell into other categories were regarding SimTeacher's features and capabilities, other people interested in the software, and problems with the software experienced by instructors or students.

Storyline structure complexity ratings

A "complexity formula" was developed to evaluate the richness of storyline structure in situations. This formula was used because it numerically indicated the differing complexity of situations among instructors' situations. The formula was as follows.

$$(D + (Q/2)) \times L = \mathbf{C}$$

D = Number of decision choices
Q = Number of embedded questions
L = Number of levels deep
C = Complexity rating

Essentially, the amount of storyline branching is being measured by multiplying the number of decision choices by the number of levels. Questions are treated like decisions because questions, like decisions, stop the storyline and ask users to act before proceeding. However, since the answers to questions do not change the story path, they were treated at half-value compared to decision choices. This is why the number of questions is divided by two.

To demonstrate, the complexity formula was used to evaluate the richness of storyline structure, it is applied here to three of the ten situations instructors created. One situation from each instructor is chosen, representing the lowest, the highest, and a mid-range complexity rating.

Instructor L created the situation that received the lowest complexity level, though it was not assigned to L's students. Figure 7 shows a screenshot of Instructor's L situation.

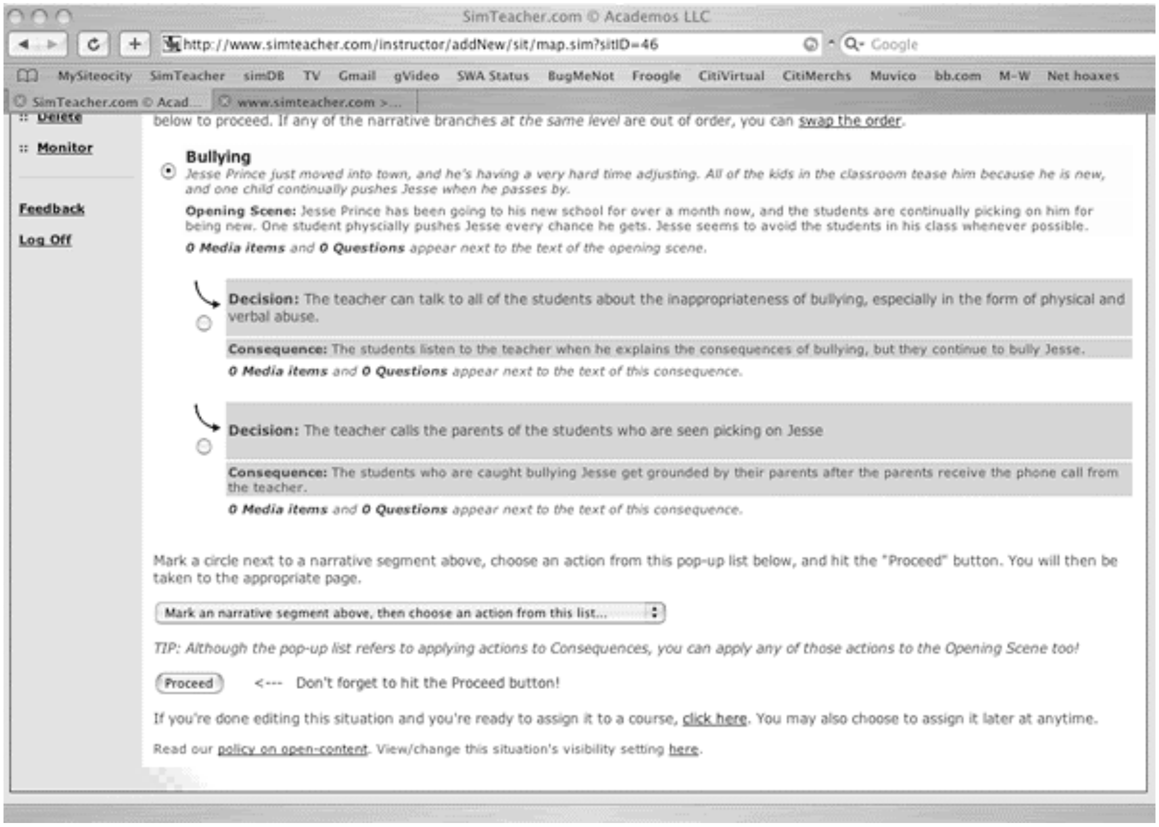

Figure 7: Situation with the lowest structural complexity level

The situation in Figure 7 has 2 decision choices, 0 questions, and only 1 level. When the formula is applied, the result is 2.

$$(2 + (0/2)) \times 1 = \mathbf{2}$$

For another example, the complexity formula will apply to a situation with a mid-range level of complexity. Instructor D developed the situation shown in Figure 8. Unlike the situation in the previous example, this situation was assigned to students.

Figure 8: Situation with a mid-range structural complexity level

The situation in Figure 8 has 6 decision choices, 4 questions (as indicated in bold underneath the “Consequences” textbox), and is 2 levels deep. When the formula is applied, the complexity level of this situation’s storyline structure equals 16.

$$(6 + (4/2)) \times 2 = \mathbf{16}$$

Lastly, the complexity formula will be applied to the situation that received the highest complexity rating. Instructor M developed and used the situation displayed in Figure 9.

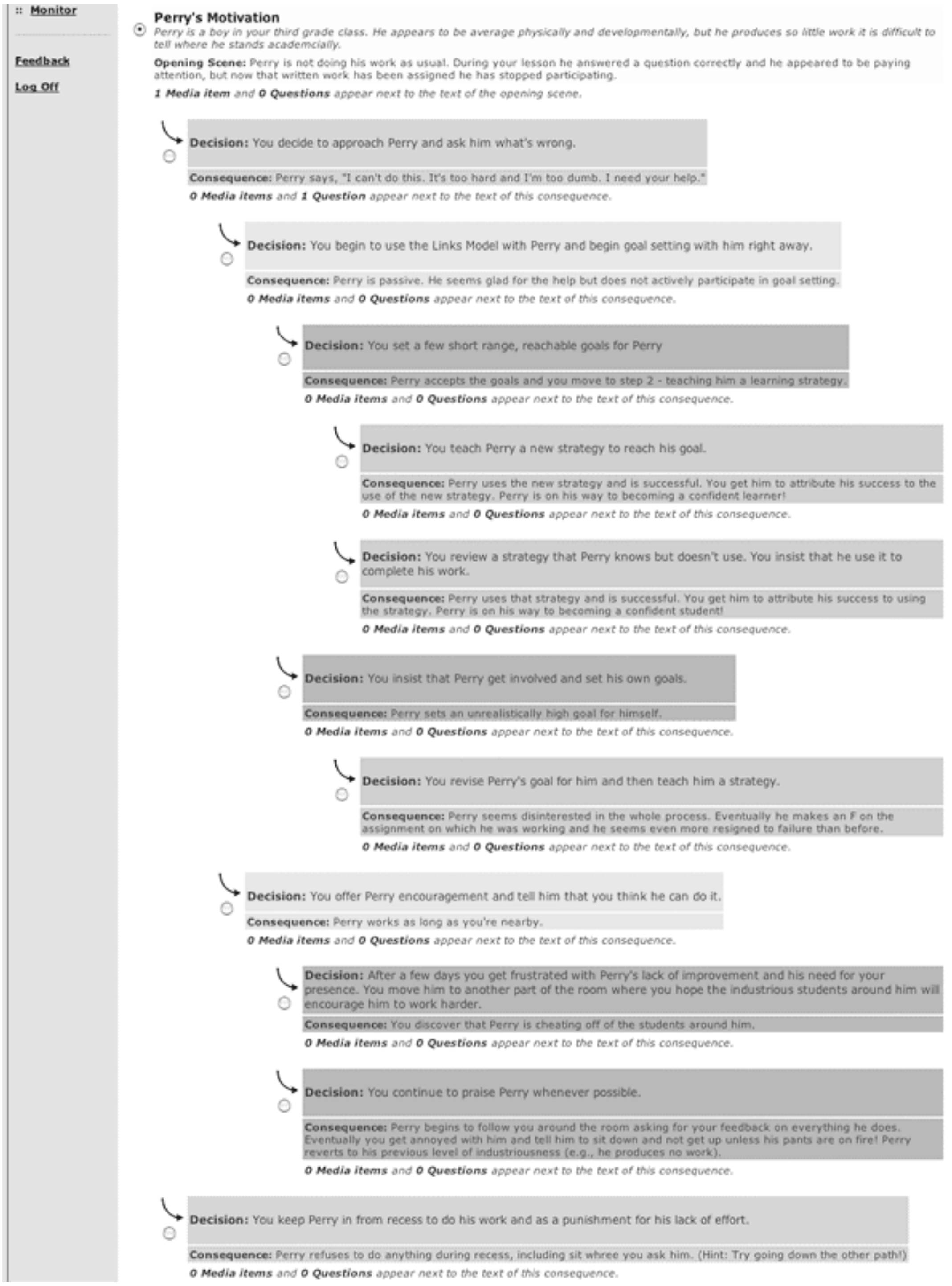

Figure 9: Situation with the highest structural complexity level

Figure 9 shows a situation has 11 decision choices, 1 question, and reaches 4 levels deep. The applied formula produced a complexity rating of 46.

$$(11 + (1/2)) \times 4 = \mathbf{46}$$

Log files

The simulation's log files showed how many of the instructors' students used SimTeacher, what situations and activities were assigned, what fictional characters instructors developed and employed, the content and frequency of assignments, and the personal preferences set by each instructor. These log files essentially demonstrated the level of instructor involvement with simulation-based learning.

Situation log

Situation content was evaluated based on its structural complexity. In sum, the complexity of a situation's storyline structure was determined by (a) totaling the number of questions incorporated into the situation, (b) dividing the total by two, (c) adding this number to the total number of decision choices (i.e., storyline branching) throughout the situation, and (d) multiplying the result by the situation's number of levels. This formula was developed to display the differing complexity levels of situations numerically. The complexity of each situation was calculated and is displayed in Table 4.

Details of Situations Used					
Instructor	Situation's Name	Opening Scene Words	Complexity (see formula below)	Media & Q's	Days Due
D	Spare the rod and spoil the teacher	741	16	Q	1 week
D	Overjustification	496	3	-	9 days
L	Bullying	45	2	-	n/a
L	Left Out and Alone	81	33	-	49 days
L	Making Praise Work	66	36	-	n/a
L	Perry's Motivation	35	44	-	56 days
M	How Do I Know?	85	18	M, Q	4 months
M	Left Out and Alone	81	33	M	4 months
M	Perry's Motivation	35	46	M, Q	4 months
M	Making Praise Work	66	42	Q	4 months
D's Averages					
618.5	opening scene words		**Average opening scene words:**	173.1	
9.5	complexity				
8.0	days due		**Average Complexity:**	27.3	
L's Averages			**Average Days Due:**	74.4	
56.8	opening scene words				
28.8	complexity				
52.5	days due		**Complexity Formula:**		
			(D + (Q/2)) x L		
M's Averages					
66.8	opening scene words		D = number of decision choices		
34.8	complexity		Q = number of embedded questions		
4.0	months due		L = number of levels deep		

Table 4: Analysis of instructors' situations

Activity log

Besides creating and assigning situations, activities were also assigned. Activities were already developed with limited options for instructors to modify the content. Instructors were able to assign four activities: the Job Interview (JI) activity, Take Attendance (TA) activity, Individualized Educational Plan (IEP) activity, and the Lesson Plan (LP) activity. At the discretion of instructors, these activities were to be completed by students once or numerous times during a semester.

The JI activity was designed to be the first experience for SimTeachers. The instructors' students were sent email invitations to become SimTeachers in this simulation. When students logged on (probably for the first time), they went through a job interview process answering questions asked by the vice principal of a fictional school. Instructors were able to edit some standard questions as well as add new questions if desired. Instructors were then able to review their students' answers and decide if they should be hired as "SimTeachers." Instructors also had the option of emailing students with follow-up questions before hiring them.

Additionally, there was an "auto-hire" setting that would hire students immediately after their interview. The JI activity was voluntarily employed by all instructors in this study. See Appendix H for a listing of all the default, modified, and new questions used in the JI activity across all courses. None of the instructors deleted any of the default questions. However, a few instructors modified questions and each created at least one new question. Instructor D hired students manually to become SimTeachers whereas the other two instructors used the auto-hire setting.

Instructors could designate how often their SimTeachers should take attendance in their virtual classrooms by assigning the TA activity. Students may have been asked to take attendance daily, weekly, or a variety of other combinations. SimTeacher.com would automatically and randomly select up to 20 percent of a virtual classroom as absent during each role call. By default, SimTeachers did not have to take attendance if the TA activity was not assigned by their instructors. Instructor D applied the TA activity for students to complete every Wednesday during the semester. Instructor L assigned the activity to occur only once for one course and daily for another course. Instructor M did not assign this activity at all.

The IEP activity allowed SimTeachers to develop an Individualized Educational Plan for one of their fictional students. Again, instructors were able to set this assignment as a repetitive task or a singular event. Instructor M was the only instructor to assign this activity. It was assigned to half of Instructor M’s courses (4 of 8): two courses were asked to complete an IEP every time students logged in over the semester while two courses were asked to complete an IEP only once over a 10-day period. Appendix F shows an example of a completed IEP assignment by one of Instructor M’s students.

Lastly, the LP activity let SimTeachers create lesson plans for their virtual classrooms. As with the other activities, instructors were able to set this assignment repetitively (e.g., daily or weekly) or only once. No instructors assigned this activity. Instructors did not make use of a few other SimTeacher resources either. For instance, the Theorybase resource allowed students and instructors to input, modify, and search for theories related to their field of study. The Library Links section of SimTeacher let users share and rate links to other online resources outside of SimTeacher.com or, if they liked, allowed them to create a Web page resource within SimTeacher.com. SimTeachers were able to converse with each other via a bulletin board system in the discussion section of SimTeacher.com. Unfortunately, the Theorybase, Library Links, and discussion section as well as the LP activity were not used in this study even though they were available.

Character log

Instructors were able to create fictional characters (students and teachers) in SimTeacher, complete with personalities and opinions, who could be cited in the situations. It only takes a few minutes to create and add a fictional character to a SimTeacher course. Instructor D created 20 fictional students and 6 fictional teachers for the simulation. Instructor L created 79 students and 6 teachers, while Instructor M created 3 students and no teachers. See Appendix I for example profiles of one of Instructor D’s fictional teachers and one of Instructor L’s fictional students.

Although Instructor L created far more fictional students than the other two instructors combined, 20 (i.e., one-fourth) of those characters – the same 20, in fact – were applied to Instructor L’s two courses. Instructor D applied all the characters that were created and Instructor M applied all created characters to only two of eight courses (two concurrent courses in the same semester). Instructor M, however, was the only instructor to incorporate a picture of a fictional student into a situation.

Preference log

Instructors could also set preferences in SimTeacher to receive an email whenever one of their students added a course, dropped a course, completed a situation, completed a situation more than once, added a new resource link, or added a new theory in the simulation’s database. Instructors did not change any of the default preference settings.

Classroom observations

Lastly, the researcher visited each instructor’s classroom at least once while students were using SimTeacher. This was to observe firsthand how the instructors were incorporating the simulated software in their courses and how their students were using it. Short descriptions of classroom visits appear within the stories below of each instructor’s experiences as well as in the “Student Data” section. For a detailed description of a visit, see Appendix J.

Instructors’ Experiences

The specific involvement of each instructor is described here, emphasizing what set each instructor apart from the others. How each instructor became involved in the study, content from their interviews, how they used SimTeacher with students, and the results of their efforts are included in their individualized stories below. Each story ends with a review of research questions relevant to that instructor.

Because of the qualitative nature of the study, the researcher served as an observer as much as possible, taking notes and documenting participants’ (i.e., instructors’) actions. Through interviews, email correspondence, and meetings, the researcher attempted to understand instructors’ experiences as well as document their actions. Additionally, the SimTeacher website logged all activity conducted by instructors and their students. The analysis of these data sources converge below to compose a complete story of each instructor's involvement – their expectations, challenges, failures, and successes. Educators can better prepare for simulation use in the future by understanding what went wrong and what went right for instructors during this particular study.

Story of Instructor D

Instructor D initially became interested in SimTeacher because Instructor M was using it. They were both in the same department and had offices next to each other. Instructor D invited the researcher to demonstrate SimTeacher in a graduate course. One graduate class session was dedicated to exploring SimTeacher as an educational tool. Demonstrative accounts were set up in advance. The instructor did not have to prepare the simulation; students simply logged on and worked through a pre-assigned situation and activities. Students appeared engaged as they evaluated SimTeacher for its educational use.

When the researcher met with Instructor D to discuss using SimTeacher with undergraduate classes, the participant was mostly interested in how to input content into SimTeacher. A few weeks later, D asked the researcher to review D's content and offer feedback. For two semesters, Instructor D used SimTeacher with undergraduate students (one course per semester). Two times during its use, D had a problem with SimTeacher due to software bugs and server issues. Otherwise, the participant did not require much assistance using the simulation.

Based on Instructor D's interviews, the participant's intention for joining the study was clearly in line with the purpose of the simulation. D said, "I wanted to use the situation feature so that students could be placed into the role of a teacher and then have to decide what to do in certain environments based on what they had studied." As intended, D used the simulation as a supplemental assignment to textbook readings and other classroom assignments. D also appreciated the simulation's potential since instructors were allowed to create content for their own students.

Despite Instructor D's good intentions, however, the simulation became a larger undertaking than expected. D put together interactive stories based on case studies from different books, but found that developing a complex decision tree was difficult. D explained, "So many decisions and outcomes were hard to develop because there were no hard and true answers [in my subject matter]." In another interview, D said it was particularly difficult developing outcomes for each decision, explaining that there "are often gray areas so I sort of felt like I was playing God in terms of stating what exactly would happen if they chose this course of action."

Email correspondence

An analysis of Instructor D's email messages showed that D's correspondence was primarily regarding student problems.

Thirty seven percent, or 13 messages out of a total of 35, were regarding student problems with SimTeacher’s use. This was mainly because of two problems that occurred with SimTeacher’s software while Instructor D’s class was using it. The first incident was a bug in the program that prevented students from completing an activity (namely, the “Take Attendance” activity). The bug was quickly fixed. The second incident involved an inability to access the database containing all the saved content of SimTeacher users. It was also quickly fixed and no data was lost.

Approximately 34 percent of Instructor D’s messages were equally split between two categories: (a) setting a time to meet about or use SimTeacher and (b) instructor problems with, or questions about, SimTeacher. Fourteen percent of the messages were about other people Instructor D knew who were interested in SimTeacher, and an equal number of messages were either about describing SimTeacher’s features and capabilities or about getting it to do something other than its current purpose.

Student traffic log

The log files show that Instructor D used SimTeacher numerous times with students. Of D’s 55 students, the average number of total logins per student was 30, with the most active student logging in 81 times and the least active student logging in 10 times. The majority (32 students), however, logged in between 20 and 40 times. More than half of those students (18 students, or 1/3 of D’s total students) logged in between 25 and 35 times.

Situation log

Instructor D developed and assigned two situations. The first situation was called “Spare the rod and spoil the teacher?” and had the description, “deals with a teacher's pressure to paddle misbehaving students.” It had a very long opening scene (741 words) and a situation complexity of 16. As previously shown in Table 4, the average length of a situation’s opening scene was only 173 words while the average complexity of a situation was 27. This suggests that Instructor D exerted too much effort creating an elaborate opening scene and too little time developing the situation’s diverting storylines. Instructor D also gave students much less time (a week) to complete the situation compared to the average duration given across all instructors (over two months).

The second situation D developed was called “Overjustification.” D described the situation as “a student is rewarded for reading books by being forced to read in front of her peers.” It also started with a long opening scene (496 words) and had one of the lowest complexity ratings (3) of all situations used. A low complexity rating is an indication of low interactivity within the storyline of the situation. Instructor D gave students only nine days to complete the situation. Again, this was much less than the average time given across all instructors, yet not much time may be needed to complete a situation with very low complexity.

Activity log

D also assigned two activities: the Job Interview (JI) and Take Attendance (TA). In the JI activity, Instructor D made use of all the default interview questions. D did not modify any of the default questions, but did create a new one (see Appendix H). D was also the only instructor to set the Auto-Hire feature to Off. When this happens, the instructor receives an email notification when each student completes the JI activity. The instructor then must manually *hire* the student online at SimTeacher.com.

The log files of student traffic, situations, and activities demonstrated that Instructor D was active in applying the simulation. However, not all of the participant's efforts produced the desired results. D invested too much effort in the opening scenes of situations and later admitted that the situations were not as developed as desired. D may have also exerted unnecessary effort by turning off the Auto-Hire feature in the JI activity. To explore Instructor D's experience further, the research questions are examined specifically in relation to D.

Perspective issues

What were key factors D considered in the decision to use the simulation? For example, what were D's expectations, goals, and motives before using the simulation? What prior experience and knowledge did D have regarding simulation-based learning and was that a factor for success? How was success determined?

Instructor D was familiar with the use of educational simulations in higher education, yet personally had not used one with students before. SimTeacher appealed to D because it allowed instructors to create their own content. D wanted to place students in environments featuring the specific content covered in class. Success, for D, was contingent on how well those goals were met. D achieved limited success because more time was needed than expected to create the simulated environment D wanted. Instructor D particularly found it hard to create rich storylines with many alternative decisions and outcomes for students.

Procedural issues

How was the simulation used? Was it an in-class or out-of-class activity? How did it accompany the course material? Was the simulation used primarily as a learning tool or an assessment tool?

In D's graduate course, students informally evaluated SimTeacher's use as an educational tool. They commented on the use of instructional design and technology. Some felt it was a creative way for learners to play with applicable theoretical content. Others felt it lacked the sophistication and media of an immersive experience. At the undergraduate level, however, Instructor D made SimTeacher part of the course curriculum, assigning due dates and awarding points for completion. SimTeacher out-of-class assignments were used both as learning tools and assessment tools, supplementing textbook readings and quizzes.

Technical issues

What resources of the simulation were most or least used, and why? For example, why did D choose particular activities, how did D use them with students, and how effective were they?

Instructor D created two new situations instead of repurposing any from another instructor. D also used the JI and TA activities and developed 26 fictional characters. Combined with the high login rate of D's students, this showed Instructor D was highly active with SimTeacher. Many of the resources not used by D were also not used by any other instructor in the study. Furthermore, D was the only instructor to attach course credit to SimTeacher assignments.

D chose to use the situations because they directly related to the course content. The JI activity was used as an introduction into the simulated environment of SimTeacher. The TA activity was used to give SimTeachers a sense of commitment and realism to the simulation and, as D said, "to give them a reason to log in each day."

Although the TA activity was not as effective as planned due to a bug in the software, the simulation as a whole did serve its purpose and D decided to use SimTeacher for a second semester. On the other hand, D struggled to create the richly complex situations desired, which would have maximized the simulation's effectiveness.

Outcome issues

Was SBL effective? How so? Did D feel it was more advantageous than (or complementary to) other methods of instruction? What could D point to or look at to suggest that students learned anything from using the simulation?

Instructor D wanted students to get more out of the simulation than they did. D said, "I thought students may have commented on the situations more but they were pretty silent about them." D felt this was due to the lack of time needed to fully use many of SimTeacher's capabilities. D said, "I underestimated how busy I would be during the semester and so was unable to use it as much as I wanted to." If adequate time were dedicated, D expressed that a simulation like this could be used as both a valuable learning activity and an effective assessment tool, and that it would be "much better than essays or multiple-choice assessments."

In the future, Instructor D would most likely continue using SimTeacher if more situations were developed in the subject area and if the subject matter lent itself to more clear right or wrong answers. Nonetheless, D appreciated the opportunity to use SimTeacher and confessed, "It made me think about authentic activities."

Story of Instructor L

Instructor L initially became interested in SimTeacher because Instructor M was using it and L "liked the thought-provoking hands-on experiences" for students. Instructor L participated in the study for two semesters with about 25 undergraduate students each semester. SimTeacher was incorporated into L's lectures and often served as "a catalyst for in-depth discussions in class and [for some students] led to further research." When the researcher visited Instructor's L classroom, the participant used the visit as an opportunity for students to ask questions and comment about the educational simulation (SimTeacher) they had been using. Students wanted to know how long it took to develop, if features like Spell Check would be added, and expressed how much they enjoyed working with it. L confirmed in a later interview that, although L had never used simulation-based learning before, students "really enjoyed it very much" and "they wanted to do more simulations."

Email correspondence

An analysis of Instructor L's email messages showed that L's correspondence (14 out of 29 messages, or about one-half) was primarily regarding setting up meetings with the researcher and (11 out of 29 messages, or approximately one-third) were regarding problems or questions about the use of SimTeacher. Besides those two categories, L only sent four other messages regarding minor student problems. Meetings with Instructor L were spent advising how to navigate within SimTeacher and informing L about what the technology could do. L appeared extremely motivated about using the new technology in a classroom setting and shared that it was something the participant was looking for.

Student traffic log

The log files show that Instructor L used SimTeacher with 50 students. The average number of total logins per student was 4.5, with the most active student logging in 14 times and the least active student logging in only twice. Approximately half (26) of L’s students, across both classes, logged in three times. Looking at each class individually, however, students in one class logged in an average of three times, whereas students in the other class logged in an average of six times.

Situation log

Instructor L assigned three situations, all repurposed from another instructor. When an instructor repurposes a situation, they merely apply a situation someone else created. L said, “I liked that I could easily re-purpose someone else's simulation for my classes.” In the “Perry’s Motivation” situation, Perry was a boy in third grade who appeared to be physically and developmentally average, but he produced so little work it was difficult to ascertain where he stood academically. The situation emphasized the concepts of learned helplessness and motivation. In the “Making Praise Work” situation, the SimTeacher was asked to use praise effectively in her classroom to create a more positive atmosphere. In effect, this situation emphasized the concept of praise. In the “Left Out and Alone” situation, Jennifer (a simulated character) needed to find friends and fit in. This situation emphasized social isolation.

The “Making Praise Work” situation had a complexity rating of 36; the “Perry’s Motivation” situation had a complexity rating of 44, and the “Left Out and Alone” situation rated 33 in complexity. The students had almost two months to complete the situations. Instructor L created one new situation called “Bullying” with a complexity of 2 (the lowest of all complexity ratings), but did not assign it to students. In the unused Bullying situation, Jesse Prince just moved into town and was having a very hard time adjusting. All of the kids in the classroom teased him because he was new. One child in particular continually pushed Jesse when he passed by. Like the Left Out and Alone situation, the Bullying situation emphasized social isolation. Although Instructor L never assigned the Bullying situation, it is significant that L took the time to create it.

Activity log

For activity assignments, Instructor L assigned the same two that Instructor D assigned: the JI and TA activities. The students essentially had the entire semester to complete these assignments. In the JI activity, Instructor L made use of all three default interview questions, plus added seven new ones -- three for one course and four for the other (see Appendix H). With the TA activity, students in one course had it assigned only once whereas in the other course it was assigned daily.

The log files of student traffic, situations, and activities revealed that Instructor L was exploring the use of SimTeacher and how it fit in with the course curriculum. L created one situation, but never assigned it. During one semester, L assigned three repurposed situations, assigned the TA activity only once, and students logged in an average of six times. The following semester, L assigned only two repurposed situations, assigned the TA activity daily, yet students only logged in an average of three times. L created 85 characters, yet only used 26 of them. This pattern indicates that L was mostly exploring SBL. The research questions are now revisited as they apply to Instructor L.

Perspective issues

What were key factors L considered in the decision to use the simulation? For example, what were L's expectations, goals, and motives before using the simulation? What prior experience and knowledge did L have regarding simulation-based learning and was that a factor for success? How was success determined?

Instructor L chose to use SimTeacher so students would, in L's words, "have real-world teacher experiences and learn from them before they were actually working with live students." L had never used an educational simulation before and therefore was not clear on what the outcome would be. If anything, Instructor L saw this as an opportunity to explore the technology and the idea of giving students a virtual teaching experience. Success was based on how well the students took to the simulation and whether the instructor could apply it to the course. Using this set of criteria, SBL was successful for Instructor L.

Procedural issues

How was the simulation used? Was it an in-class or out-of-class activity? How did it accompany the course material? Was the simulation used primarily as a learning tool or an assessment tool?

L first incorporated SimTeacher in course lectures and then had students access the website during subsequent class sessions. L said the educational simulation was used to “assess my students knowledge of course material and also as a learning activity.”

Technical issues

What resources of the simulation were most or least used, and why? For example, why did L choose particular activities, how did L use them with students, and how effective were they? Were there aspects of the simulation’s design or feature-set that helped or hurt its efficacy as a learning tool?

Instructor L mostly used the situation feature of SimTeacher, which is its most central feature. However, instead of constructing new situations, L chose to repurpose ones already created by other instructors. L said, “I wish that someone had more time to set up several more simulations for my students.” Apparently, L preferred to have others create the interactive story content, even if L had the time to do so. This was not because it was difficult to get the content into SimTeacher. L thought it was “relatively easy” to create content, but simply preferred to spend time on other teaching efforts and have simulation components pre-constructed and ready to apply.

Outcome issues

Was SBL effective? How so? Did L feel it was more advantageous than (or complementary to) other methods of instruction? What could L point to or look at to suggest that students learned anything from using the simulation?

L said, "I was pleased with the results of SimTeacher." This may be because L took more of an exploratory approach to using the simulation compared to the other instructors. To see if students actually learned anything, L was able to look at their responses to the simulated situations and, as Instructor M did, center classroom discussions around the content used in SimTeacher. When it was time for suggestions, L commented, "The main shortcoming was not due to SimTeacher, but was due to no Internet access." Instructor L's class met in more than one location and the Internet was not always available.

Story of Instructor M

Instructor M participated in the study for four semesters, with two undergraduate courses each semester and about twenty students in each course. In other words, M applied SimTeacher to 8 courses and 160 students. By far, Instructor M had the most experience using SimTeacher over time.

The researcher first approached Instructor M because of the instructor's research interests, which were publicly displayed on the website of the university where M was employed. After agreeing to participate in the project, M was the first to use

SimTeacher in a classroom setting. M explained why using SBL with online tools had only recently become an option.

> The School of Education recently implemented a new requirement for students to own an Apple iBook with wireless Internet capabilities. Now that all students have this, there's a new opportunity to use Web-based simulations. This opportunity didn't exist before; it wasn't always convenient to hold class sessions in a computer lab. Furthermore, there's a lack of non-computer educational simulations out there, or at least an awareness of them. So an educational simulation wasn't used before mainly because the resources weren't available in the past.

Instructor M particularly liked SimTeacher because it was reality-focused and had the capability to be a multi-dimensional simulation – in other words, many things could happen at once. The participant strategically used course topics that "seemed amenable" to SBL. M also prepared a "fluid and flexible" packet of readings for the opportunity, if needed, to change the teaching emphasis after the semester began. As M stated, "that allows me to shape my class according to whatever I want my students to be able to do with the information [...] including doing a simulation."

The researcher's visit to Instructor's M classroom was the most revealing of instructor visits in terms of directly observing SBL in action. See Appendix J for a full description. Instructor M was particularly skillful at using SimTeacher as a springboard for lively classroom discussions. M would let students work on a SimTeacher situation for 10 minutes at a time, then have everyone share with the group how they responded to it. Some students would mention points that other students had not thought of even though they chose to “act” similarly in the simulation (i.e., they chose the same pathway of the storyline). Instructor M ended each discussion topic by referring to theories previously covered in the course material.

Email correspondence

An analysis of Instructor M’s email messages showed that M’s correspondence was primarily regarding other people interested in the simulation. Approximately half of the participant’s emails (16 of 31) fell into this category mainly because M knew the study needed more instructor participants early on. After all, it was Instructor M who encouraged Instructors D and L to get involved. About a third of the messages (10 of 31) were about setting up a time to meet to discuss SimTeacher. Discussions were mostly regarding the features and capabilities of SimTeacher, with a focus on new development ideas for future versions of the simulation. Two email messages were regarding development ideas, two messages were regarding SimTeacher problems or questions of operation, and only one message was a suggestion to use SimTeacher for something other than what it was developed for.

Student traffic log

The log files showed that Instructor M used SimTeacher with 160 students. The average number of total logins per student was 2.75, with the most active student logging in 6 times and the least active student logging in only once. M’s students logged in fewer times than the average student across all instructors (5 logins); however, M assigned more situations and activities than other instructors. Therefore, it is evident that M’s students were much more productive per login as compared to the other students.

Situation log

Instructor M developed and assigned four situations. M explained that SimTeacher was always used “at the end of the course because that's when there's more of an emphasis on practical application.” As elaborated more in the “Conclusion” section of this study, M’s approach was identified as a key ingredient for successful simulation-based learning. Also, some of Instructor M’s applied situations will sound similar to those applied by Instructor L. This is because the situations were originally developed by M and then later repurposed by L.

M’s Making Praise Work situation was about a teacher who “wants to use praise effectively in her classroom to create a more positive atmosphere.” It emphasized theories of praise. The How Do I Know situation was described as “a student in your first grade class is having difficulty in reading [and] before recommending a special education screening, you decide to assess the student yourself.” This situation focused on informal classroom assessment. The Perry's Motivation situation was about learned helplessness and motivation. Lastly, the Left Out and Alone situation, about social isolation, was regarding a student’s need “to find friends and fit in.”

The complexity levels of each of the four situations were, respectively, 42, 18, 46, and 33. Considering the average complexity level of 27.3 across instructors, Instructor M generally used situations that were more complex. Consequently, M allowed students an average of four months to complete the situations (extending beyond the semester's end). M's situations may have been more complex because of more time spent with SimTeacher. As M explained,

> At first I had some difficulty using the tool. I think it was because I hadn't tried a simulation on SimTeacher before I tried to write one of my own. That made it more difficult for me to figure out exactly what I wanted my simulations to look like. After I got the hang of it, though, I was able to use the site easily. I can find and fix what I need to very quickly. So, over time I've learned what to do and how to do it fairly well.

Activity log

M also assigned two types of activities: the JI and the IEP. In the JI activity, Instructor M made use of all four default interview questions, modified two of them, and added two new ones (see Appendix H). The two questions M modified were edited a second time for another of M's courses. Notably, Instructor M was the only instructor to utilize the IEP activity in SimTeacher (see Appendix F). M applied it to half of the participant's courses, and was also the only instructor to make use of the Notes feature. However, unlike the other instructors in the study, M did not use the TA activity at all. M explained,

> There are other things, like the Attendance and Lesson Plan activities, that I haven't used because I teach a class about practical application, not a methods

> class. In particular, much can be done with the Notes feature. [...] One thing I've noticed is that they find it more engaging when I send them notes, especially individually, as they are working in the simulation. For instance, I can send a personalized note through the simulation from the principal of the school to a specific student (i.e., SimTeacher) in my class. When I send the entire group the same message, it doesn't have as good as an effect. They are more engaged in the simulation when their interaction is personalized.

The log files of student traffic, situations, and activities demonstrated that Instructor M was the most advanced user in the study. M had the most experience using SimTeacher, developed more complex situations, and made use of features that were bypassed by the other instructors. Now, the research questions are revisited as they relate to Instructor M.

Perspective issues

What were key factors M considered in the decision to use the simulation? For example, what were M’s expectations, goals, and motives before using the simulation? What prior experience and knowledge did M have regarding simulation-based learning and was that a factor for success? How was success determined?

Although Instructor M had the most experience using SimTeacher, it was the first simulation M used. “I liked the reality of it in that it has pictures of people and asks students to go through processes that are things they will be doing in a real classroom,” M said. Each semester, M’s students said they liked it too, so M continued to use it and became more comfortable with it over time. Apparently, SimTeacher was successful enough at meeting M's expectations to apply it semester after semester.

Procedural issues

How was the simulation used? Was it an in-class or out-of-class activity? How did it accompany the course material? Was the simulation used primarily as a learning tool or an assessment tool?

Instructor M used the simulation solely as an in-class activity. The concepts emphasized in the situations reflected those in the course readings. M also led in-class discussions regarding those concepts (e.g., social isolation, praise, and learned helplessness) after students completed each SimTeacher situation. M commented,

> I have always used the simulations as class activities, but I could use them as a form of assessment. However, I would prefer to make them more open-ended if I were going to do that. I want to know what my students think and plan to do with what they've learned in my class, more than just wanting to know if they've learned anything. By asking what they plan to do in their own way with the new knowledge they've gained I can assess their level of understanding of the knowledge as well as their ability to think for themselves.

Technical issues

What resources of the simulation were most or least used, and why? For example, why did M choose particular activities, how did M use them with students, and how effective were they? Were there aspects of the simulation's design or feature-set that helped or hurt its efficacy as a learning tool?

As previously mentioned, Instructor M was the only instructor to make full use of the Notes feature. Notes can be sent in real time as students work through the simulation, making the virtual school more interactive and dynamic. M was also the only instructor to use the IEP activity, yet also the only instructor not to use the Take Attendance activity. M admits, "I haven't used all of the features, although I think they look useful. I guess that means that some of the features are less useful than they first appeared, although I think it's really that I haven't taken the time to try to use them in my class." Nonetheless, M's experience was most salient with the use of situations.

By far, M created more richly complex situations than the other instructors, leading M's students into informative classroom discussions. "At first I found it hard to create the content. In the future, I'd use a program like Inspiration to create the layout first," M said. "The content wasn't as hard to produce as managing the conceptual layout of a story." Inspiration® (see http://www.inspiration.com) is a software tool that helps users visualize, organize, and think about concepts. Instructor M would use it to graphically map the interactive story branches of situations.

Outcome issues

Was SBL effective? How so? Did M feel it was more advantageous than (or complementary to) other methods of instruction? What could M point to or look at to suggest that students learned anything from using the simulation?

Instructor M's primary goals for SimTeacher were to apply course concepts in a more practical fashion, to give students a relevant space to practice their newly learned theories, and to stimulate lively class discussions. Each semester, M succeeded in meeting these goals. When asked how the participant would further develop the simulation, M wished it would "allow students to create their own pathways." Indeed, such an approach would make the tool more learner-centered in future versions.

Member checking

Within a year after simulation use, instructors were asked to member check the data collection and interpretation of their experiences. This process was conducted to verify the validity and accuracy of the researcher's findings.

Instructor D briefly concluded,

> The attached document looks accurate. It was very interesting to read.

Instructor L concluded,

> I have read the attachment and agree with it. Pre-service teachers were placed in situations that they will encounter as teachers. They were forced to make decisions that affect their "students" and reflect on the outcome of those decisions. Just like a simulation for pilots or automobile drivers, simulations offer real world situations to hone the future teachers skills and decision making before it is critical to their success as a classroom teacher. It is more advantageous than a theoretical classroom discussion for example. First of all, the students enjoyed the Sim Teacher very much. So, it offered a "fun" way to learn. Secondly, the student had to make decisions and then see the result of the decision without harming a real student. So, the Sim Teacher allowed

> the pre-service teacher to learn what might work and what would not work in a classroom without adversely affecting a child. Another benefit from Sim Teacher was the INTERVIEW that the pre-service teacher had to complete to be hired. Of course they were all hired, but that was a very insightful experience for future interviews and became the basis for classroom discussions regarding the interview process.

Instructor M concluded,

> I agree with everything it says, except one small point. That is the part when you say that I allowed up to 4 months for my students to do the simulations because they were more complex. Actually, I set up the access to all of the simulations at the same time and set the start and end dates the same because it was easier. I knew that I would use them in particular classes, but just in case I wanted to access one at a different time I set everything up to be open over most of the semester. It was done for my benefit, not the students.

In sum, the instructors all agreed their experiences were accurate and valid. Additionally, Instructor L reinstated some of the outcome goals and Instructor M clarified the intension of assigning extended due dates on simulation assignments.

<u>Retrospective questions</u>

While member checking, instructors were also asked to respond to three retrospective questions. The questions and instructors answers were as follows.

- How much time did you spend or need to set up the simulation, maintain it, provide students feedback, etc?

  Instructor D responded,

  > Not much time. I mainly worked on creating the two simulations and then examining student performance. Overall, it was time well spent because it was an activity that made me think about "real world" activities.

  Instructor L responded,

The simulation was not very time consuming. I spent about 2-3 hours per week on it.

Instructor M responded,

I spent quite a bit of time initially getting used to SimTeacher and creating the simulations. I think I probably spent about 2-3 hours per simulation I wrote and about an extra 4-5 hours just trying to figure out how to use all of it. There were so many options and ways to access different parts of the simulation that I would get lost sometimes and have to figure out what to do next. It took me awhile to feel comfortable navigating to the different parts of the simulation and finding what I wanted (for instance, building a character or adding questions to my simulation). After that I didn't spend very much time each semester using it in my classes. I would spend about a half hour or less per simulation making the assignments and figuring out if I wanted to assign something extra beyond the basic simulation, such as the IEP. During class my time was minimal, just signing in and helping the students get in so they could work.

- What kind of support or scaffolding did you provide for your students while they were working on the simulation?

Instructor D responded,

None. SimTeacher was well-supported. [The researcher] was very quick to respond to support questions. I did demonstrate how to log into SimTeacher in class and how to do a few things but it was very user friendly.

Instructor L responded,

We demonstrated it in class and then [the researcher] and I were both available by email and I was available by phone for any problems or questions that students had. Also, the students had discussion boards available to help one another.

Instructor M responded,

I showed them how to login the first time and what to click on, and I explained to them the purpose of the simulation. But, after that they were able to handle it on their own. Their part was easier than mine.

- What learning goals did the simulation satisfy for your class(es)?

  Instructor D responded,

  > The application goals of applying skills learned in the classroom to authentic teacher situations.

  Instructor L responded,

  > The simulation met a technology goal that I have for my classes: to integrate technology into the classes whenever possible. Also, the simulation provided opportunities to learn more about social isolation, motivation and praise of students in the classroom using real world situations, and it was readily available at home via the internet.

  Instructor M responded,

  > I wanted my students to have practice with the material and SimTeacher allowed that. I wanted them to have to think and justify decisions they made using some of the concepts we had just discussed in class, which was what they got to do with the simulations. It made their practice seem a little less hypothetical, even though none of the simulations were based on real students. However, some of the things I wrote were composites of behaviors of students I had when I was teaching.

In sum, instructors invested a few hours to become acquainted to the SimTeacher environment, to explore the options available to them, and to learn how to create content. After initial use, it took Instructor M two to three hours to create the structurally rich situations used in the study, whereas Instructor L merely repurposed Instructor M's situations in a matter of minutes.

Instructor M spent a half hour or less each subsequent semester to reassign simulation situations and activities to new students. After students received their SimTeacher assignments, Instructor L spent two to three hours a week monitoring student use and providing feedback. Overall, instructors claimed that they did not have to invest much time to integrate the simulation into their classes. Instructors did not need to provide much scaffolding or support to their students either after introducing the simulation tool and demonstrating how to log on. Lastly, SimTeacher satisfied the instructors' learning goals by offering students a more authentic way to think about and practice the course material.

Student Data and Experiences

Secondary to instructor data were the data collected from instructors’ students. Some of the college students in this study were observed in class by the researcher during simulation use to provide additional information about instructors’ experiences with SBL. Students also received a voluntary questionnaire after simulation use to capture a student perspective of using SimTeacher.

Classroom observations

Instructor D’s students completed SimTeacher assignments outside the classroom. However, the researcher did observe D’s graduate students exploring SimTeacher. They worked through assignments for demonstrative purposes. The graduate students were interested in SimTeacher’s use of design and technology. Students of Instructors L and M completed a majority of their SimTeacher work during class time. L chose to use the researcher’s classroom visit as an opportunity for students to ask questions about SimTeacher. L’s students commented on the features they liked (e.g., the TA activity) and features they would like to see (e.g., a built-in spellchecker). The visit to M’s classroom, though, was an informative glimpse of SimTeachers in action. Observation notes from the visit are found in Appendix J.

Post-simulation questionnaire

Instructors received a questionnaire (See Appendix C) to administer to their students within two weeks of completing simulation use in a course. Instructors had the option of handing students paper copies of the questionnaire or emailing it to them. The researcher was willing to receive responses in any format. Again, this assessment was subject to whether or not the instructor wanted to be part of this process. The benefit was the opportunity to gain a better understanding of what students thought about using the educational simulation.

Of the 265 students who used SimTeacher, 48 (or 18 percent) completed and returned questionnaires. Some were received in email form, while others were written responses on paper-administered questionnaires. More than half were submitted by students from Instructor M’s course. All were undergraduate students at a major southwestern university. See Appendix K for the questionnaire results, including themed results and individual quotes.

In sum, students liked having many choices to act within the situations and wished the situations offered even more choices. Many students indicated that they synthesized concepts from previous classes or consulted other resources while working with SimTeacher. They felt simulation use was a fair way to test their course knowledge and that it helped prepare them for the field. Interestingly, students suggested that SBL was not an effective means of teaching new course material but that it did provide good practice using course material already learned. Lastly, almost all students found the website easy to use and reported using it up to an hour each week.

Chapter 5: Conclusions

This study examined how instructors used an online simulation for teacher education. It explored instructors' motives for using the simulation, their level of involvement, and the results of their efforts. In this chapter, theoretical implications of the study's findings are emphasized. Specific attention is paid to *why*, *when*, and *how* SBL was successful. Limitations of the study are considered, and future directions for SBL are proposed.

Theoretical Implications

Based on the literature review, a number of research questions were developed. Initially, the questions were applied to each instructor's experiences to facilitate data analysis. To expand on the *interpretation* of data, as Wolcott (1995) put it, the research questions will be revisited in light of all three instructors' experiences as a whole, focusing on the theoretical implications of the study's findings.

Perspective issues

What were key factors instructors considered in their decision to use the simulation? For example, what were their expectations, goals, and motives before using the simulation? What prior experience and knowledge did they have regarding simulation-based learning and was that a factor for success? How was success determined?

None of the instructors had used an educational simulation with students prior to this study. For each, the decision to start using one was contingent on how well it seemed to fit in with course content and teaching goals. Overall, instructors were careful not to make SBL too large a part of their curriculum, mostly because educational simulations were new to them. Additionally, SimTeacher was a new product in general.

Success with SimTeacher depended on whether or not the simulation's effectiveness matched an instructor's level of involvement. If instructors dedicated considerable time to using SimTeacher, they wanted to see results. Instructors reported *success with SBL* when they saw their students become engaged in the content, as opposed to when students learned content. This resonates with Salomon (2000) and Lainema and Nurmi's (2006) assertion that the results of simulation use are qualitatively different than those of more traditional methods of instruction. This finding also suggests that simulations are better suited for deepening students' understanding of material rather than for covering new material.

Whitehouse (2005) found similar results after studying simulation use at the Wharton School of Business in the University of Pennsylvania. Based on faculty feedback, a central goal of SBL emerged that has shaped most of Wharton's projects: to *enhance* classroom experience and to *strengthen* student-faculty interaction without trying to *replace* either. Accordingly, a greater focus was placed on *deepening* the educational experience rather than *extending* its reach. In particular, Wharton School Marketing Professor Peter Fader believes the goal of most teaching materials, including simulations, is to stimulate discussion (Whitehouse, 2005). Both Instructors M and L used SimTeacher to stimulate discussion.

Procedural issues

How was the simulation used? Was it an in-class or out-of-class activity? How did it accompany the course material? Was the simulation used primarily as a learning tool or an assessment tool?

In each case, the simulation was used for its intended purpose: to give students the opportunity to apply concepts they were learning in class to real world scenarios. As Instructor M put it, SimTeacher provided "a way to have students practice what they've learned in class in a more authentic way than simply talking about theory." Instructor D had students access the simulation out-of-class, whereas the other two instructors used SimTeacher as an in-class activity. Instructor D awarded students points for completing SimTeacher assignments; the other two instructors used assignments as a springboard for classroom discussions.

M clarified why simulation use was paired with in-class discussions: "I would say they [i.e., situations] met my purpose for using them because my purpose is mainly to get the students to think actively about the day's topic. No matter how much I try to engage the students in discussion, some won't talk. By making them respond to a particular situation they all have to participate equally.” All three instructors – as well as most students – agreed that SimTeacher could be used as an effective means of assessment. However, it was only used as a learning tool when integrated into the classroom curriculum.

Instructors M and L were able to find room for SBL in class. Instructor D may not have had the luxury of time. As Gros (2003) pointed out, the greatest difficulty of simulation use in classrooms may be finding room for it inside the syllabus. Therefore, the question of *when* to incorporate SBL is relevant. By using simulations in-class, in-class discussions may naturally follow. If simulations are used out-of-class, students could still be asked to share their experiences during class discussions. However, the latter approach may not be as effective as the former.

Graham (2005) described four levels of blended learning: (a) activity-level blending, (b) course-level blending, (c) program-level blending, and (d) institutional-level blending. Instructors M and L blended simulation use with in-class discussions at the activity-level. The technology was used to make learning activities in class more authentic. Instructor D, however, blended SimTeacher into curriculum at the course-level. The course level is one of the most common ways to blend, where computer-mediated activities support face-to-face activities yet they do not necessarily overlap in time (Graham, 2005).

Simulations may also have a better chance of improving field-specific abilities after the learner has already reached a certain level of prior experience and knowledge in the field (Gros, 2003). Salomon (2000) posited that traditional teaching methods (e.g., textbooks and multiple-choice exams) are better suited to enhance recall information, whereas technology intensive, constructivist teaching methods are better suited to promote question formulation, hypothesis generation and sophisticated problem solving. Swaak et al. (2004) suggested using expository instruction to lay a foundation of definitional knowledge, and subsequently use discovery learning or simulations to build more complex intuitive knowledge. Therefore, educational simulations might work best in more advanced courses or at the end of a course, succeeding a prerequisite understanding of the field (Gee, 2005; Kneebone et al., 2005). Instructor M intentionally used SimTeacher at the end of the course for this reason and found positive results.

Despite how fantastic instructional technology might appear, students may get little out of it if they are not appropriately prepared. Novice learners often draw spurious conclusions when given a rich learning environment without any guidance or direction (Gee, 2005). Also, while we expect students to create their own knowledge, we do not expect them to recreate entire fields of knowledge. Novices gradually become part of the practicing community through the help of learning facilitators or established practitioners (Kneebone et al., 2005).

Technical issues

What resources of the simulation were most or least used, and why? For example, why did instructors choose particular activities, how did they use them with their students, and how effective were they? Were there aspects of the simulation's design or feature-set that helped or hurt its efficacy as a learning tool?

The most central asset to SimTeacher was its use of interactive storylines, called situations. Begg et al. (2005) reminded educators that, when placing students in simulated environments, students should feel compelled to intervene. Furthermore, each intervention should prompt further action. SimTeacher's situation feature afforded this functionality and instructors used it more than any other feature. However, the feature required a large time commitment from instructors. Coming up with multiple branching within a storyline's structure proved to be a difficult task. Each instructor approached the task differently.

D drew from published case studies for ideas to use in situations. Unfortunately, like case studies, D's situations had long introductions and lacked interaction. Although Instructor M did not refer to unidirectional case studies for situation content, multidirectional branching was still a difficult task. As M explained,

> I wrote the simulations out on paper and tried to type them in from there. [...] The simulations branch so much that it's almost impossible to keep up with them on paper. I think the most challenging part was to try

> to figure out sensible options at each branch. I didn't want one branch to seem too obviously the right choice.

Instructor L, however, chose to simply repurpose the situations that M had already created. When an instructor repurposes another instructor’s situation, the repurposed situation can be edited; content can be modified, and the storyline branching can be altered. L repurposed M’s situations without modifications. When L created an original situation, it lacked the structural complexity of the repurposed ones. Ultimately, L chose not to assign it to students. Nonetheless, Instructor L and the others planned SimTeacher activities around situations. The students also voiced the importance of having structurally complex situations. According to the questionnaire results, the students’ favorite part of the simulation was having multiple pathways in the situations. Not surprisingly, their least favorite part was not having enough pathways.

There were a number of other features not used mostly due to the time constraints of instructors. Features such as the Theorybase, the Library resource, the Discuss area, and the Lesson Plan activity were never used by any of the instructors in this study. M, the only instructor to use the Notes feature, said that sending notes to students while they worked on the simulation provided a heightened sense of interaction and excitement with SBL. Like well-structured situations, however, this feature also demanded a high level of involvement from the instructor.

Outcome issues

Was SBL effective? How so? Did instructors feel it was more advantageous than (or complementary to) other methods of instruction? What could instructors point to or look at to suggest that their students learned anything from using the simulation?

SimTeacher can be an effective tool if instructors use their time wisely. D invested ample time in developing situations, but they were too top-heavy; D's opening scenes were almost four times the average length. The effort did not produce rich, complex storylines. In comparison, M had much shorter opening scenes to situations, spent more time developing multiple decision choices, and added levels of structural depth to the situations. M's approach had a better payoff, confirmed by student responses to the post-simulation questionnaire.

Furthermore, both Instructors M and L reported successful use of SimTeacher to launch in-class discussions, making SBL complementary to classroom lectures and group activities. If the goals of SimTeacher were to get students to practice what they learned and to think actively about a topic, then the goal of follow-up discussions may be to assess if this had happened. Follow-up discussions give students opportunities to share their understandings of the practice exercise with peers, to hear multiple perspectives, and to correct personal misunderstandings. Instructor D's students logged into SimTeacher much more frequently than the other students, yet using the tool as an out-of-class activity did not engender in-class discussions. As a result, D did not report the success that M and L did.

There are a few other examples of misdirected effort. D spent time individually accepting his students as SimTeachers after the Job Interview activity, while the other instructors used the default auto-hire setting. D did not report any advantage to manually hiring students. According to the log files, Instructor D specifically spent time on efforts that made the simulation appear more *realistic* (e.g., manually hiring SimTeachers, applying the Take Attendance assignment for each log in, etc.). On the other hand, Instructor M concentrated efforts on making the simulation appear more *interactive* (e.g., creating structurally complex situations, sending SimTeachers notes in real time as they worked on the situations). Instructor M reported achieving great success by engaging students in the content. These examples show that not only is investing time in SBL activities important for success, but *how* time is invested may also be crucial.

Interestingly, instructors did not provide any examples of students learning anything new during simulation use; they only reported success when they observed their students engaged in the content. Students may very well learn with SBL, but the distinction is that SBL fosters the understanding of how things work in practice (Salomon, 2000; Swaak et al., 2004). SBL involves the learning of process and application more than the learning of new content. In other words, SBL facilitates tacit understanding as compared to an increased knowledge base of facts.

Although a product like SimTeacher may not be the best option to increase factual knowledge, it did offer a viable way to assess factual knowledge. By embedding questions inside of situations, as instructors did, they were able to ask questions similar to any paper exam. Answers to those questions were saved in the online student portfolio section of SimTeacher.com. Furthermore, SimTeacher provided instructors with information such as how many times each student logged in and how long it took each student to complete an assignment. Based on this information, instructors could assess students' involvement as well as students' understanding of the course content.

Deconstructing Successful SBL

One instructor (M) reported substantial success using SBL with an extensive amount of effort. Another (L) reported moderate success with little effort. A third instructor (D) reported little success with a considerable amount of effort. Effort alone, therefore, did not guarantee success. Simulation design did not guarantee success either since they all used the same system. Success depended on where instructors' effort was placed and how the simulation was used. The pedagogical value of instructional technology, like simulations or games, can only be understood within the context of classroom use (Squire, 2002).

Particularly, interactivity *during* simulation use paired with in-class discussions *directly after* simulation use was a winning combination. Why? Perhaps these two activities offered students an opportunity to engage in social practice. Research in this area suggests that the *exercise of learning* often involves understanding appropriate social practice (Gros, 2003). Can an educational simulation offer social practice to learners?

<u>Defining social practice</u>

Learners cannot become professionals in their field without being exposed to its culture, values, problems, and solutions. Shaffer (2005) claimed that professional communities have their own ways of doing their job, practicing their craft, caring about their interests, and understanding their world, all organized within an "epistemic frame." Different types of practitioners have different epistemic frames. A lawyer, doctor, and teacher, for example, will have unique, acculturated ways they look at, think about, and act in the world.

The idea of an "epistemic frame" is similar to what Gee (2005) has labeled "authentic professionalism." A simulation would allow learners to practice authentic professionalism if it afforded opportunities to use skills, knowledge, and values similar to the way a professional group thinks, behaves, and solves problems (Gee, 2005). Students learn by assuming an identity in a community of practice (Kneebone et al., 2005). After examining why some simulated sessions for final year medical students failed and why some succeeded, Begg et al.

(2005) found that students experienced problems when roles or identities were not clearly specified.

Simulating social practice

Since Instructor D’s situations lacked interactivity and D’s students did not socially reflect with their peers, there was not much opportunity to practice in this space of authentic professionalism. By having more interactive situations and allowing students to connect in class discussions, the other instructors did provide a space for authentic professionalism to be actualized.

Interactive situations with structurally rich storylines allowed students to apply concepts in context and to actively think about the subject matter, as reported by instructors. Class discussions, stimulated by simulation use, further engaged students, encouraging social reflection with peers. Roschelle et al. (2000) referred to the inability of traditional methods of instruction to afford this element of social practice.

> One of the core themes of twentieth century learning research has been the frequent failure of students to apply what they learn in school to problems they encounter in the real world. A vast literature on this topic suggests that to develop the ability to transfer knowledge from the classroom to the real world, learners must master underlying concepts, not simply memorize facts and solution techniques. (Roschelle et al., 2000, p. 12)

SBL may offer a way to integrate social practice and reflection into course curriculum. SimTeacher gave instructors the ability to create their own educational simulations, with complete control over content and events. The instructors in this study were able to use the tool in any manner they saw fit. D thought "when it comes to micro-teaching and classroom management, these [educational simulations] could be very helpful as a class activity or as individual assignments where students can see what consequences follow from the choices they make." Unfortunately, the study showed that to get the most out of SBL, D needed to do more than use SimTeacher as an individual assignment. Simulations can place students in authentic environments. However, without the instructor extending simulations socially into the classroom – though in-class discussions or other socially oriented activities – there will be little room for reflective practice.

Facilitating social practice

Interacting with a simulation's model and observing the outcomes is not the same as participating in social practices (Squire, 2002). This may be why Instructor D's approach was not as successful. D may have been more successful by facilitating class discussions about why students chose certain pathways in the situations. Since much of learning involves the meaning and correct usage of ideas and symbolic representations, informal student-student and student-teacher conversations are invaluable opportunities to clarify concepts and ensure students they are "on the same page" as everyone else (Roschelle et al., 2000).

An intelligently designed computer program may serve as a virtual peer or tutor for a learner, but its influence will pale in comparison to a human tutor's influence (Salomon, 2000). As students discuss concepts with classmates, their ideas may or may not harmonize with peers, as is the case when practitioners have discussions with colleagues. Facilitating learning, in this pedagogical framework, means helping students become appropriately practicing members of a specialized community. When using a scenario-based simulation, Kneebone et al. (2005) concluded that students learned as much from listening to each other as they did from listening to their teacher. Similarly, when observing Instructor M using SimTeacher, students spent as much time discussing the simulation's content with each other as they did working on the situation by themselves.

Engaging students in social practice was central to defining success for instructors in this study. Furthermore, research in this area suggests that social practice is necessary for learners to develop tacit knowledge of a field. Figure 10 depicts three concepts: (1) authentic environment, (2) social practice, and (3) tacit knowledge.

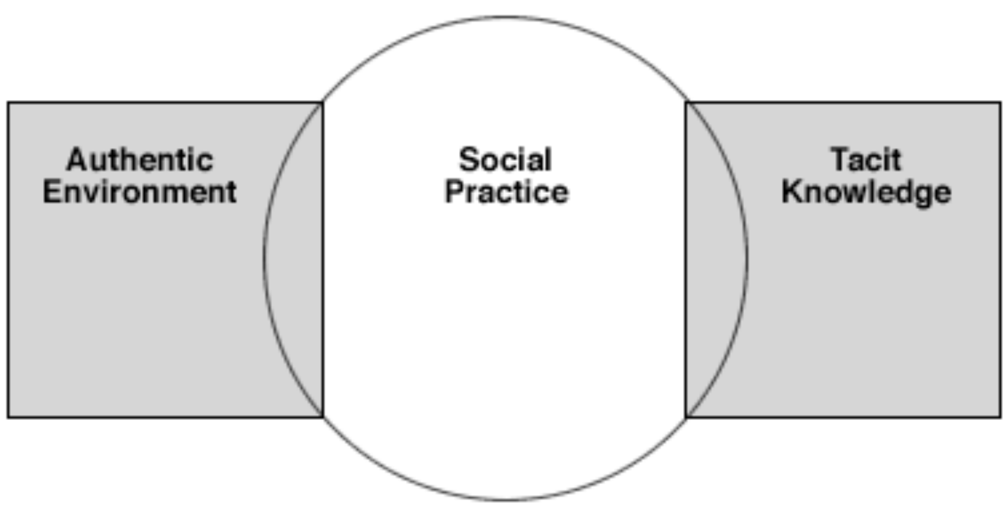

Figure 10: Tacit knowledge is attainable from an authentic environment through social practice

In Figure 10, "authentic environment" does not directly connect to "tacit knowledge." Likewise, putting a student in an authentic environment is not enough to cultivate tacit knowledge. An authentic environment can provide an opportunity for students to engage in social practice, and by engaging in social practice, students may develop tacit knowledge of a field. If the goal of SBL is to encourage tacit knowledge, facilitating social practice is the key to success.

Shaffer (2005) described contexts that engage learners in socially valued practices – using real tools to address real issues – as "thickly authentic." A learner has the opportunity to develop authentic professionalism when placed in these thickly authentic contexts. However, as seen with Instructor D's experience, providing authentic environments alone does not guarantee results.

In contrast, Instructor M employed the IEP activity within SimTeacher. This activity simulates a task regularly performed by teachers that requires more teaching skills than, for example, the Take Attendance assignment. (See Appendix F for a completed IEP by one of M's students.) Instructors D and L did not assign the IEP activity. Based on instructor interviews, students seemed to get more out of M's use of simulation as compared to D and L. This suggests that structuring simulation use to best facilitate social practice is a fundamental guideline for successful SBL.

The how, when, and why of successful SBL

Instructors' experiences with SimTeacher might suggest *how*, *when*, and *why* simulation-based learning could be successful. Table 5 offers a summary of these suggestions.

HOW	WHEN	WHY
■ Create structurally complex situations ■ Use time wisely ■ Enhance interactivity ■ Offer authentic activities from the professional field ■ Stimulate class discussions	■ After basics are covered ■ As a practicum ■ In class to more naturally encourage social reflection and dialogue with peers ■ When concepts are easier to grasp through demonstration	■ To engage students in social practice ■ To correct misunderstanding through trial and error ■ To foster tacit knowledge by having students think actively about a subject in context

Table 5: Summary of the how, when, and why of successful SBL

Instructors used SimTeacher in different ways and, as a result, some reported more success than others. Because Instructor M reported the most success, the instructor's experiences will primarily demonstrate the how, when, and why of successful SBL.

How was SBL successful?

M's situations had the highest complexity level – a quality that students reported as being their favorite aspect of the simulation. More storyline branching offered more interactivity. Further interactivity occurred when M sent SimTeachers real-time notes while they worked through situations. M reported that the Notes feature had better results when messages were sent to individual SimTeachers rather than to all SimTeachers at once. M assigned the IEP activity (rather than the TA activity) because it gave students an opportunity to practice a meaningful task that real teachers do on a regular basis.

Lastly, M used the situations to stimulate in-class discussions. Although class discussion is a frequent and widespread instructional method, it fosters peer interaction and socially constructed meaning among learners (Graham, 2005). Social discourse encourages learners to evaluate the viability of individual understandings (Cheaney & Ingebritsen, 2005). If simulation technologies can bring course material to life, instructors may keep it alive by provoking reflection through class discussions (Thomas & Milligan, 2004).

<u>When was SBL successful?</u>

Instructor M deliberately presented SimTeacher at the end of the course when there was more focus on practical application. Cheaney and Ingebritsen (2005) found that students who learned material using a PBL approach performed lower on exams of factual knowledge than students who received a lecture-based approach. To circumvent this problem, M did not use the simulation to teach new material, but rather used it to deepen the understanding of course material already covered.

Instructor M used SimTeacher in class as an activity-level blend to more naturally follow up with class discussions (Graham, 2005). Notably, M ended each discussion topic with a calculated connection to the course material. Providing discussion topic summaries is an effective technique used with CBL, as well, to help students grasp concepts that may need a demonstration for better understanding (Asal, 2005).

Why was SBL successful?

M found success by engaging students in social practice. Students interacted in an environment that simulated authentic activities and then – through class discussions – were able to socially reflect on their actions. This approach encouraged the development of tacit knowledge; students were able to think actively about a subject in context (Gee, 2005; Kneebone et al., 2005).

Students had opportunities to learn through trial and error by trying multiple pathways in the situations. Students also had opportunities to hear multiple perspectives and to correct their misunderstandings through instructor-facilitated dialogue with peers. This suggests that SBL activities should include a "debriefing" period to let students reflect, exchange ideas, and co-construct meaning with peers (Asal, 2005; Basnet & Scott, 2004; Squire, 2002).

Study Limitations and Future Research

There is a limited ability to draw conclusions about SBL based on the findings of this study. SimTeacher is only one example of an educational simulation. Additionally, the focus of the study was restricted to three instructors' experiences. This section extrapolates on the study's limitations and some possible directions for future research. Factors related to (a) technology, (b) participants, (c) content, and (d) pedagogy are considered. Table 6 provides a summary of areas needing further investigation in SBL research.

TECHNOLOGY	PARTICIPANTS	CONTENT	PEDAGOGY
■ Adopting new technology ■ Online vs offline ■ Computer-mediated vs face-to-face ■ Rich, immersive media ■ Student-authored storylines ■ Pre-made simulations vs simulation-creation tools	■ Student experiences ■ Larger instructor sample ■ Inter-national comparisons ■ Beyond teacher education	■ Larger selection of situations to repurpose ■ Content analysis of situations ■ Character development analysis ■ Content from different fields of study	■ In-class vs out-of-class discussions ■ Student blogs for reflection ■ Coaching instructors on SBL before use ■ Simulation-based assessment

Table 6: Suggested areas for future SBL research

Factors related to technology

As more educational simulations become available, their potential value for educators must be studied. SimTeacher utilized the advanced technologies available at the time of development, yet computers, software, programming, and Internet technologies continue to evolve. The next section, "The Future of SBL," details some upcoming advancements and what they may mean for educators. Continued research on these new instructional technologies may help indicate interesting and effective directions.

SimTeacher was Web-based. It relied on the Internet to be accessible and to deliver its functionality to users. However, Internet problems occurred. Servers went down. Database connectivity failed. Instructor L could not use SimTeacher at all class meetings because some locations did not have Internet access. Also, SimTeacher's only programmer (i.e., the researcher) experienced technical limitations. Software bugs occurred. Media delivery was restricted to text and photographs. There were no animated images, video, or sound.

Future research could explore the benefits of online simulations versus those that could operate offline (e.g., running from a CD without the need for Internet connectivity). Research should clarify the advantages and disadvantages of computer-mediated simulations as compared to face-to-face simulations (Cathers, 2005; Cheaney & Ingebritsen, 2005). Also, future research could explore how rich multimedia (e.g., video, animations, and audio content) may add to the realism of simulated situations.

Instructors could create multiple storylines in their situations in SimTeacher. This offered students interactivity; students' actions drove the story's plot. Actions had consequences. However, their options were not limitless. In most cases, students only had two to four decisions to choose from. Students also had to justify their decisions while they were making them. If students did not find an action suitable to them, they had to identify which action they would most support and state their reasons why. A more advanced educational simulation would let students come up with their own choices before continuing the storyline, perhaps relying on artificial intelligence to unfold the plot. It would be interesting to research the benefits of having students create their storyline paths rather than forcing them to choose from a limited list of options.

Furthermore, SimTeacher relied on the participation of instructors. Most commercially available simulations, as described in the literature review, do not require instructor input. How do “pre-made” simulations differ in terms of use and efficacy when compared to simulation-creation tools that offer instructors more flexibility? In particular, the study found that creating effective situations were difficult and time consuming for instructors. What could the software offer to help instructors in this regard? Further research could investigate these important questions.

Factors related to participants

The scope of the study – investigating three instructors’ experiences – was another limitation. Besides a post-simulation questionnaire, researcher collection and analysis of student work was outside the reach of this study. Future research on SimTeacher could shift the focus to students. How would students define successful simulation use? A study could evaluate students’ work to see if changes in performance occurred over extended use. Since instructors used the simulation differently, would it be confusing for students to use SimTeacher in more than one course with more than one instructor designing assignments?

Furthermore, while the study included three instructors at a southwestern university, instructors at other universities were exploring the tool as well. Again, these users were beyond the scope of the study. A larger study, however, could include the national or international usage of a simulation tool like SimTeacher. For instance, in what ways would instructors modify, if at all, repurposed situations that were developed by instructors from other countries?

Beyond teacher education, a number of other fields of study could be examined. Virtual Dig, for example, is a simulation for archeology students (Carr, 2000). How might a simulation like Virtual Dig or SimTeacher be of any educational value to practitioners in their respective fields (e.g., just-in-time or recurrent training)?

Factors related to content

SimTeacher provided instructors with a high level of flexibility. Instructors could create their own content or repurpose other instructors' content. Instructors could create fictional characters for the situations or they could use a *jumpstart* feature that automatically created a set of fictional characters for them. Instructors could choose to assign a number of pre-made activities and set the frequency that their students completed them. Finally, instructors could determine how involved they and their students would become in SimTeacher, designating the amount and timing of assignments. Future research could explore the result of providing instructors more direction and less flexibility. A large pool of structurally rich situations could be available for instructors to choose from.

Besides storyline structure, story content could be examined in future research as well. What would a content-rich situation look like? Preliminary research in this area suggests that simulated stories may rely more on character interaction rather than plot (Begg et al., 2005). If characters are tantamount to plot, research needs to explore the elements of character development and character interaction in simulated stories. For example, how much detail is necessary and what kind of descriptors should be used to make simulated characters believable? Are characters and stories more easily simulated in some fields of study as compared to others?

Factors related to pedagogy

The study found that using SimTeacher helped stimulate engaging class discussions. Could out-of-class simulation use still engender good in-class discussions? Would it be helpful for learners to use online discussion forums or reflective blogs in conjunction with out-of-class simulation use? SimTeacher did provide students and instructors with a Discuss section of the website that could have been used – especially by Instructor D – for this purpose. Unfortunately, none of the instructors in the study used the online discussion feature. It would be interesting to see if students in one class could benefit from discussing their situations online with students from other classes. Could one instructor facilitate online discussions for students across multiple classes? As information technology continues to connect people with similar interests, questions like these offer a necessary direction for future research.

Additionally, it would be interesting to research the benefits of coaching instructors on the successful use of SBL before its implementation. All three instructors had not used a simulation with students before. Instructor M and L asked students to share their experiences with the class after completing situations. Would it have been advantageous to stop students in the middle of completing a situation to share experiences as well? Although SimTeacher was primarily used as a learning tool, participants acknowledged its potential as an assessment tool. As Sutton (2005) noted, research is needed in the area of simulation-based assessment.

The Future of SBL

Simulation-based learning offers a relatively new landscape for educators. This section discusses what appears to be on the horizon – including new conferences and initiatives, Internet2 and Web 2.0 – and how these developments may affect the future of educational simulations.

Embracing simulation use

SBL is a new approach to instruction, yet it is growing in popularity as software-authoring tools become widespread, inexpensive, and easy to use. Bonk et al. (2005) surveyed instructors and administrators in, primarily, North American postsecondary institutions to explore future directions of online education. Over a third (198 of 544) of respondents selected "simulations or role play" as in the top four of twelve pedagogical techniques predicted to most be widely used in the near future. When a similar survey was presented to training professionals in the corporate environment, half (115 of 230) of respondents predicted "simulations or gaming" as one of the most widely used methods of e-learning in workplace learning settings.

Conferences and initiatives

There are a number of concerted efforts to encourage the next generation of educational games and simulations. The Games-to-Teach Project, which has been subsumed under the Education Arcade (see http://www.educationarcade.org), was a partnership between MIT and Microsoft to develop next-generation media for math, science, and engineering education. A few prototypes were developed, but nothing substantial arose. The Education Arcade, however, now hosts an annual "Games in Education" conference to discuss the latest developments in the field.

The Serious Games Initiative (see http://www.seriousgames.org) is helping to forge working relationships between the game industry and projects involving game use in education, training, health, and public policy. The Initiative hosts an annual Serious Games Summit (see http://www.seriousgamessummit.com) to discuss the latest developments in this area.

At the end of 2004, Stanford University inaugurated a new initiative for simulation-based learning (see http://med.stanford.edu/irt/immersive). The VA Palo Alto Health Care Systems Simulation Center, the Center for Advanced Pediatric Education, Stanford University Medical Media and Instructional Technology, and the Department of Surgery's Center for Simulation in Medicine will coordinate efforts to improve education, training, research and clinical management in health care.

Internet2 and Web 2.0

As bandwidth increases, so does the capacity for richer, more satisfying visual and audio content. Internet2 (see http://www.internet2.edu), an initiative supported by a nationwide consortium of over 200 American universities, is a complete remaking of the Internet infrastructure as we know it. The original Internet was created for the quick exchange of text-based data, not the e-commerce, Java-based, Flash-animated, video-streaming online world that has developed over time. Graphic designers in particular have had to be creative, not only in making art, but also in their delivery of it through the restrictive bottleneck of data-transfer rates (Cloninger, 2000; Rogak, 2000).

For instance, consider that a four by six inch scanned photograph amounts to about 70 or 80 thousand bytes when saved in JPEG format. A standard modem running on the Internet today allows 36 to 56 thousand bits per second (Kbps). That means that the photograph would take roughly 2 seconds to completely download into a Web browser (assuming there is little throughput congestion). A T1 line, used for many fast Net connections today, runs at 1.5 million bits per second (Mbps); T3s run at 45 Mbps.

The new Internet2 infrastructure will have two backbones: vBNS and Abilene. The Abilene backbone allows for the transfer of 2.4 billion bits of data per second (Gbps). The vBNS backbone (using OC-48) will have an average connection speed of 9.6 Gbps. That is 1,600 times faster than a T-1 line. With that level of throughput, streaming-HDTV is possible. Besides sheer speed, the Internet2 infrastructure will incorporate other welcomed advancements, such as guaranteed delivery of packets and dedicated connections.

Other projects similar to Internet2 are also in development. The United States government is developing the Next Generation Internet (see http://www.ngi.gov) used for governmental services like healthcare and defense projects. Canada is creating the CA-Net2 network (see http://www.canarie.ca) that closely parallels the development of these other Internet infrastructures (Business Wire, 1998).

Software technologies are evolving as well. Several websites have been credited as part of a new generation dubbed “Web 2.0” (Marshall, 2006). Two qualities distinguish a Web 2.0 site from the prior generation. First, Web 2.0 sites are created with innovative programming tools like AJAX (an acronym for Asynchronous JavaScript and XML) and Ruby. These tools allow programmers to make website content management highly interactive and with interfaces as functional as software running on a hard drive (Kantor, 2006). Only portions of a webpage immediately and automatically update as new content becomes available rather than having the entire page reload. Also, content is multilayered and more contextual menus allow users to initiate actions from a centralized interface.

Secondly, the user's experience with Web 2.0 sites is much different than with Web 1.0 sites. Instead of the solitary experience of viewing static content, newer sites offer a social experience with dynamic content created and managed by its users (Kopytoff, 2006). On a 1.0 site, the user reads content; in contrast, on a 2.0 site, the user reads and writes content. In fact, the greatest asset of a 2.0 site is the content contribution from its community of users. With 1.0 sites, users needed search engines to gather relevant information. With 2.0 sites, users create and link relevant information together at a single location.

For examples of Web 2.0 sites, see Writely (at http://www.writely.com) for document creation and sharing, Wikipedia (at http://www.wikipedia.com) for an internationally community-contributed online encyclopedia, Flickr (at http://www.flickr.com) for photograph posting and sharing, Upcoming (at http://www.upcoming.org) for community events, Del.icio.us (at http://del.icio.us) for community-managed website links, and Google's GMail (at http://www.gmail.com) for synchronous and asynchronous communication.

Next generation of simulations

SimTeacher was a new SBL product for instructors, grounded in theory and practical for classroom use. SimTeacher not only empowered students with numerous tools within a learner-centered environment; it also gave instructors unprecedented control over developing their simulation content. SimTeacher.com usage over time continued to grow, showing increased interest from users outside the study. Table 7 shows that the number of SimTeacher student accounts doubled every year, reaching close to 400 student accounts with over 50 registered instructors. The increase of SimTeacher users occurred without any intentional advertisement. This acceleration of new accounts demonstrates that instructors are interested in trying an educational simulation for teacher education.

TOTAL NUMBER OF:	October 2002	May 2003	June 2005
Instructors enrolled	11	35	53
SimTeachers enrolled	39	101	388
Courses created	10	33	49
Situations that can be repurposed	5	15	21
Situations currently in use	0	3	20
Activities currently in use	0	16	0
Fictional Students created	6	25	148
Fictional Teachers created	2	2	21
Questions created	7	43	92
Library resource items	4	4	4
Notes active	1	56	360

Table 7: SimTeacher Usage Over Time

What will the Internet2 and Web 2.0 technologies mean for educators? Physical simulation, game-based training, and intelligent tutoring will continue to evolve (Lane, 2005). Next generation instructional technology will let learners interact more with content. It will offer more content management and creation tools emphasizing student collaboration. Learners will not only be able to share their information with other learners; similar information will be linked together, facilitating the social construction of knowledge in action. Perhaps it will empower students, from similar classes and across universities, to essentially create their own textbooks by the end of their courses. By the end of their academic program, they could have a cohort-contributed encyclopedia that may continue to be updated as they practice in the field.

Shaffer (2005) suggested that a simulation should be based on how a professional field creates its epistemic frame. That is, a simulation should involve the processes and activities that professionals use to become better practitioners. This would be more attainable if computers became even more seamlessly integrated in the lives of practitioners. For example, if it became commonplace for K-12 teachers to create "podcasts" for students (Campbell, 2005), a simulation for teacher education should be able to accurately replicate this activity. This would provide preservice teachers with the thickly authentic environment Shaffer (2005) talked about.

With the release of Internet2, immersive environments containing highly rich multimedia will soon follow. These virtual reality environments may not only offer visual and auditory stimuli, but tactile stimuli as well for "multisensory instruction” (Smedley & Higgins, 2005). Researchers (Begg et al., 2005; Squire, 2002) have mentioned the powerful role emotion may play in simulated environments. The three-dimensional (3D) impressions new technologies could provide may help elicit the emotional “in” a participant needs to identify with a virtual setting (Chang, 2000; Stein, 2000; Yahlin, 2000).

The first versions of this technology, however, may be too overwhelming for educational use. A recent study (Kim, Kim, Kim, Ko, & Kim, 2005) found that cybersickness, a motion-sickness-like symptom that occurs when using virtual reality, was experienced by 80 percent of participants after only ten minutes of immersion. Nonetheless, virtual reality systems will eventually become available to the general public. As Kirsner (2000) reported, Paramount’s theme parks will become more intimate with tailored experiences for individual guests, the Seattle's Experience Music Project will let participants “virtually” sing or play an instrument in front of a rock concert audience of screaming fans, and the Los Angeles Police Department’s virtual experience will run visitors through realistic training drills.

Lastly, there will always be an effort to repurpose old materials for new methods of delivery. This was evidenced by the flourish of online syllabi after the Web debuted. For instance, 3Dsolve Inc. (Boosman, 2004) is developing technology to help convert instructional video content into game-driven simulations. However, this was an ineffective strategy for Instructor D;

content from case students did not transfer well into the multidirectional storylines in SimTeacher.

Moreover, this recycling of old content does not seem to fit the vision of what future educational technology has to offer. Considering the technologies and contemporary learning theories discussed above, a new vision of Education 2 emerges: (simulation) technology will allow educators to situate students in highly interactive environments where students will learn by creating their own content and by managing that content with peers.

Summary

This study discussed the theoretical foundation for simulation-based learning and described the current status of educational simulations. The research literature suggests that successful simulation-based learning largely depends on the instructional design principles behind the simulations. How instructors effectively use well-designed simulations with students, however, was less clear.

An original simulation (SimTeacher) was created based on contemporary learning theories. Three instructors at a major southwestern university used the simulation in their teacher education courses within a span of four semesters. Qualitative data were collected through interviews and observation. Instructors decided on their extent of involvement based on their teaching style, objectives, technology skills, and available time. The study provided a detailed look at the issues, concerns, failures, and triumphs of instructors using SimTeacher in their courses. Students also provided feedback after simulation use to offer an additional perspective.

This study posed a number of important research questions regarding SBL that were addressed by closely examining instructors' experiences. Instructor D was ambitious and set high expectations, but found the goals to be just out of reach. Instructor L mostly explored the use of SBL, used the SimTeacher tool to create content never used, had some success combining simulation use with in-class discussions, but did not commit to using the simulation as much as the other two instructors. Instructor M was the most experienced, created structurally rich situations, and was able to integrate SBL successfully into the course agenda.

Overall, the results indicate that SBL could be an effective instructional tool. It demands a sizable amount of time and commitment from instructors who want to produce significant results. In particular, interactivity was confirmed as a key strategy to heighten student motivation. Interactivity was accomplished with multidirectional storylines and the Notes feature of SimTeacher. However, interactivity was also found to be the most challenging aspect for instructors given their time constraints and inexperience using SBL.

The study results concur with related research to illustrate how, when, and why simulation use was successful.

Specifically, the findings suggest that adding an advanced technological tool like an educational simulation will have little effect on learning unless it is integrated well into the curriculum. Furthermore, simulation-based learning might be better used to encourage tacit knowledge than used as a tool to teach new material. Specifically, instructors who facilitated social practice by (a) using structurally rich storylines and by (b) blending simulation use with classroom discussions reported the most success with simulation-based learning in teacher education.

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Appendix A: Sample of a Tigerlake Scenario

NOTE: The following is actual content developed by an instructor and used in the Tigerlake Project.

Behavior Problem: Consultant Scenario 3

This is your second week on the job, and your first class period of the day in the eighth grade social studies class from outer space. No, again, you did not necessarily major in this area, but because of hiring constraints and to keep your job there, you have agreed to be "emergency certified" in this subject area (this happens very frequently in underserved areas). Every time the class of 32 arrives you can feel the acid in your stomach start to churn, especially on the days that August is there. He seems to push every one of your buttons, and you are thinking seriously of calling his parents in for a conference, but you don't know how that works yet. He disagrees with, makes fun of, or challenges nearly everything you say. Are you supposed to go see that student's counselor first, or do you just go ahead and call yourself? Where do you find the student's phone number, anyway?

But August is just part of the difficulty here. Whenever you are taking attendance at the beginning of class, two other students, Jabraun and Curry begin to talk and laugh with each other so loudly that soon that whole back corner of the classroom is booming loud enough to disturb Ms. Cratchet's reading class across the hall. Starting off the class period with so much commotion each time is a mistake, you realize, but it feels to you like they are the ones in control here. Sending any one of these three boys to the office never helps. They just act satisfied, even smug, that they get out of your social studies class for one more day. Besides, the new vice principal just put a note in your box the other day saying that you need to stop sending so many students down to the office. Why can't these boys be more like Elle or Maria? What will you do?

QUESTIONS

1. Use "student files" to learn more about individual student performance patterns and any available details of personal background and/or behavioral history.

2. Use the "teacher's lounge" link to communicate with your other P 251 colleagues: leave messages for each other as you come up with hypotheses or important discoveries.

3. Use the "phone the principal" link to leave a message for the school administrator. Make your questions specific, and he will reply within a day or two via your own e-mail account.

4. Review the goals outlined in your blue course packet regarding this Personal Theory III assignment. Be sure you have made use of all information available in the Tigerlake School System AND that your write up reflects your command of all relevant topics discussed this semester!

Appendix B: Course Size and Number of Student Logins

D		L	L	M	M	M	M	M	M	M	M
ALD 320 (1)	...continued	ALD 328 (N)	EDC 370E (T)	0004 (00000)	00005 (00001)	ALD 328 (000002)	ALD 328 (000003)	ALD 328 (07750)	ALD 328 (07756)	ALD 328 (07990)	ALD 328 (08025)
39	48	6	3	3	3	3	1	2	4	3	3
35	27	5	3	3	4	4	2	1	4	3	3
30	17	3	3	4	3	4	1	1	3	3	3
34	32	11	3	4	3	4	1	1	3	3	3
33	24	6	3	4	3	5	1	1	4	3	3
43	20	14	3	5	3	4	1	1	4	3	3
53	31	7	3	4	3	6	1	1	4	3	3
26	23	9	3	4	3	4	1	1	4	3	2
35	23	5	3	4	3	1	1	1	4	3	3
63	19	9	3	3	3	3	1	1	4	3	3
48	81	8	3	4	3	2	1	1	4	3	3
22	13	9	2	4	3	2	1	**1**	3	3	3
26	41	3	3	3	3	4	2		5	3	3
33	19	4	3	4	3	3	1		4	2	3
23	18	3	3	4	3	4	1		4	3	3
44	18	5	3	4	3	1	1		4	3	3
29	33	2	3	4	3	1	1		4	3	3
40	18	4	3	4	3	6	**1**		4	3	3
22	22	3	3	3	3	2			3	3	3
16	18	3	3	4	**3**	3			5	3	3
24	31	9	3	5		2			4	**3**	**3**
44	24	4	4	4		2			3		
39	10	5	**3**	4		1			3		
44	17	9		5		**3**			3		
19	28	3		4					**4**		
32	25	2		4							
20	17	4		**4**							
30	**30**	2									
		6									

D's class size:	55	
L's class sizes:	28	22
M's class sizes:	26	19
	23	17
	11	24
	20	20
Average Logins Across All Instructors:	5	
Average Class Size Across All Instructors:	24	

Appendix C: Instructor Interview Questions

BEFORE THE SIMULATION:

-- How did you plan to adopt the simulation to your course material (lectures & textbook)? Did you have any particular method or process in mind before getting started?

-- Had you used an educational simulation before SimTeacher?

-- What intrigued you about this simulation, if anything?

DURING THE SIMULATION:

-- Based on your impression, how did your students react to the simulation?

-- Was it easy for you to use SimTeacher, to create content, and to navigate around the site? (Please comment on the design aspects of the simulation tool.)

-- (Please comment here on the features and capabilities of SimTeacher.) Did you find particular features or capabilities more or less useful than anticipated? Do you wish it had a specific feature or capability? What or where are its shortcomings? What are its positive aspects?

AFTER THE SIMULATION:

-- If you created your own interactive situations, (a) what process did you use, (b) what was the most challenging part, and (c) did you use it to highlight one theory/concept or many at a time?

-- What features (e.g., activities) and resources (e.g., theorybase) did you use and did they achieve your purpose for using them?

-- Could you use this online tool as a means of assessment of course material, as a learning activity, or both? How did you use it this (last) time around?

-- Did you supplement the simulation with any other Web resources?

IN CLOSING

-- Would you use this simulation again? Explain in what fashion.

-- While such simulations may never replace real life practice in a field of study, do you think it could be a valuable tool for authentic assessment?

-- Is there anything else you would like to comment on?

SimTeacher

Professor's Journal

Apart from interviews and observation, another source of qualitative data for this SimTeacher dissertation is professors' journal notes. Please make entries in this journal as inspiration strikes before, during, and after simulation use. Journal notes are intended to "capture" ideas or problems at the time they appear to you. You will occasionally receive tips and reminders about journaling your SimTeacher experiences.

Note that each page in this journal has a date box in the upper right corner. Please indicate the date for each note written. Use a separate page for each idea or problem that occurs (even if multiple ideas/problems occur in the same day).

Contact me anytime if you have questions or concerns about this or anything else within the SimTeacher study. Thank you for your participation.

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Appendix E: Student (Post-Simulation) Interview Questions

1. What did you like most about this simulation? Comment on either specific features or the simulation as a whole.

2. What did you like least? Please specify any suggestions for improvements.

3. Yes or no: Would you say this simulation is a fair way to test your knowledge (about the field of study)?

4. When interacting with the simulation, to what degree had you applied knowledge from other courses? Pick one:
   a. No, I didn't apply knowledge from other courses.
   b. I did use things I've learned from other classes, but only very seldom and/or indirectly.
   c. Sometimes I pulled on concepts and theories I've learned from other courses.
   d. I frequently applied knowledge from other courses and/or subjects.

5. Yes or no: Did this simulation *motivate* you to research problems in your field? An example of this would be consulting your textbook before responding to something in the

simulation.

6. Did the simulation help you to understand the course material better? If so, what specific course concepts do you better understand as a result of using this simulation?

7. Did you learn anything related to your course material that was not covered in class lectures or readings? If so, please describe what that was.

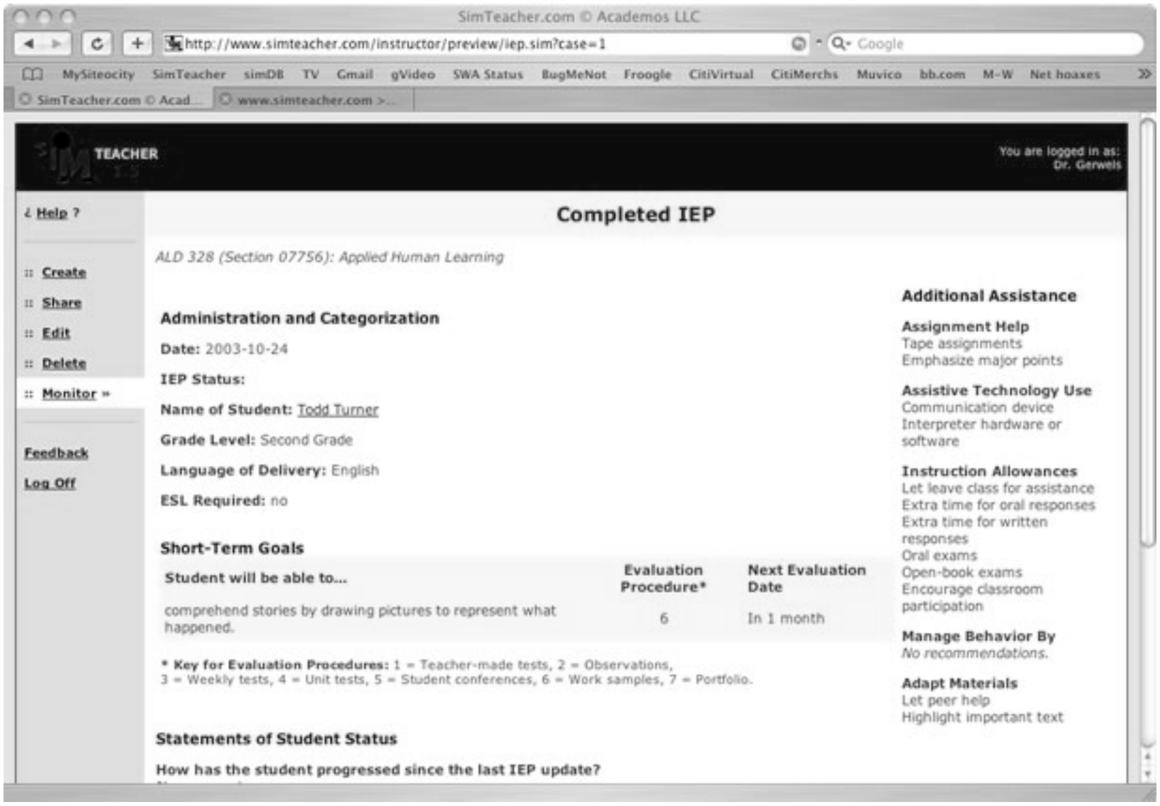
8. What learning theories do you see embedded in this simulation? In other words, explain how this simulation may make use (or is an example) of contemporary learning theories.

9. Yes or no: Did you find the Website design easy to use and navigate around in? If not, please explain.

10. You were asked to role-play within a fictional environment without real face-to-face interaction. Please explain how that may have been good or bad for you.

11. How many hours per week did you use the simulation: 1 or less, 2, 3, 4, 5, or more?

Appendix F: A Completed IEP Assignment in SimTeacher



Appendix G: Analysis of Email Messages from Participants

35	emails from Prof D*
29	emails from Prof L*
31	emails from Prof M*
95	total emails from Profs*

** These numbers represent the total number of emails sent **from** instructors to the primary investigator, excluding emails irrelevant to the study and excluding emails sent **to** instructors.*

Describing SimTeacher's features and capabilities	
3	: Prof D
0	: Prof L
2	: Prof M
5	: Total Msgs

Other people are interested in the simulation	
5	: Prof D
0	: Prof L
16	: Prof M
21	: Total Msgs

Setting time to meet or use SimTeacher	
6	: Prof D
14	: Prof L
10	: Prof M
30	: Total Msgs

Suggesting to use SimTeacher to do something else	
2	: Prof D
0	: Prof L
1	: Prof M
3	: Total Msgs

Student problems with the simulation	
13	: Prof D
4	: Prof L
0	: Prof M
17	: Total Msgs

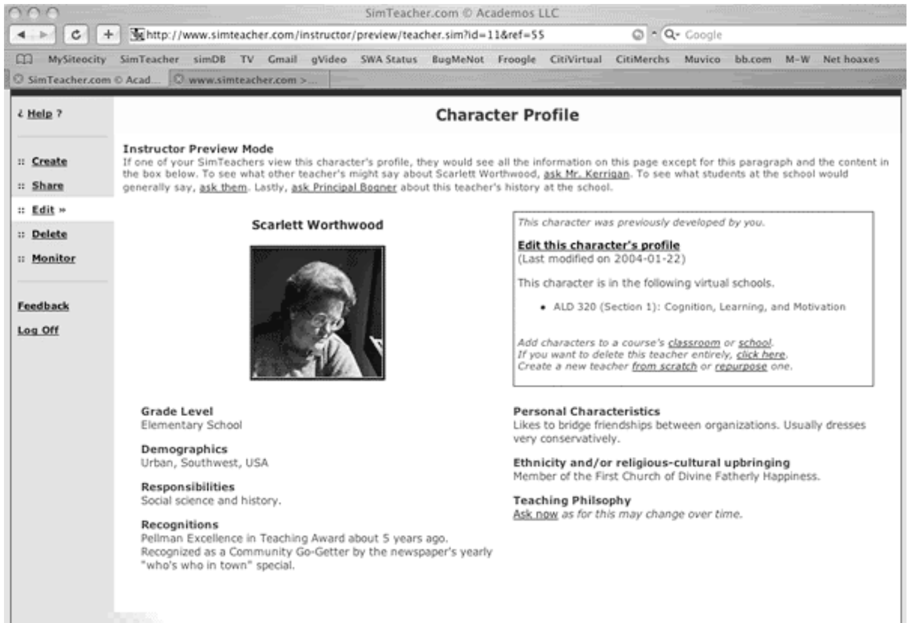
Professor problems with, or questions about the operation of, SimTeacher	
6	: Prof D
11	: Prof L
2	: Prof M
19	: Total Msgs

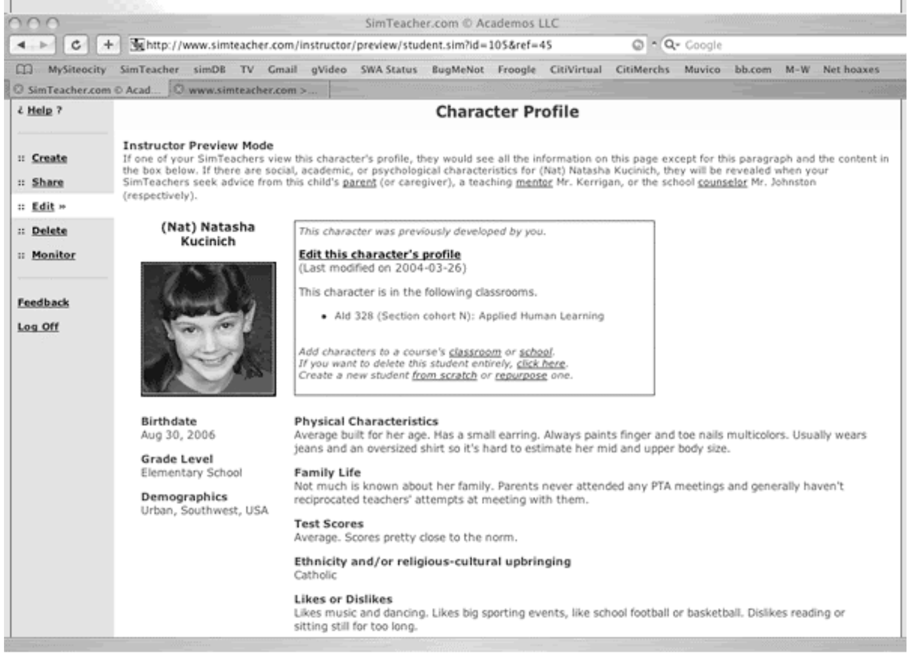
Appendix H: Questions Used in the Job Interview Activity

QUESTIONS	USED BY
(DEFAULT) Hello. I am Louis Simone, the Assistant Principal here. Call me Lou. We have a job opening for a teaching position and I hear you are interested in it. I have a few questions for you. First question, would you like anything to drink? [Short pause.] Please tell me a little about yourself. How do you see yourself being a good fit with this school?	D's ALD 320 (1) L's EDC 370E (T) M's ALD 328 (08025) M's ALD 328 (07990) M's ALD 328 (07750) M's ALD 328 (07756)
(**MODIFIED**) Hello. I am Louis Simone, the Assistant Principal here. Call me Lou. We have a job opening for an elementary teaching position and I hear you are interested in it. I have a few questions for you. Please tell me a little about yourself. Why are you interested in teaching at this school?	M's ALD 328 (000003) M's ALD 328 (000002)
(**MODIFIED**) Hello. I am Louis Simone, the Assistant Principal here. Call me Lou. We have a job opening for an elementary teaching position and I hear you are interested in it. I have a few questions for you. What do you think is the most important part of being an elementary school teacher?	M's 00005 (00001)
(DEFAULT) What do you see as being your content area specialty here? And what other areas might you be able to cover too, if we need you? Any special certifications? Are you more interested in elementary or secondary education?	D's ALD 320 (1) L's ALD 328 (N) L's EDC 370E (T) M's ALD 328 (07750) M's ALD 328 (07756)
(**MODIFIED**) What do you see as being your content area specialty here? And what other areas might you be able to cover too, if we need you? Any special certifications?	M's ALD 328 (000002) M's ALD 328 (08025) M's ALD 328 (000003) M's ALD 328 (07990)
(**MODIFIED**) What do you see as being your content area specialty here? Any special certifications? Are you bilingual, or do you have any special talents or hobbies outside of teaching?	M's 00005 (00001)
(DEFAULT) Can you briefly describe your teaching philosophy? In other words, what are your general beliefs, approaches to, and concerns with teaching in your content area.	*All ten instructors' courses*
(**NEW**) Finally, I see that you have taken the course ALD 320 at UT. Which of the topics covered in that course were you most interested in at the beginning of the semester?	D's ALD 320 (1)

(**NEW**) What previous experience do you have that relates to teaching?	L's ALD 328 (N)
(**NEW**) What is your strongest area regarding teaching? What is your weakest area?	L's ALD 328 (N)
(**NEW**) What professional organizations have you joined, or will you join, if hired?	L's ALD 328 (N)
(**NEW**) What qualifies you for this position?	L's EDC 370E (T)
(**NEW**) Why do you want to teach in this elementary school?	L's EDC 370E (T)
(**NEW**) What is your greatest strength?	L's EDC 370E (T)
(**NEW**) What areas would you like to improve as a teacher?	L's EDC 370E (T)
(**NEW**) Do you have any questions for me?	M's ALD 328 (07990) M's ALD 328 (08025)
(**NEW**) Why have you chosen teaching as a career?	M's ALD 328 (000003) M's ALD 328 (000002)
(DEFAULT) I see we have your email address on file. If any questions should come up, someone here will email you. Otherwise, thank you for your time and we'll be in touch soon.	*All ten instructors' courses*

Appendix I: Fictional Teacher and Student Profiles in SimTeacher





Appendix J: Researcher's Notes from Observing Instructor M's Class During Simulation Use

It was a planned visit. The classroom resembled an ordinary college classroom: desk chairs, florescent lighting, no windows. About 20 students attended. The student chairs lined three of the four walls, with the instructor's desk by the fourth wall (in front of the class), creating a rectangle all together. As each participant was able to see everyone in the room, it was conducive for classroom discussion. Each student had an Apple iBook® or Powerbook® and placed it on his or her desk's top when the instructor asked. Instructor M was using a similar computer, yet it was connected to the overhead projector so that everyone in the room could see it's screen. The university's wireless internet access was available to all participants, and all participants' computers were equipped with wireless internet capability. The researcher sat in a desk chair next to the classroom door and observed activity for about an hour.

M first asked all students to go to SimTeacher.com using their personal portable computers so they could join the simulation. Students then worked through the Job Interview activity. Based on their initial comments, students liked how the simulated characters were dressed, wondered if they really had to answer seriously, and were concerned about how they would be evaluated. On this observation day, the instructor did not assign a grade or credit to SimTeacher assignments. After the JI activity, students began to work on their first situation out of three. There was also another activity and one note to work through. The *notes* feature allowed an instructor to send a note from any fictitious character in the simulation to any or every SimTeacher.

The tapping of keyboards was heard for most of the class time as students worked on each assignment. The instructor gave students ten minutes to do each situation before moving on to the next. Early finishers could go back to “redo” it and “monkey-type” (as the instructor called it) just to see what the other decisions and consequences look like. One student commented that SimTeacher could be more useful if they were not rushed and had more time to think while working through it. The instructor led students in discussion about what decisions and justifications they used. It was an active group discussion with some “oh’s” and “ah’s” as people choose the same decision but for different reasons. Students seemed highly interested and engaged in discussing their experiences. In fact, they spent nearly the same amount of time discussing their SBL assignments in a group as they did completing them. The instructor always summarized and incorporated class material at each turn in the discussion.

Appendix K: Analysis of Student Responses to the Post-Simulation Questionnaire

Here are the questions and the *themed responses* from across all students. Responses that were supported by less than 5 students (i.e., less than 10 percent of the sample) were not categorized into a themed response. Student quotes are included as examples of the most supported themed responses for each question. Because some questions were true/false or multiple-choice, the themed responses to those questions do not have associated student quotes.

1. What did you like most about this simulation? Comment on either specific features or the simulation as a whole.
   -- 21 students liked having different teaching situations available and within the situations they liked having various options available (i.e., story branches). Quote: *I liked that the situations were different ones. These are the ones I am afraid of.*
   -- 5 thought the Job Interview was a helpful exercise.

2. What did you like least? Please specify any suggestions for improvements.
   -- 9 wanted more pathways in the interactive storylines. Quote: *Limited options. I didn't always totally agree with either answer. Provide more options or a "create your own" option.*
   -- 9 reported that they did not find anything they disliked.

3. Yes or no: Would you say this simulation is a fair way to test your knowledge (about the field of study)?
   -- 27 said "yes".

-- 17 said “no”.

4. When interacting with the simulation, to what degree had you applied knowledge from other courses? Pick one:
   a. No, I didn’t apply knowledge from other courses.
   b. I did use things I’ve learned from other classes, but only very seldom and/or indirectly.
   c. Sometimes I pulled on concepts and theories I’ve learned from other courses.
   d. I frequently applied knowledge from other courses and/or subjects.
   -- 23 chose “c”.
   -- 14 chose “d”.
   -- 7 chose “b”.

5. Yes or no: Did this simulation *motivate* you to research problems in your field? An example of this would be consulting your textbook before responding to something in the simulation.
   -- 26 circled “no”.
   -- 21 circled “yes”.

6. Did the simulation help you to understand the course material better? If so, what specific course concepts do you better understand as a result of using this simulation?
   -- [Most students skipped this question.]
   -- 9 reported “yes” but specified different concepts or did not specify one. Quote: *I believe that it helped me to practice the things that I had been taught. It made them sink in a little bit more and gave me an opportunity to apply what I have learned.*

7. Did you learn anything related to your course material that was <u>not</u> covered in class lectures or readings? If so, please describe what that was.

-- [Again, most students left the answer space blank or said they could not remember.] Quote: *I am sorry, I cannot recall.*
-- 7 replied "no".

8. What learning theories do you see embedded in this simulation? In other words, explain how this simulation may make use (or is an example) of contemporary learning theories.
   -- [16 students did not provide any answer.]
   -- 15 wrote either "social isolation" or "social learning theory". Quote: *Social isolation & incorporating children into groups so that it feels natural to them.*

9. Yes or no: Did you find the Website design easy to use and navigate around in? If not, please explain.
   -- 47 (out of 48) reported "yes". Quote: *I did find the website easy to navigate. I really liked the way it was set up. Very user friendly.*

10. You were asked to role-play within a fictional environment without real face-to-face interaction. Please explain how that may have been good or bad for you.
    -- 17 felt it was a good experience, good practice, and applicable to teaching in the real world. Quote: *It is no substitute for real experience, but it does heighten some familiarity and expose you to problems that you would not have considered otherwise.*

11. How many hours per week did you use the simulation: 1 or less, 2, 3, 4, 5, or more?
    -- 39 marked "1 or less".

INDIANA UNIVERSITY

RESEARCH AND THE UNIVERSITY GRADUATE SCHOOL

NOTICE OF APPROVAL
EXEMPT REVIEW

TO: Robert Fischler
Education

DATE: April 30, 2001

FROM: Cybil Cole, Director Human Subjects Risk Compliance

RE: Protocol entitled: Sim Teacher
Protocol #: 01- 4328

Approval Date: April 30, 2001

The Human Subjects Committee (HSC) has reviewed and approved the research protocol referenced above as exempt; §46.101b, ¶#1. As the principal investigator of this study you assume the following reporting responsibilities:

AMENDMENTS: Investigators are required to report on these forms ANY changes to the research study (such as design, procedures, study information sheet/consent form, or subject population). An amendment form is attached for your future use. **The new procedure may not be initiated until HSC approval has been given.**

COMPLETION: You are required to notify the HSC office when your study is completed (data collection finished). You may do this by memo (paper or electronic).

STUDY INFORMATION SHEET: All subjects should be given a copy of **the stamped approved** study information sheet.

We suggest you keep this letter with your copy of the approved protocol. Please refer to the exact project title and protocol number in any future correspondence with our office. All correspondence must be typed.

Enclosures: Documentation of Review and Approval
Amendment Form
Approved Study Information Sheet - **stamped copy must be used**

DHHS Multiple Project Assurance #M1167-02
IU Multiple Project Assurance available at: http://www.iupui.edu/%7Eresgrad/spon/ass

BLOOMINGTON CAMPUS
COMMITTEE FOR THE
PROTECTION OF
HUMAN SUBJECTS

Indiana University
Bryan Hall, Room 110
107 South Indiana Avenue
Bloomington, Indiana
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812-855-3067
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OFFICE OF RESEARCH SUPPORT & COMPLIANCE

THE UNIVERSITY OF TEXAS AT AUSTIN

P.O. Box 7426, Austin, Texas 78713 (512) 471-8871 - FAX (512 471-8873)
North Office Building A Suite 5.200 (Mail code A3200)

Date: **2/12/2004**

PI(s): **Robert Fischler** Department & Mail Code:

Dear: **Robert Fischler**
IRB APPROVAL – IRB Protocol # **2004-01-0107**

Title: **SimTeacher.com: Simulation-Based Learning in Teacher Education**

In accordance with Federal Regulations for review of research protocols, the Institutional Review Board has reviewed the DRC's exempt status assessment of the above referenced protocol and found that it meets Exempt Approval under the category designated below for the following period:

Your study has been approved from 02/09/2004 - 02/09/2005

Exempt Category of Approval:

[x] 1. Research conducted in established or commonly accepted educational settings, involving normal educational practices, such as:
   (i) research on regular and special education instructional strategies, or
   (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

[ ] 2. Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless:
   (i) Information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; **and**
   (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subject's financial standing, employability, or reputation

[ ] 3. Research involving the use of educational tests, survey or interview procedures, or observing public behavior that is not exempt under number 2 above, if the subjects are public officials or candidates for public office or a federal statute requires that the confidentiality of personally identifiable information will be maintained throughout the research and thereafter.

[ ] 4. Research involving the collection or study of existing data, documents, records, pathological or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified, either directly or through identifiers linked to the subjects. To qualify for this exemption, the data, documents, records or specimens must be in existence before the project begins.

[ ] 5. Research and demonstration projects which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine:
   (i) Public benefit or service programs;
   (ii) procedures for obtaining benefits or services under those programs;
   (iii) possible changes in or alternatives to those programs or procedures; or
   (iv) possible changes in methods or levels of payment for benefits or services under those programs.

☐ 6. Taste and food quality evaluation and consumer acceptance studies, involving adults only.

____ **Please use the attached approved consent forms**

__x__ **You have been granted Waiver of Documentation of Consent**

__✓__ The research presents no more than minimal risk AND

__✓__ The research involves procedures that do not require written consent when performed outside of a research setting

or

____ The principal risks are those associated with a breach of confidentiality concerning the subject's participation in the research AND

____ The consent document is the only record linking the subject with the research

____ **You have been gratned Waiver of Informed Consent**

____ The research presents no more than minimal risk to subjects;

____ The waiver will not adversely affect the rights and welfare of subjects;

____ The research could not practicably be carried out without the waiver; and

____ Whenever appropriate, the subjects will be provided with additional pertinent information after they have participated in the study.

RESPONSIBILITIES OF PRINCIPAL INVESTIGATOR FOR ONGOING PROTOCOLS:

(1) Report **immediately** to the IRB any severe adverse reaction or serious problem, whether anticipated or unanticipated.
(2) Report any significant findings that become known in the course of the research that might affect the willingness of subjects to continue to take part.
(3) Insure that only persons formally approved by the DRC enroll subjects.
(4) If relevant to your study, please use **only** a currently approved consent form (remember approval periods are for 12 months or less).
(5) **Protect the confidentiality of all personally identifiable information collected and train your staff and collaborators on policies and procedures for ensuring confidentiality of this information.**
(6) Submit for review and approval by the IRB all modifications to the protocol or consent form(s) prior to the implementation of the change.
(7) Please note that this office will send out a reminder prior to the end of your approval period (typically at the end of the 12 months). At this time we will ask you to give us an update on whether the study is still in progress and/or has had any changes that need to be reviewed for approval.
(8) Notify the IRB and the DRC when the study has been completed and complete the Final Report Form.
(9) Please help us help you by including the above protocol number on all future correspondence relating to this protocol.

Thank you for your help in this matter.

Sincerely,

Clarke Burnham, Ph.D., Chair
Institutional Review Board

cc: DRC

Dr. Robert Fischler

robert@academos.com

EDUCATION

Doctor of Philosophy: 2006
Educational Psychology, Indiana University

Masters of Science: 1997
Educational Psychology, Indiana University

Bachelors of Arts: 1992
Psychology, San Diego State University

EMPLOYMENT

2004-Present

Flight Attendant
Southwest Airlines
Pass out peanuts and Coke™ but also am prepared for any medical, safety, or security emergency that could happen miles high.
http://www.southwest.com

2001-2004

Senior Web Administrator
Texas House of Representatives
Created entire site, from inception, to information system design, to graphics and database development, to dynamic programming, to delivery and maintenance. The site received an average of over a million hits a day and uses advanced technologies such as XML, PHP, and Real™ streaming media.
http://www.house.state.tx.us

1999-2001

Associate Instructor
School of Education, Indiana University
I taught "Using Computers in Education". This is generally the first college course for undergraduate education majors. In 2000, I was awarded the "Associate Instructor of the Year" by both the Indiana University Student Association and the Graduate Student Organization at Indiana University. Only one person across the entire campus can earn this recognition annually.

1999 **Instructional Technology Consultant, (Freelance)**
Indiana University; Hougton-Mifflin; Bell+Howell.
In 1999, I worked three independently contracted jobs for website creation and consultation. I solely developed a web-based course for the language education department at Indiana University. I worked for Houghton-Mifflin publishing company on a companion website to their popular educational psychology textbook. Lastly, I designed an online reader for Bell+Howell. See http://college.hmco.com/education/snowman/psych_app/9e/students/about/creators.html

Also in 1999, I founded a company called Academos LLC. The company's flagship product was SimTeacher.com, an online simulation for teacher education. This was also the focus of my doctoral dissertation.

1996-1998 **Instructional Consultant**
School of Education, Indiana University
I supported the School of Education faculty in achieving their instructional goals by the integration of technology, and then collaborated on its evaluation.

1997 **Associate Instructor**
School of Optometry, Indiana University
I taught an office procedures class where first year optometry students learn how to use various computer applications they may encounter in their field.

1995-1996 **Associate Instructor**
School of Education, Indiana University
I taught three educational psychology courses. These positions included the development and delivery of lectures, in-class activities, lesson plans, grading criteria, out-of-class assignments, course structure, etc.

ADDITIONAL INFO

2003-2004 **Young Austin Leadership Alliance**
Jewish Community Association of Austin
This is a year-long leadership program designed teach lifelong leadership skills as well as build Jewish identity and commitment in the Austin community.

1997-2001 **Big Brother**
Big Brothers Big Sisters of America, Indiana
I volunteered to be a big brother to a 10-year old child in need and remained committed for four years until I moved out-of-state. We still keep in touch.

REFERENCES

Dr. Bradley C. Wheeler: bwheeler@indiana.edu
CTO, Indiana University

Dr. Curtis Jay Bonk: cjbonk@indiana.edu
Professor, Indiana University

Monica Vigil-McDonald: monica.vigil-mcdonald@house.state.tx.us
Director, Texas House of Representatives