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# A Simulation-based Approach to Educational Psychology

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# ABSTRACT

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This paper summarizes a design project entitled "Choose Your Own Teaching Adventure" completed for the Instructional Psychology and Technology Department at Brigham Young University. The purpose of the design project was to prototype a learning tool that instructs beginning pre-service teachers in the classroom application of the principles of behaviorism. Originally, the project was designed to be a static learning object that would be combined with other similar learning modules for additional topics of an Educational Psychology course. At the conclusion of the first prototyping round, however, the project was generalized to become a testing ground for a simulation builder project that would allow other instructors to create their own learning simulation based on the findings of this prototype. The Rapid Prototyping methodology used in this project allowed for quick revisions, lower stakes testing, and more flexibility in the design. The various stages of the design and evaluation process, including revisions and prototypes, are shown and discussed in this paper.



Keywords: simulation, educational psychology, rapid-prototyping, computer-based learning

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## Introduction

Many educators consider active learning, or learning by doing, as the most effective way to learn (Lombardi, 2007). Sawyer (2006), for example, asserts that "students cannot learn deeper conceptual understanding simply from teachers instructing them better. Students can only learn this by actively participating in their own learning" (p. 2). This active learning becomes more valuable the more closely it resembles authentic environments and the more closely it aligns to the way the human mind turns information into useful, transferable knowledge (Lombardi, 2007). Ideally, that authentic situation for pre-service teachers would be a place such as the classroom, somewhere that could provide real practice of teaching skills. However, because of the challenges associated with providing such authentic contexts, many pre-service teachers learn through traditional lecture and short field experiences prior to student teaching. Girod and Girod (2008) point out four specific shortcomings of this type of teacher education.

First, practice exercises usually focus only on minor skills that do not align with the central goal of enhancing student achievement. Second, allowing students to teach strategies in a practicum situation that they are unprepared for may be an invitation for failure resulting in chaos and horrified supervisors. Third, because of the large variation of possible practicum assignments, a disconnect can occur between the counsel and advice given in college classes and the implementation in the schools (Bullough & Draper, 2004). Finally, although the foremost task expected by student teachers is that of classroom management, other professional skills—such as ensuring alignment between outcomes and student learning and providing sufficient feedback—are directly connected with management decisions, and yet these complex connections are not seen by a typical beginning teacher (Girod & Girod, 2008).

These shortcomings influence the effectiveness of teacher preparation. However, educational researchers are finding that "the value of authentic activity is not constrained to learning in real-life locations and practice, but that the benefits of authentic activity can be realized through careful design of Web-based learning environments" (Herrington, Reeves, Oliver, & Woo, 2007, p. 3). Simulations, in particular, have become increasingly popular for creating realistic digital environments that closely replicate the world and the workplace (Ferry et al., 2004). In the following section, I outline what is meant by a simulation, how simulations have been successfully used in different fields to create effective, authentic experiences, and finally, the implications of creating a successful simulation in the preparation of teachers.

## Simulations

The terms *gaming* and *simulation* are often used interchangeably in research. For the purposes of this project, I choose to define these terms separately and focus solely on simulation-based learning. I hold to Gorrell and Downing's (1989) definition in which a simulation is a program that attempts to "model reality authentically for the user, thereby providing an opportunity for the user to acquire skills, engage in problem-solving, and attain new concepts" that they may later encounter in professional activity (p. 335).

Simulations have been used successfully in many fields for training and educational purposes for several decades (Herrington, Reeves, & Oliver, 2007; Lainema & Nurmi, 2006). One meta-analysis completed on the effectiveness of flight simulators found that simulation is an effective method of training with the major finding that "the use of simulators combined with aircraft training consistently produced improvements in training for jets compared to aircraft training only" (Hays, Jacobs, Prince, & Salas, 1992, p. 63). Because of findings such as this, the military continues to develop simulations to improve human performance training. A recent example of these simulation developments can be seen in a pilot simulator module recently developed to aid helicopter pilots during conditions where an entrainment of dust and debris dangerously limits visibility, also known as a brownout. The brownout module was successfully integrated into the U.S. Army Advanced Prototyping Engineering and Experimentation (APEX) laboratory rotorcraft flight simulation for the UH-60M, CH-47F and ARH aircraft (Keller, Whitehouse, Wachspress, Teske, & Quackenbush, 2006).

Additionally, students feel that simulations are valuable and effective in their own education. For example, in the medical field, Weller (2004) completed a qualitative study evaluating the effectiveness of the management of medical emergencies using a medium fidelity simulator. Thirty-three 4th-year medical students were given a pre- and post-questionnaire as part of a three-hour workshop on the management of medical emergencies. According to the five-point rating scales and follow-up comments, students valued the simulation-based learning "very highly" and felt that their competence with the material improved as a result of the workshop. Students made comments such as, "[putting] theory into practice is quite difficult," "[the workshop] reinforced what we'd read," "[the workshop] provided an opportunity to practice," and "skills you read about are hard to put into practice in real life" (p. 35). Almost half of the students felt that simulation should be used more or that it was essential to their training.

More specifically, teacher education has also experienced the influence of simulations since the mid-1960s (Cruickshank & Telfer, 1980). Early studies of the effects of simulation in teacher education give evidence to support positive outcomes such as learning specific skill sets and transfer of knowledge and skills to the actual classroom (Gorrell & Downing, 1989; Smith, 1987). One study conducted by Gorrell and Downing (1989) compared extended traditional instruction, group problem-solving, and computer simulation within a group of 64 pre-service education majors studying educational psychology. Learning was assessed through a 30-item multiple-choice test, a written application test of behavioral principles, and a self-efficacy questionnaire. The findings indicated that the simulation group out-performed all the other groups with respect to targeted sub-skills by allowing for more practice than the traditional method and more variety of problems than the problem-solving group. An earlier study by Forgan in 1969 also gives evidence that simulation training can benefit pre-service teachers in the authentic environment of the classroom. For example, Forgan, as reported by Smith (1987), accounted that student teachers "more frequently used effective strategies to counter pupil disruptions, they provided more opportunities for pupil leadership, were more supportive of pupils, and were reported to have fewer discipline problems by their classroom supervisors" (p. 406).

Recent research continues to support the findings of earlier studies (Ferry et al., 2005; Fischler, 2006; Girod & Girod, 2008). For instance, one study by Ferry et al. (2005) reports on the success of a simulation focused on the teaching of literacy skills to lower primary students. This simulation, tested on over 185 pre-service teachers, allowed students to take on the role of a virtual teacher and explore a variety of instructional and classroom management processes and practices during literacy lessons. Pre-service teachers were observed, user-entries analyzed, and interviews conducted. Outcomes indicated that the simulation design had the potential to engage pre-service teachers in deep thinking about the virtual classroom environment. For example, 157 out of 180 students reported that "the simulation motivated them to think in more detail about the decisions teachers make on a daily basis" (p. 29). Upon being interviewed, one participant stated, "I think it was the closest thing to actually being in a classroom that I have experienced at university. It gave me something that was really tangible" (p. 28). Additionally, the simulation gave students the opportunity to "slow down or accelerate classroom events, revisit and reflect on critical decision points and replay events in the light of new understandings" (p. 30). Other findings included the ability to help students identify potential classroom problems, see new perspectives and reflect on preconceived ideas, and develop opinions and new ways of thinking.

Even more recently, Girod and Girod (2008) designed a web-based simulation that allowed teachers to practice skills in connection with a Teacher Work Sample (TWS)—a comprehensive project demonstrating a teacher's ability to draw connections between teaching and learning. The simulation aligned with five specified criteria said to encourage high quality practice activities: focus on authentic skills, repeatable actions, available feedback, safe setting, and appropriate complexity. A quasi-experimental study was conducted with 64 participants. Participants in the treatment group received simulation instruction in addition to regular teacher preparation courses and field experiences. Analysis of pre- and post-assessments, as well as participant work samples and group interviews, brought several positive outcomes to light. First, users of the simulation came to a more clear and detailed understanding of the concept of alignment. Second, they gained a heightened awareness of the need to individualize instruction and the challenges associated with such individualization. Third, simulation users gained a better awareness of the role of assessment in learning beyond traditional end-of-unit testing. And fourth, students using the simulation better understood the necessity of data-driven decision-making, analysis, and reflection in connection with student achievement and engagement.

In considering the further need for research in this area, Girod and Girod (2008) conclude by saying, "as the power and potential of computing technology continues to be realized in teacher education, it will become necessary to understand where and how to use simulations more effectively to support teacher development" (p. 331). In answer to this call for a better understanding of where and how to use simulations, this development project investigates the ability to effectively teach the principles of behaviorism by simulating authentic situations and allowing students to take an active role as classroom decision-makers.

## Design Constraints

The principles of behaviorism taught are part of an undergraduate educational psychology class for pre-service teachers. In considering the approach used for this project, a few constraints must be considered. The first constraint is time. Scheduling is very limited and the educational psychology class is only taught in three-hour blocks each week for ten weeks. One of the challenges associated with only teaching once a week is that students become less and less attentive as time passes and are not as engaged near the end of the three-hour class. As an instructor, it is challenging to cover a large amount of material all at once. Covering so much does not allow students to reflect or analyze the different concepts before moving on to the next ones. In the online student ratings, one student commented, "the class covers a lot of material and three hours is a long time to sit in class . . . . By the last hour of class, most students were tired and struggled paying attention and getting something out of the lesson" (personal communication, January 2, 2010). Complaints about the length of the class are not uncommon, yet scheduling does not permit the class to be broken up into smaller segments.

Another constraint of the class is that eight of the ten weeks of the course are taught prior to a practicum, which is a four-week teaching experience completed in the surrounding schools. Because many of the students have not had many teaching experiences in the classroom prior to the Educational Psychology course, students do not have the schema that would allow them to see the application of the principles taught in the course. Furthermore, by the time students participate in the elementary practicum, they are so fully concentrated on the planning, teaching, and management of the class that they are not able to consider the principles learned in the course that would help them analyze classroom problems and guide their instructional decisions (Johnston, 1994).

**Design Approach**

The instructional design model Rapid Prototyping has caught the attention of many designers (Nixon & Lee, 2001). A prototype is a preliminary model of what the finished project might look like. After some initial needs analysis in which general objectives are proposed for a project, developers quickly build a prototype that can then be tested, evaluated, and refined, leading to another version of the prototype. This iterative cycle continues until the most recent prototype becomes the final product.

In contrast to the classic linear Instructional Systems Design (ISD) model, Rapid Prototyping generally follows a spiral pattern using successive approximations to arrive at a workable solution in a more time- and cost-efficient manner. Tripp and Bichelmeyer (1990) suggest that because of the involvement and feedback of end-users throughout the process, errors can be detected earlier and clients can get a more clear picture of the final product early on in development. These advantages can become invalid if proper front-end analysis is incomplete or if designers become undisciplined in their revision cycles leading to a design-by-repair philosophy. Additionally, this model presupposes a design environment requiring modularity and plasticity. In other words, this model requires the availability of tools that makes it feasible to add, remove, or modify segments of the design without significantly affecting the rest of the design, and also the possibility for the design to be quickly and easily revised (Tripp & Bichelmeyer, 1990). With today's technological advancements, this type of environment is increasingly common, which ultimately enables higher fidelity prototypes. Computer-based instructional (CBI) interventions are just one of many examples well suited for the modularity and plasticity of Rapid Prototyping (Nixon & Lee, 2001).

Although admittedly this model does not fit every design problem, Tripp and Bichelmeyer (1990) outline three instances in which this model is suitable given an appropriate design environment: cases with complex factors, cases with unfamiliar situations, and cases where conventional methods yield unsatisfactory results. For the purposes of this project, I will only expound upon the first two.

First, cases that involve complex factors can make prediction problematic. In learning situations, communication problems can occur when complex factors such as human-computer interaction, higher-order thinking skills, or management skills are involved because the knowledge base is undefined. Because Rapid Prototyping does not heavily rely on rigid decisions made near the beginning of the design process, problematic prediction is not as much of an issue; the Rapid Prototyping model provides for modularity and flexibility in altering plans during the research, development, or utilization phases.

Second, Rapid Prototyping can also be useful in unfamiliar situations, or situations where there is little experience from which to draw. Because the research and development processes are happening simultaneously, much of the information can be gathered through feedback from the users and then implemented in the next prototype.

In addition, Lange and Shanahan (1996) pointed out that classroom-based or instructor-led instructional packages also lend themselves well to the Rapid Prototyping model. Implementing the model, their five-person development team successfully designed a four-day instructor-led school called the Enterprise Group Consulting School in just four weeks and within a budget of $15,000. Of their experience they reported,

> Rapid Prototyping enabled our team to design, develop, and implement an effective learning experience within the budgetary and scheduling parameters established by management. It generated much more evaluation data from focus groups and written evaluations than a formal needs assessment would have. It enabled the design team to revise the course to more precisely meet participants' needs. It also required far fewer resources than would have been necessary in developing the course over three or four months with a formal needs assessment . . . and related materials. (1996, p. 29)

## Original Product Description

The instructional materials for this project are based in an Adobe Flash program that students can access online. The project was funded through the graduate department and closely overseen by a professor from the department acting as both the client and supervisor for the Educational Psychology course. To capture some authenticity, the client requested that the program have a "Choose Your Own Adventure" feel. Students would be presented with video vignettes from a classroom and then be able to choose what to do next from a list of actions (see Appendix A). Based on the perceived problem, students would make authentic choices about how to learn more about the situation and how to address that situation based on the principles of behaviorism highlighted in the educational psychology course.

After students make an instructional decision, they follow the narrative to learn the results of their choice. Traditionally, textbooks and other materials provide a variety of case scenarios from different classrooms and grade levels. In contrast, a proposed feature of this program is that all of the core narratives are interconnected and relate to one comprehensive classroom experience.

The client requested that the instructional strategies offered in the simulation tie into what students read and discuss in class. The purpose of presenting the strategies is three-fold. First, it allows students to be familiar with what options are available to them as teachers, and to help them expand their personal schemas of potential options. Second, it connects a concrete example of a strategy being implemented to the name of that strategy. And third, it allows students to connect practical actions to a particular theory or framework. Additionally, a unique feature of the simulation would be that students could redo the simulation to improve their performance or to see the situation from a different perspective. This type of safe environment encourages exploration and allows students to experience success early in their teacher training.

## Design Process

The following sections will detail the four prototyping rounds of this project. Each round will describe the design changes made, testing procedures and results, and the evaluation results that impacted the subsequent series of design changes.

### Prototype Phase 1

**Design.** Given the large scope of the project, the focus of the first prototyping phase was to create an authentic decision-making model similar to that of an actual teacher. This model would provide a breakdown of authentic teacher decision options when faced with finding and solving an educational challenge. As a third-grade teacher in the public schools, I have had many rich experiences working with students in the classroom. I chose one particular student from my experiences and designed a decision tree that would allow a pre-service teacher to walk through all the steps of finding and correcting the specific behavior of completing an assignment in class. With this particular experience in mind, I scripted my experience with that student to conform to the resources I used and the resources that were available to me in resolving the issue. Next, I categorized these data and decision-making resources into five main categories: classroom observation, conferencing with students, conferencing with parents, reviewing student academic records, and talking with colleagues and professional educators.

These five resources could be used in any order depending on the nature of the problem and the experience level of the teacher. Based on these categories, a decision tree was mapped out to show what additional knowledge and resources the user would gather from each resource based on their current knowledge level. I discovered that a decision tree that takes into account every possible decision and every possible result quickly multiplied into an unmanageable number of possibilities and outcomes. As a result, the decision was made to guide the learner into making better-informed decisions by giving a limited number of choices that would ultimately lead to obtaining the same background information and the same conclusion about the nature of the student's educational challenge (see Figure 1).

In an effort to keep classroom decisions tied to the principles they are based on, the user's available choices are organized according to general types of instructional strategies rather than specific ways those strategies are manifested in the classroom. For example, instead of letting a user decide to reward a student with additional recess, the user is allowed to choose a principle such as positive reinforcement, negative reinforcement, shaping, or punishment. Then the user can decide how to implement that principle based on a more specific series of options within that category. This type of arrangement not only keeps the simulation more organized, but also provides a physical structure and order to facilitate internalization of the principles cognitively. A representation of that structure is captured in Figure 1.

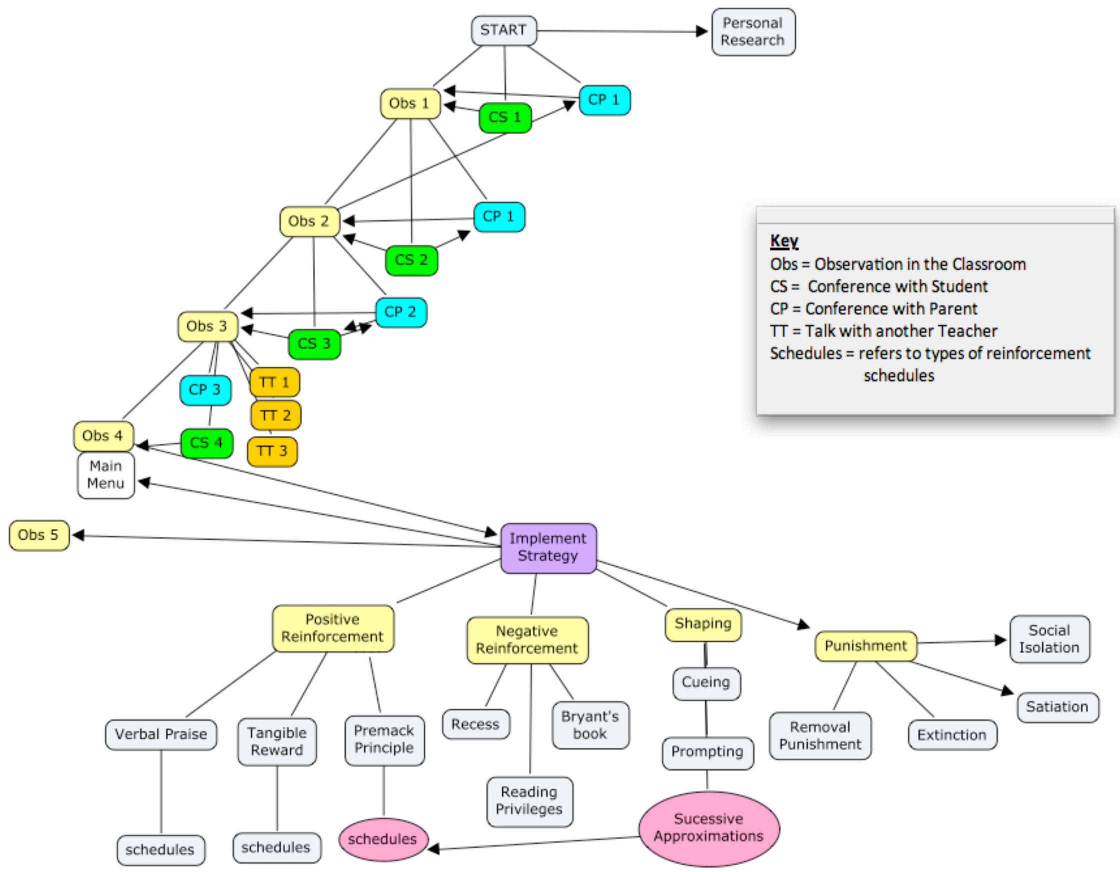


*Figure 1*. Simulation Decision Tree

**Development.** Development of this prototype included building the story and structure of the simulation into a viable platform. The platform chosen for this project was Adobe Flash CS4 using the Actionscript 3 programming language. This platform was chosen based on the knowledge and experience of the designer. The purpose of the first prototype was to test the story's perceived authenticity, and the simulation's structure as a viable experience to use with pre-service teachers. The prototype was built from scratch and the graphics were based on the look and feel of a classroom illustration. At the completion of the first round, a functional prototype was available for testing that included all the narrative script as well as the basic navigation (see Appendix B, Figure B.1).

**Testing.** The simulation was then put into a shockwave file and housed on a server where three other Educational Psychology instructors could access it through a link. The instructors were asked to complete the simulation and respond to the following questions: Does the simulation narrative and experience make sense? Does it appear to reflect an authentic experience? What bugs do you run into during the simulation?

While exploring and completing the simulation, instructors took notes on their personal experiences. We then debriefed the experience as a group to share thoughts and ideas, discuss challenges, and brainstorm solutions.

**Evaluation.** This evaluation round was specifically focused on overall effectiveness and soundness of content, authenticity, navigation, and overall functionality. The overall judgment of the first prototype was that this simulation was effective in helping users connect a real-life example to educational principles. Instructors reportedly felt that the content presented was sound, but that the “Personal Research” area could be further developed to provide a better learning resource. They indicated that the storyline was engaging and authentic in representing a real classroom situation. The navigation was mostly intuitive, but needed a few minor adjustments to make it more clear in some areas. Finally, there were several bugs that made implementing strategies confusing.

***Strengths.*** Instructors identified several strengths with this simulation prototype. First, they thought students could better see the connection between principles and their actual application in the classroom, specifically the use of reinforcement schedules, which are a key element of behaviorism. They also saw the “Talk with Teachers” options as particularly valuable in extending the teaching scenario to other classrooms and encouraging collaboration. Because this simulation was patterned after a personal teaching experience, they perceived the authenticity of the storyline as true to what one might find as a schoolteacher. The presented situation demonstrates how behaviorism relates not only to classroom management, but also to classroom learning.

Instructors also reported that the navigation of the product was fairly intuitive and allowed for more user choice and control in progressing through the simulation. Because the simulation is designed to guide the user through the simulation so that they can explore different options, but still be eventually led to the correct path of decisions, the design improves learner focus and avoids unnecessary frustration.

***Challenges.*** As a result of the evaluation, several key elements that needed improvement emerged. Table 1 includes a summary of the navigation problems and programming bugs found in the first prototyping round.

Table 1

*Navigation Problems and Programming Bugs Identified in First Prototype*

| | |
|---|---|
| Navigation Problems | User does not know that the "Observe" option is available multiple times |
| | User needs more direction in how to use the reinforcement schedules |
| | User needs feedback on the "submit" button |
| | Users request a back button or some way to track where they have been |
| Programming Bugs | A few misspelled words |
| | Buttons that worked or did not work at inappropriate times |
| | Buttons that where white or grayed out at inappropriate times |
| | A "please wait . . .loading" sign that appeared where it should not have |

Although many efforts were made to eliminate bugs, several remained in the first prototype tested by the three Educational Psychology instructors. Most of these could have been prevented, but the nature of the platform does not mesh very well with the format of the simulation, producing many hard-to-resolve problems. As a result, the decision reached at the end of the first prototyping round was to transfer the product to a different platform and create not just a static simulation learning object, but a builder of simulations. This builder would allow future instructors the ability to build their own narratives in a similar fashion without having to hard code it in a difficult programming language. Thus, at this point, the goal of the design project changed from being an end product to being a testing product for the simulation builder. This decision impacted the nature and types of modifications I could make since the prototype testing remained in the original Flash platform.

**Prototype Phase 2**

**Design changes and development.** The second prototype phase began by keying in on the following recommendations from the first evaluation:

1. Allow for a place to keep notes on the side
2. Written prompts need to be grouped together and printed
3. Instructions should be bulleted or divided among screens to make it more manageable.
4. Include more information in the scenario for non-working endings to make it less repetitive and more satisfying
5. The amount of time passing in the scenario needs to be more clear as delineated by days or weeks
6. Scroll button needs to be reset to always start at the top

7. Just-in-time instruction could be included as users predict or learn more about a particular strategy before implementing it

Giving better instructions (recommendations 2 and 3) and implementing just-in-time instruction (recommendation 7) were the main focus of this revision. The instructions were rewritten to spread across three screens instead of one in order to appropriately chunk the information for users to remember (see Appendix B, Figure B.2). Instructions were also expanded and rewritten for clarity and readability purposes.

To increase the teaching effectiveness of the simulation as a teaching tool, brief descriptions of the strategies were included on the screen so that students would understand what the strategy was before they implemented it. For example, some principles, such as the Premack Principle, seemed less intuitive than a principle such as Positive Reinforcement, so a brief description was included to instruct and remind students of the basic definitions (see Appendix B, Figure B.3).

**Testing.** Twenty-two students enrolled in my section of Educational Psychology were instructed to complete this simulation outside of class prior to reading their textbook covering the same material. The students could use this simulation to earn a few extra credits points as well as a replacement for a weekly reading response assignment. Twenty-one of the 22 students chose to complete the simulation experience. One of the purposes of this simulation was to test whether it could be a viable replacement for the current textbook. Following completion of the simulation, students were asked to complete a Google Docs form that automatically populated a spreadsheet with their quantitative and qualitative evaluation. Students were asked to respond to overall likes and dislikes of the simulation, as well as specific aspects regarding their level of understanding, application, and motivation to complete the simulation. A copy of that form is found in Appendix C.

**Evaluation.** Overall, students reported that they liked the simulation and had a positive experience using it. On a five-point scale, where a one represents very displeased and a five represents very pleased, students gave an average score of 3.95 for how pleased they were overall, an average score of 3.76 for how well it helped them understand the concepts, an average score of 4.48 for how well it helped them understand the application of the concepts, and a 3.9 for how fun or motivating the simulation was. Students also reported that they spent an average of 41 minutes completing and exploring the simulation, and an average of 20 minutes to complete the evaluation. In addition to quantitative data, students gave qualitative feedback on their experience. Tables 2 and 3 contain a summary of the most repeated positive and negative themes, respectively, that emerged from the qualitative data, and the corresponding design changes proposed for the next prototyping round.

Table 2

*Positive Aspects Mentioned by Students with Accompanying Design Changes for Round 3*

| Positive Aspects | Design Changes |
|---|---|
| Authentic | Make users aware that this simulation was based on a real-life experience |
| Choice | Keep the simulation student-centric |
| Multiple examples of concepts | Encourage exploration |
| Lots of detail given in story | Provide continued detail in story |
| "Better than a textbook" | Provide learning opportunities to limit/replace the textbook |
| Charts | Make the purpose of the schedules clear by improving the layout and providing a definition/explanation of schedules |

Table 3

*Negative Aspects Mentioned by Students with Accompanying Design Changes for Round 3*

| Negative Aspects | Design Changes |
|---|---|
| Confusing Schedule Charts | Make the purpose of the schedules clear<br>Improve the layout<br>Provide definition/explanation of schedules |
| Unclear progress | Include a progress indicator either by proximity to answer or number of criterion-based points earned |
| Unclear Directions/Purpose | Provide screen shot during the directions<br>Make the purpose more clear |
| Improve Learning of Concepts | Bold the terms<br>Simplify the presentation<br>Include more definitions or explanation of terms |
| Examples limited to one context | Illustrate concepts in more than one context |

Some limitations of this data are that students were required to indirectly identify themselves creating a potential conflict of interest since the creator of the simulation was the same person assigning their final grade for the course. This could explain why the ratings fell slightly between the second and third round even though many improvements and adjustments were made.

## Prototype Phase 3

**Design changes and development.** Evaluation results from the end-user of the product revealed several necessary design changes. The design and development of this phase focused on increasing student motivation to explore, incorporating a point system, integrating outside learning resources, and providing a self-assessment component.

First, in order to increase student motivation, the directions were again reworded and bulleted to be more encouraging of exploration (see Appendix D, Figure D.1). The fact that the simulation is based on an actual teaching experience was also included in the introduction of the simulation since students commented that knowing that information also made the simulation more motivating. In addition, to help motivate students to continue exploring even at the conclusion of the simulation, a glossary page was included immediately following the resolution to encourage students to return to parts of the simulation they might have missed.

A point system was also incorporated to investigate its effects on student motivation. A point display was included at the top with an indicator that the points possible were out of 50 points. Points were added on a variable ratio schedule as students explored various options and resources. The points were meant to be an indicator of how much more of the simulation still needed to be explored. If students solved the simulation challenge quickly, they were well under the 50-point goal, and would then need to continue to explore the other options until they reached 50 points.

Another design change was the implementation of response boxes. Response boxes allow students to submit responses to prompts given at various points throughout the simulation. The prompts ask students to interpret and analyze the reinforcement schedules and propose reasons why the different behaviorism strategies may or may not work with that particular student. These collected responses were printed out at the conclusion of the simulation to serve as tangible evidence in checking the students' understanding. Instructors could then analyze and evaluate responses based on the depth and accurateness of a student's response. The simulation also allowed instructors to see how many responses a student completed and in what order they were completed.

To accommodate the additional features of the response boxes and point display, the user interface was enlarged and redesigned. The new interface featured a space for anecdotal notes, the response box area, and the point system display (see Appendix D, Figure D.2). The anecdotal notes option was another authentic feature of this product. In the schools, classroom teachers are encouraged to take anecdotal notes and keep records of student behavior and progress. These records are then used as evidence for supervisors and specialists to help students qualify for extra assistance and therapy. To help users develop the habit of noticing what is happening in the classroom and the habit of keeping records, the users could take notes from the narrative to help them remember the details of the situation when making decisions.

Finally, during the concluding screens of the simulation, a quizzing feature was incorporated to allow users to check their understanding. The quizzing feature was built into a resource wiki where users could easily link to the quiz answers as well as additional resources.

This feature allows users to self-evaluate their own understanding of the concepts at a deeper level and to be better informed of what knowledge would be required at the conclusion of the simulation experience. Furthermore, users could also be able to easily access the web address at any time without having to redo the simulation. Screenshots of these features can be found in Appendix D, Figure D.3 and D.4.

**Testing.** The simulation was explored by 45 students from three sections of students taking Educational Psychology Winter semester from other instructors (i.e., not the same class as earlier evaluations). Following the simulation, the students were asked to complete the online evaluation form. Twenty-five students were invited to participate in an evaluation of this simulation during class, and approximately fifteen students completed the simulation outside of class for a small amount of extra credit. Because students from several classes tested out this version of the prototype across several days, small changes were made to the prototype in the middle of the testing phase based on student comments. These smaller changes were made to see if those particular minor changes affected future student ratings and comments. Comments and scores were separated based on which version of the simulation they used. These design and development changes included another improvement on the directions for the simulation, removal of the target goal for how many points were to be earned, inclusion of a few well-placed sign posts to let students know they were on the right track, and the correction of a few bugs in the simulation dealing with response boxes and printing.

**Evaluation.** Overall, the students again responded positively to the simulation experience, particularly during the second half of the testing phase. The change in the quantitative scoring of the simulation is notable. The average overall rating of how pleased the students were with the simulation on a scale of 1-5 for the first 33 people was 2.9, whereas, after the minor changes had been made to the prototype, the average rating of the last 12 students was 3.9, a 20 percent increase. A significant increase in ratings occurred in each of the categories rated including level of understanding, level of application, level of motivation, and time spent completing the simulation and evaluation. A summary of the student ratings are found in Table 4 and a summary of major themes from all the student comments during the third round are included in Tables 5 and 6.

Table 4

*Student Evaluation Comparison for Rounds 2 and 3*

| Evaluation Round | Overall | Level of Understanding | Level of Application | Level of Motivation | Time Spent on Simulation | Time Spent on Evaluation | Personal Effort in Evaluation |
|---|---|---|---|---|---|---|---|
| Round 2 | 3.95 | 3.76 | 4.48 | 3.90 | 40.76 min | 19.52 min | 4.81 |
| Round 3 (Group 1) | 2.90 | 3.06 | 3.47 | 3.27 | 19.40 min | 9.50 min | 4.06 |
| Round 3 (Group 2) | 3.92 | 4.17 | 4.17 | 4.00 | 25.00 min | 16.67 min | 4.33 |

Table 5

*Positive Aspects Mentioned by Students with Accompanying Design Actions for Round 4*

| Positive Aspects | Design Actions |
|---|---|
| Authentic/Realistic | Make users aware that this simulation was based on a real-life experience |
| User Choice | Keep the simulation student-centric |
| Multiple examples of concepts | Encourage exploration |
| Lots of detail/info given in story | Provide continued detail in story |
| "Better than a textbook" | Provide learning opportunities to limit/replace the textbook |
| Reinforcement Schedule Charts | Make the purpose of the schedules clear<br>Improve the layout<br>Create a key to read the schedules<br>Provide definition/explanation of schedules |
| Student Research of Math Scores | Continue to provide real assessment data |

Table 6

*Negative Aspects Mentioned by Students with Accompanying Design Actions for Round 4*

| Negative Aspects | Design Actions |
|---|---|
| Confusing Schedule Charts | Provide definition/explanation of schedules |
| Unclear progress/Ending | Include a progress indicator<br>Proximity to answer<br>Clear indicator of the end |
| Unclear Directions/Purpose | Make the purpose more clear |
| Point System | Use a continuous point system and explain how to get points<br>Take the points away as it encourages more extrinsic motivation instead of intrinsic motivation |

## Prototype Phase 4

**Design changes and development.** Visual appeal and video modeling was the focus of the fourth prototyping round. Seventeen illustrations were added to the simulation to help users better visualize the narrative in addition to clearly marking the separation of screen changes. In the original design, the actual narrative was to be filmed and shown in small segments throughout the experience. The change in focus at the end of round one to create a prototype for the simulation builder changed the scope of the project such that it would be unreasonable to expect future authors to be able to record a scene for each story segment. Additionally, student feedback indicated that a written narrative could adequately describe the detail of the situation, and critical details can often be pointed out in words more easily than a camera could capture. In order to continue to offer authentic, live examples of different concepts however, I decided to include outside examples that could enrich the scenario and expand the user's ideas for implementation of the various strategies. Thus, the focus of video for simulation changed from filming staged portions of a single simulation, to providing vignettes exemplifying individual concepts as a way to provide additional examples from the written simulation (see Appendix D, Figures D.5 and D.6).

The most updated version of the simulation can be located at http://www.jburningham.net/BehaviorismPro5-19.swf.

**Testing and evaluation.** The fourth prototype was not tested or evaluated by students because it occurred during spring term when the course was not in session. The next evaluation will be completed during fall semester 2010 using the simulation created on the new platform. A prototype version on the new platform can be located at http://301.benmcmurry.com.

## Critique

Student evaluations show that this simulation was very successful in helping pre-service teachers see the classroom application of the principles of behaviorism. Students consistently commented that they appreciated the authenticity of the narrative to help contextualize the information. They also mentioned how much they enjoyed how learner-centered the simulation was, and many students found the simulation to be engaging. One student captured the experience well in commenting:

> I liked that it was like a 'choose your own adventure' book. It allowed me to choose options of what to do and see what theoretically would happen in that situation. I like that the problems were true to a real classroom experience. The whole time I was doing the simulation I thought of students I have worked with that had similar problems. I also thought it was useful to be able to observe more, talk to teachers, look at their record, and conference with the student. Each time you did something like this you gained more information to help you make a more informed decision. (Student Evaluation comment, April 8, 2010)

One of the biggest weaknesses of this simulation is that I completed all the prototypes in an Adobe Flash platform. This platform was used because it was the only one that I was familiar with at the time of development. However, there were many inherent difficulties in using that platform that surfaced later in the project. As a result, I was not able to correct all of the design flaws that I would have liked because of the development platform in combination with my limited programming skills.

Another shortcoming of the original design was its static nature. The simulation could not be easily modified and additional simulations would come only at great cost. The decision to modify the design to eventually be a simulation builder, or a dynamic generator of simulations, not only solves that design problem, but the alternative dramatically increases the longevity of the project and facilitates the ability to meet the needs of more instructors and students. This new simulation builder will allow for improved scalability and will significantly reduce the cost of building additional simulations.

Another weakness of the project occurred in the test phase of the third round of prototyping. Because I did not personally introduce the simulation to all of the students, I could not control for the information received before starting, or for the expectations communicated as a participant in the evaluation. Even though the situations of students completing the simulation were varied, the reports received appeared to still contain trustworthy data from which to draw conclusions.

Many ideas for this simulation are heavily influenced by the ideas of Anchored Instruction and Situated Learning that stress richer connections and better knowledge transfer. Although this type of learning has many advantages, it also requires a greater amount of time and resources, not only to design, but also to produce. For example, originally the simulation was to include short vignettes similar to the Jasper Woodbury Series (Cognition & Vanderbilt, 1990), but the time and resources required to keep the narrative consistent were not practical in terms of the cost of time and resources. Additionally, trying to scale that type of production for additional modules would also be equally impractical.

To compensate, I incorporated a just-in-time aspect to the experience where, although the narrative experience was still embedded in an authentic context, the additional resources such as video clips, wikis, and web resources could be modular enough to meet the changing needs of students, the growth and development of technology, and the resources allotted in the project budget.

**Conclusion**

In an attempt to meet the needs of both the client and the students, a narrative simulation was successfully designed and developed to help students better understand and apply principles of behaviorism in a classroom context. Using the Rapid Prototyping design method, many significant design changes could be made at a lower risk and cost of production. These cycles proved to be very effective in continually making adjustments to the design in order to meet the needs and satisfaction of students. As an outgrowth of the simulation, work on the simulation builder continues. Based on the research and experiences of my project, I have several recommendations for the new simulation builder:

1. Make continued efforts to create simple, easy-to-read directions for the simulation. Students do not always read directions thoroughly and often have a poor simulation experience as a result. The lowest ratings given for the simulation always came from disgruntled students that did not understand the directions or the nature of the simulation.
2. Debrief the simulation as a class soon after the experience, that same day if possible. Students will have the most to say and will be the most interested in discussing and sharing their experience immediately following the simulation. This window of learning opportunity should be maximized, especially considering the class meets only once a week.
3. Encourage students to complete the simulation *before* equivalent material is covered in the class. According to a study done by Brant and Hooper (1993), completing the simulation first better prepares the students to read, listen, and understand the material

afterwards. The first student group evaluators were able to test this suggestion out, and 18 out of 21 students said they were glad they did the simulation first because the textbook reading that followed was much more understandable and went more quickly since they had already had an experience with it.

4. Eliminate the point system and replace it with a more intrinsic alternative. Students did not respond favorably to the point system. One reason could have been that the points were not clearly explained in the introduction. Nevertheless, student comments revealed that students were so focused on point totals that they were distracted from the learning experience. A better alternative to points would be to provide an advance organizer of questions at the beginning of the simulation and allow students to "unlock" the ability to get the answers as they explore the corresponding area of the simulation. Consequently, instead of being rewarded with less meaningful points, they will be rewarded with additional resources and knowledge to correctly answer the questions expected of them. This change in motivational direction also strengthens the alignment between the instruction and the assessment.
5. Include a progress indicator. Students wanted feedback regarding how close they were to the end and how well they were doing. This bar should indicate how close the student is to finishing the advance organizer mentioned above and thus to finishing the gathering of the desired information and experience offered by the simulation.
6. Offer more information regarding the use and purposes of reinforcement schedules within the simulation. Students often commented on their confusion regarding the reinforcement schedules. This problem could be resolved by including more information

on the screen during their first encounter with the reinforcement schedules to better explain the nature of the schedules and how to interpret them.

## Schedules

Differences in schedules between the Proposed Schedule (Table 7) and the Actual Schedule (Table 8) result from a combination of factors. First, the prototype built was part of a course project taken during fall semester 2009. As part of that project, the elements of the first two cycles were combined to meet the requirements of the course project before a formal evaluation was done. Also, at the conclusion of the first cycle, the client decided that the product would better serve its purposes in a different platform as a dynamic builder of simulations instead of a static product. Therefore, with the change in the nature of the project, the following cycles focused on major design elements to improve the integrity of the design that would then be incorporated into the next model. Finally, because of time constraints and my inexperience as a programmer, many of the cycles took longer to develop than the proposed allotment of time.

## Costs

This project, including analysis, design, development, and evaluation of four cycles is estimated to have required 200 hours of paid work costing $3000, 75 hours of voluntary work, and $325 to hire an illustrator for additional visual images to be added to the simulation. Total cost is estimated to be approximately $3500 at the concluding stages of the fourth prototyping cycle.

Table 7

*Proposed Schedule of Revision Cycles*

| CYCLE | FOCUS | TIMELINE |
|---|---|---|
| CYCLE 1 | LEARNER NEEDS CYCLE | OCT. 2009 |
| Analyze | Learner needs and gap in learner knowledge/skills | |
| Design | Situational script for behaviorism | |
| Develop | Paper copy of script with decision tree | |
| Implement | Present instructors of the course in Instructors' Meeting | |
| Evaluate | Questionnaire | |
| CYCLE 2 | COMPUTER MODEL CYCLE | NOV. 2009 |
| Analyze | Flow on computer navigation/ Transition from paper to computer model | |
| Design | Navigation, video segments | |
| Develop | Navigation, video segments | |
| Implement | Former instructors of Educational Psychology and other teacher educators in the Teacher Education Department | |
| Evaluate | Questionnaire | |
| CYCLE 3 | USABILITY CYCLE | JAN. 2010 |
| Analyze | Navigation and usability for end-user | |
| Design | Administrative materials, evaluation rubrics | |
| Develop | Administrative materials, evaluation rubrics | |
| Implement | Students from prior semesters (Student Teachers/2nd Cohort Students) | |
| Evaluate | Questionnaire, observation, and student product | |
| CYCLE 4 | LEARNER OUTCOMES CYCLE | FEB. 2010 |
| Analyze | Effectiveness and learner outcomes | |
| Design | Implementing revisions/ Clean up for master copy | |
| Develop | Implementing revisions/ Clean up for master copy | |
| Implement | Actual students in the course (Students in my class) | |
| Evaluate | Questionnaire and student product | |
| CYCLE 5 | FINAL REVISIONS CYCLE | MAR. 2010 |
| | Final Revisions | |

Table 8

*Actual Schedule of Revision Cycles*

| Cycle | Focus | Timeline |
|---|---|---|
| Cycle 1 | Learner Needs Cycle | Oct. 2009 |
| Analyze | Learner needs and gap in learner knowledge/skills | |
| Design | Situational script for behaviorism, flow on computer<br>Navigation/Transition from paper to computer model | |
| Develop | Paper copy of script with decision tree | |
| Implement | Present instructors of the course in Instructors' Meeting | |
| Evaluate | Questionnaire | |
| Cycle 2 | Expanding Resources, Improving messaging, Usability | Jan. 2010 |
| Analyze | Feedback given from other instructors | |
| Design | Additional resource links, improved instructions | |
| Develop | Additional resource links, improved instructions | |
| Implement | Current students in one section of Educational Psychology | |
| Evaluate | On-line evaluation form, student responses from simulation prompts | |
| Cycle 3 | Refining Usability, Interface redesign, Motivation | Mar. 2010 |
| Analyze | Navigation and usability for end-user, cycle 2 feedback | |
| Design | Interface, response boxes, self-evaluation tool, point system | |
| Develop | Interface, response boxes, self-evaluation tool, point system | |
| Implement | Current students in other sections of Educational Psychology | |
| Evaluate | On-line evaluation form, in-person observations, student responses from simulation prompts | |
| Cycle 4 | Visual Appeal, Video Vignettes | Apr. 2010 |
| Analyze | Feedback from cycle 3 | |
| Design | Implementation of video segments, additional illustrations | |
| Develop | Implementation of video segments, additional illustrations | |
| Implement | | |
| Evaluate | Make recommendations for future product | |

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# Appendix A

## Mock-ups of Original Product Description

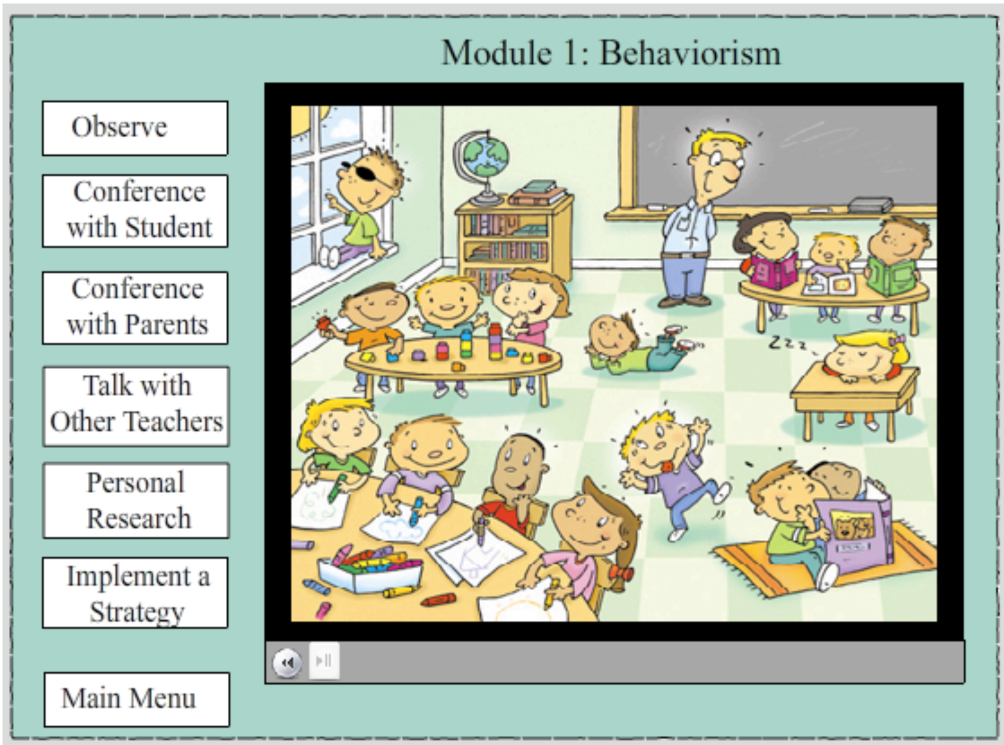


*Figure A.1*. Proposed screen shot of classroom decision options

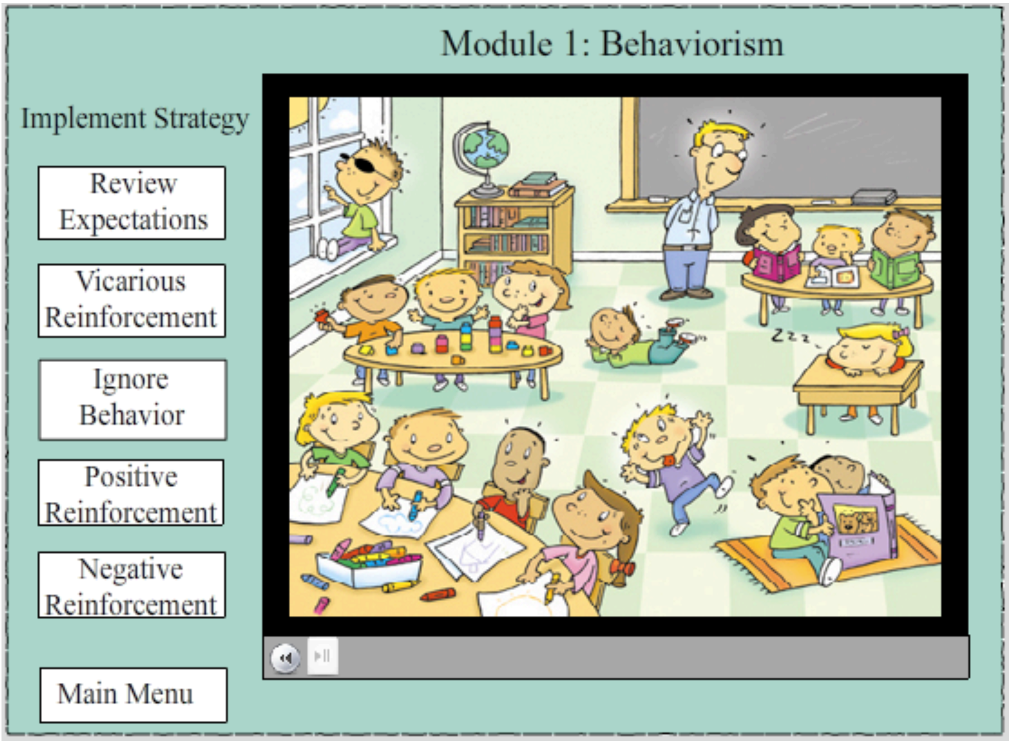


*Figure A.2*. Screen shot of proposed "Implement Strategy" menu

# Appendix B

## Screen Shots of Prototype Rounds 1 and 2

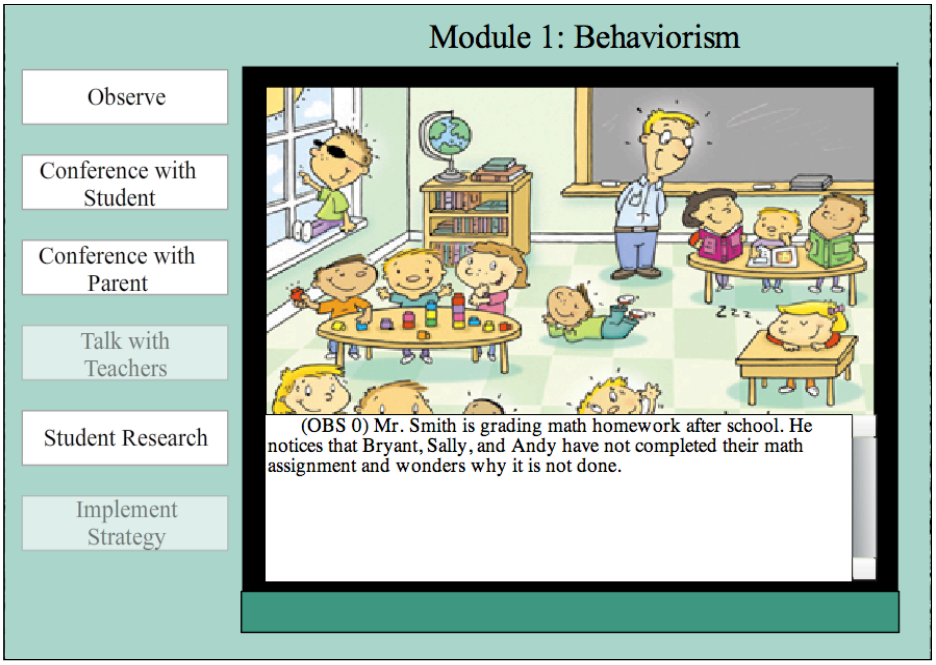


*Figure B.1.* First prototype with narrative and navigation

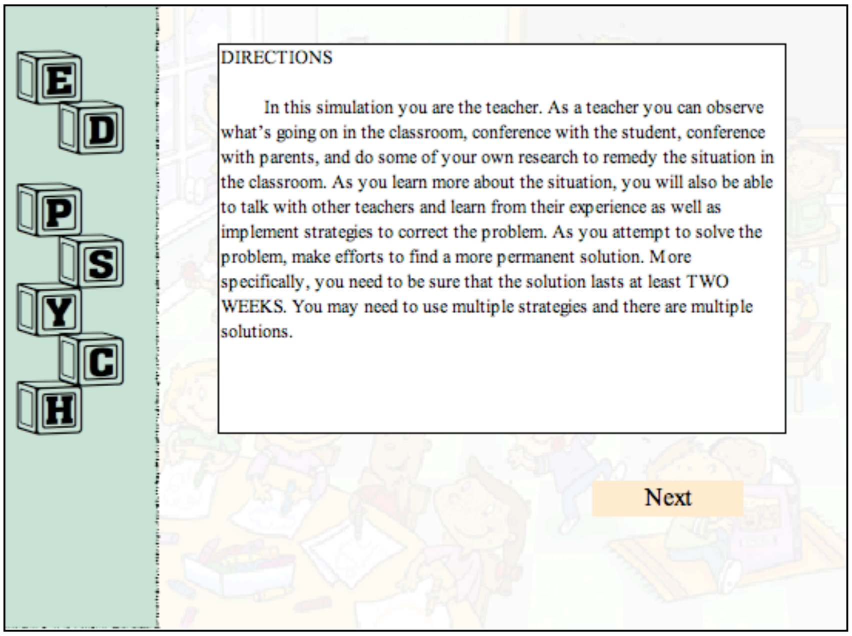


*Figure B.2*. Revised directions for Prototype 2

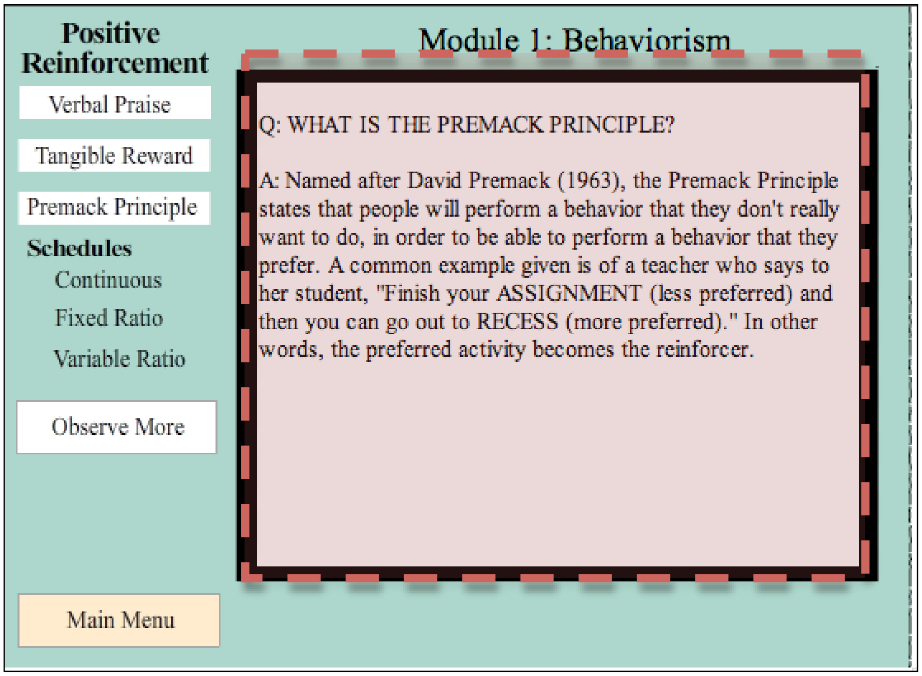


*Figure B.3.* Just-in-time instruction added to Prototype 2

Appendix C

Student On-line Evaluation Form

# Simulation Evaluation

This form is for you to give feedback regarding a learning object that is currently being developed for Behaviorism and eventually other units in Educational Psychology. Please be thorough and honest in your feedback so this learning object can be improved for the next round of development.

## Class Information

Student Number e.g. 092584665 ☐

Section Number ☐

## Evaluation Questions

Overall, on a scale of 1-5, how pleased were you with this simulation?

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Very Displeased | ○ | ○ | ○ | ○ | ○ | Very Pleased |

In general, what were some things that you liked about this simulation?

In general, what were things that you disliked or were confusing?

# Effectiveness

On a scale of 1 - 5, how useful was this simulation in helping you better understand Behaviorism concepts

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Not Helpful | ○ | ○ | ○ | ○ | ○ | Very Helpful |

What specific aspects of the simulation were useful in helping you better understand? e.g. format, story example, design, etc

What could be added or clarified to make this simulation more useful in helping you better understand?

On a scale of 1-5, how useful was this simulation in helping you see the APPLICATION of the concepts of Behaviorism as a teacher

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Not Helpful | ○ | ○ | ○ | ○ | ○ | Very Helpful |

What aspects of the simulation helped you see the classroom application?

What could be added or clarified to help you better see classroom application?

## Technical Difficulties

Did you run into any technical difficulties? If so, please explain them below.

## Motivation

On a scale of 1-5, how fun or motivating is this simulation?

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Not motivating | ○ | ○ | ○ | ○ | ○ | Very motivating |

What suggestions do you have that could make this experience more motivating?

## Assessment

If you were to receive a grade for doing this simulation, how would you prefer to be graded? Why? e.g. participation, quality of writing, etc.

## Logistics

How long did you spend on the simulation?

How long did you spend completing the evaluation?

If you were grading yourself on effort in completing this evaluation, what would you give yourself

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Low effort | ○ | ○ | ○ | ○ | ○ | High effort |

What day and time did you complete the simulation? e.g. Wed. at 6:00pm

Submit

# Appendix D

## Screen Shots from Prototype Rounds 3 and 4

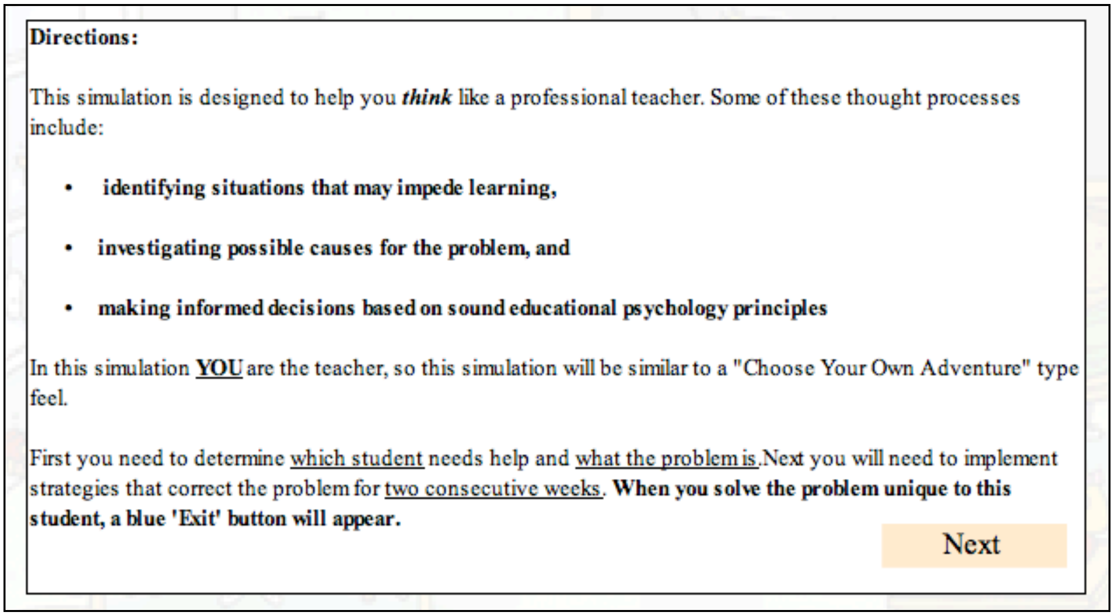


*Figure D.1.* Bulleted and bolded directions for Prototype 3

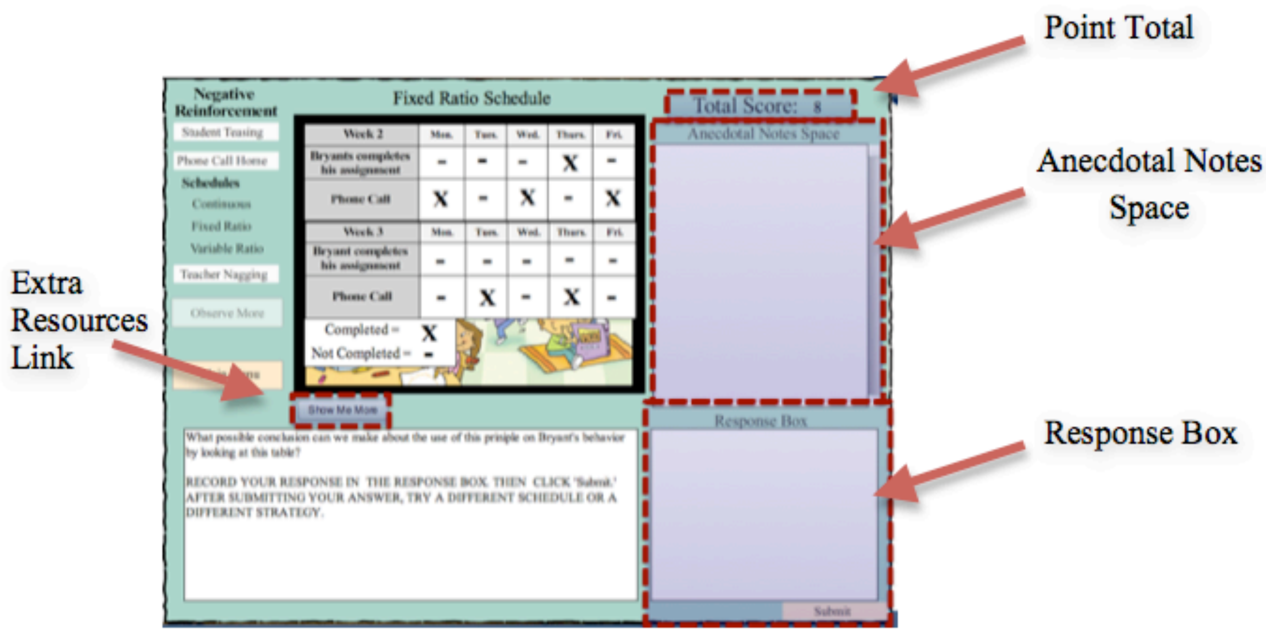


*Figure D.2*. Interface and new design features made available in Prototype 3

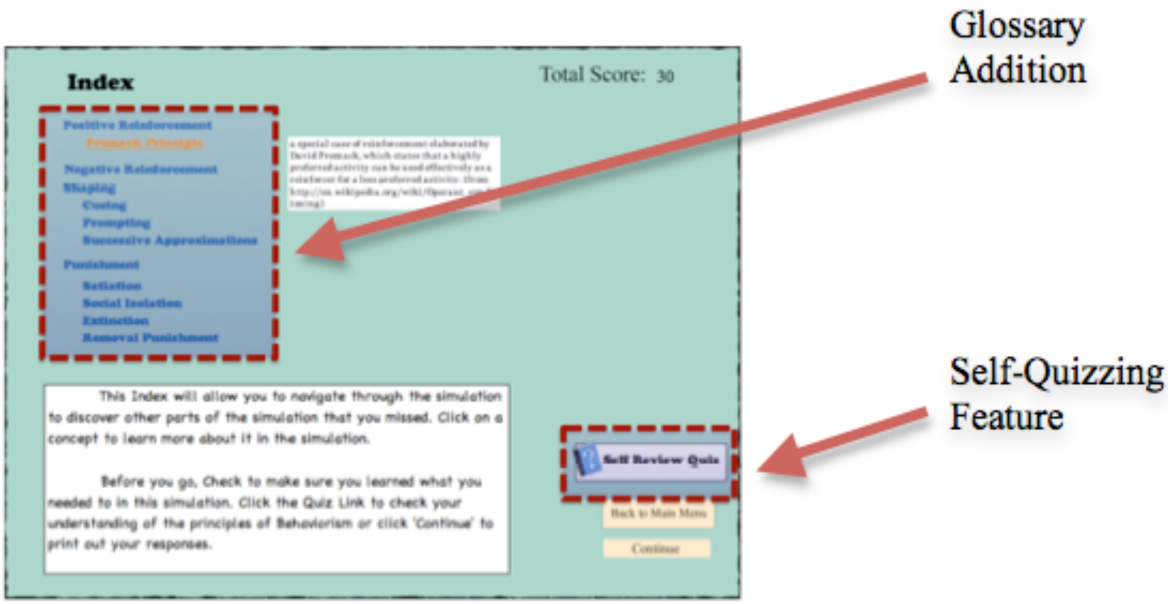


*Figure D.3.* Self-quizzing link and glossary addition to Prototype 3

## What You Should Know! Check your Understanding

i. What is Positive Reinforcement?
ii. What are some classroom examples of positive reinforcement?
iii. What is Negative Reinforcement?
iv. What are some common examples of Negative Reinforcement?
v. What is the difference between negative reinforcement and positive punishment?
vi. How can reinforcement schedules be used most effectively?
vii. What is one way you could use successive approximations in the classroom?

### Terms

- Positive Reinforcement
    - Premack Principle
- Negative Reinforcement
- Reinforcement Schedules
    - Continuous
    - Fixed Ratio
    - Fixed Interval
    - Variable Ratio
    - Variable Interval
- Shaping
    - Cueing
    - Prompting
    - Successive Approximations
- Punishment
    - Satiation
    - Social Isolation
    - Extinction
    - Removal Punishment

*Figure D.4.* Self-assessment quiz added to Prototype 3

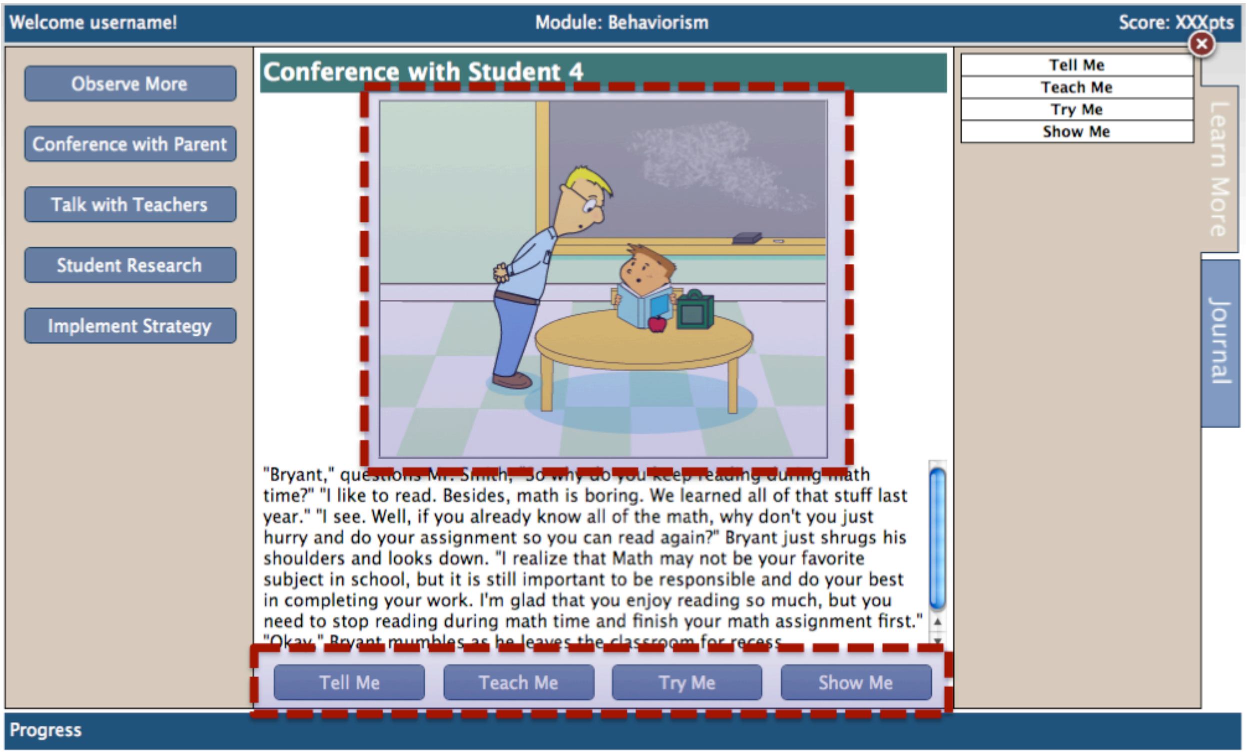


*Figure D.5*. Illustrations and additional resource categories included in Prototype 4


*Figure D.6.* Embedded video vignettes in Prototype 4