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SimSchool: An Online Dynamic Simulator for Enhancing Teacher Preparation

Rhonda Christensen, Gerald Knezek, Tandra Tyler-Wood and David Gibson

Abstract

A rationale for using a simulated teaching environment to train pre-service teacher candidates is presented, followed by the key components of the simSchool dynamic simulator created to accomplish this task. Results of analyses of two sets of data, for the areas of pedagogical practices and teaching skills, are used to illustrate that changes in pre-service educators can be assessed as a direct outcome of activities completed within the simulated environment. Major outcomes to date indicate that teacher candidates gain a sense of instructional self-efficacy (confidence in their competence) more rapidly using the simulator, compared to traditional teacher preparation classes and related activities. This outcome is true for pre-service candidates working with simulated students spanning the normal range of personality attributes and sensory abilities, as well as pre-service teacher candidates working with simulated students with disabilities.

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Introduction

Good teachers constantly negotiate a balance between technology, pedagogy, and content in ways that are appropriate to the specific parameters of an ever-changing educational context (Bull, Park, Searson, Thompson, Mishra, Koehler, & Knezek, 2007). A major challenge facing beginning teachers is how to juggle teaching and learning parameters in an often-overwhelming context of a new classroom, given a particular mix of the students and the available tools at hand. A four-year project at a large southwestern university was initiated in November 2006 to address beginning teacher challenges. An initiative to include special populations was added in October 2007. The main goal was to improve the capacity for resilience among pre-service teachers, thereby enhancing teacher retention once candidates enter the classroom. The purposes of the current paper are: to present the rationale for using a simulated teaching environment; to determine the key components of the simulator that have evolved; to report major project findings to date and convey conclusions regarding what pre-service teachers learn; and to review what can be assessed regarding pre-service teacher learning – when teacher candidates are working within a simulated teaching environment.

Conceptual Rationale

The use of digital games and simulations to help prepare teachers is inspired by the dramatic rise and growing appreciation of the potential for games and simulation-based learning to help prepare future teachers (Aldrich, 2004; Foreman, Gee, Herz, Hinrichs, Prensky & Sawyer, 2004; Prensky, 2001). Research and development of teacher education games and simulations is just beginning. The new field has the twin goals of producing better teachers and building operational models of physical, emotional, cognitive, social and organizational theories involved in teaching and learning (Gibson, 2007, 2008, 2009). These considerations are situated in the broader arena of the role of technology in field experiences for pre-service teachers, since the goal of simulation as construed here is to provide learning and training opportunities that can transfer to the real classroom and if possible, improve teacher preparation. Specific benefits of technology use in field experiences are identified in a recent review of literature (Hixon & So, 2009) including: a) exposure to various teaching/learning environments, b) creation of shared experiences, c) promoting reflectivity, and d) preparing students cognitively. Our research illustrates some results of these benefits.

In addition, the Hixon & So (2009) review identified three types of experiences categorized according to the degree to which the experiences are situated in reality. In Type 1 experiences, technology tools are used to facilitate supervision, reflection, and communication. Type 2 experiences provide vicarious experience by remotely observing teachers and students in real classrooms. Type 3, which includes simSchool, utilize simulated environments. Zibit and Gibson (2005) call this type of field experience a "virtual practicum" based on simulated apprenticeship models.

There are many challenges and issues that need to be addressed as we integrate games and simulations into teacher training. Here, we will concentrate only on the broadly configured conceptual frameworks for cognition, assessment of learning, and teaching actions that become encoded in computer languages for the purpose of controlling a game or simulation (Gibson, Baek, Knezek, & Christensen, 2007).

Encoding operational definitions of teaching and learning into computer languages provides a new way for educators to hold a conversation about the science of teaching and learning. With appropriate and effective models, reproducible contexts can be presented for problem-solving by future teachers. Classroom contexts with complex relationships can model many of the key aspects of the evolving dynamics of individual learners interacting with tasks, the teacher, and other students. Hypothesized internal dynamics of emotional and motivational variables involved in learning can be assessed, tested, and adjusted. As these applications indicate, the potential for digital game and simulation-based teacher education is just beginning to be explored and understood.

SimMentoring Project

SimMentoring began in 2006 as a four-year project designed to support pre-service and induction-year teachers in the development of successful teaching strategies. The goals for the project illustrate the potential of simMentoring for:

- Demonstrating positive impact on new teacher practices and teacher retention
- Providing new testable models for the study of teaching and learning in higher education and teacher education

- Producing new knowledge about teaching and the path of novice-to-expert development
- Becoming quickly institutionalized and self-sustained as a new method of teacher preparation and professional development.

SimSchool and the SimMentoring Project

SimMentoring is grounded in the web-based computer application named simSchool that dynamically simulates classroom learner behaviors and emulates teaching and learning activities (Gibson, 2007). The simMentoring project uses simSchool with pre-service teachers to improve their abilities to learn successful teaching strategies for use in classroom environments. The key innovation of the simMentoring project is that it provides teachers or teacher trainees many learning trials with simulated students, thereby increasing teacher confidence, competence, and retention. As a part of the simMentoring project a simSchool user manual and other documents have been developed to help pre-service teachers and university instructors guide their teacher candidates in the effective use of simSchool.

Conceptual Foundations of simSchool

SimSchool was conceptualized from initial design stages to operate as an "on-demand, in-flight" practice arena to stimulate and shape the dialog between novice and expert teachers – the latter of whom traditionally serve as the novice's mentors. The solution integrates well with existing best practices and can be transferred to many additional settings in both pre-service and in-service education.

SimSchool promotes pedagogical expertise by re-creating the complexities of classroom decisions through mathematical representations of how people learn and what teachers do when teaching. The model includes research-based psychological, sensory and cognitive domains similar to Bloom's Taxonomy of Educational Objectives (Bloom, Mesia, & Krathwohl, 1964). However, in simSchool these domains are defined with underlying subcategory factors that reflect modern psychological, cognitive science and neuroscience concepts. For example, the Five-Factor Model of psychology (McCrae & Costa, 1996) serves as the foundation of the student personality spectrum. This model includes the following characteristics: extroversion, agreeableness, persistence, emotional stability, and intellectual openness to new experiences. For each of these five factors a continuum from negative one to positive one is used to situate the learner's specific emotional processing propensities, which can shift as the context of the classroom changes. A simplified sensory model with auditory, visual and kinesthetic perceptual preferences comprises the physical domain. For each of these physical factors, a scale from zero to one represents the simulated student's strength and preference in a unified model (e.g. a setting of zero means that the simStudent both cannot see and has no preference for visual information and a setting of one indicates that the student can both see and has a high preference for visual information). A flexible single factor is used to represent a specific academic domain. Together the physical, emotional and academic factors are used to represent salient elements of classroom teaching and learning (Gibson, 2007). More details are provided below in the modeling paradigm of cognition.

Modeling Paradigm

The most fully developed tier of the simSchool cognitive model are the five components of the student's emotional make-up, built on the OCEAN or Big Five model of personality (McCrae & Costa, 1996; Srivastava, 2006):

- Openness to experience - Appreciation for art, emotion, adventure, unusual ideas; imagination and curiosity.
- Conscientiousness - A tendency to show self-discipline, act dutifully, and aim for achievement.
- Extroversion - Energy, urgency, and the tendency to seek stimulation and the company of others.
- Agreeableness - A tendency to be compassionate and cooperative rather than suspicious and antagonistic towards others.
- Neuroticism - A tendency to easily experience unpleasant emotions such as anger, anxiety, depression, or vulnerability.

Each trait or dimension is treated as a continuum with a polar opposite. For example, the opposite of Extroversion is Introversion: a tendency toward isolation and being inward or self-absorbed. SimSchool uses the OCEAN "trait theory" variables as "temporary state variables" to model the emotional make-up of a student. The translation of stable traits into dynamic states is accomplished by treating the current variables as vectors, that is, when measured at a point in time, they are frozen artifacts of a direction (moving up or down over time) that we learn more about as the class evolves and students behave (Gibson, 2007).

The academic components are currently represented by a single variable representing overall academic performance. In the planning stages are multiple sub-elements within any selected domain of knowledge; for example if mathematics, then the sub-elements engaged might be computation, problem solving, and communication. The physical variables include auditory, visual and kinesthetic awareness. All student variables change during the simulation so that learning, making no academic or behavioral progress, or even "going downhill" in academics or behavior can all occur (Gibson, 2007).

SimSchool also contains a verbal interaction model built on the "Interpersonal Circumplex Theory" (Kiesler, 1983) which proposes that verbal interactions involve both power and affiliation negotiations. The power component ranges from dominant to submissive and the affiliation component ranges from friendly to distant or hostile. The interactions of the variables give rise to 16 pairs of opposites such as "sociable to aloof" that are used to model attitudes in teacher-student interactions.

The model's dynamic equations combine variables in different ways depending on the context and intention of the user, made evident through the range of available options for action. This gives rise to highly differentiated behaviors in the students that are not strictly reproducible from simulation to simulation, but which follow heuristics that can be learned – such as the need to individualize instruction for some students in order to have all students succeed.

The modeling paradigm in simSchool works by computing a time series evolution of the classroom as a system. This modeling allows novel dynamics to evolve moment by moment as the user, a teacher candidate makes decisions. SimSchool promotes thinking on one's feet because class time waits for no one. The experimental logic model framework (Figure 1) is also relevant in simSchool but instead of each state of the system waiting upon a user's action as in a Customer Satisfaction Degree (CSD) model, in simSchool, the classroom evolves whether or not the teacher takes actions. The dynamic modeling approach uses initial conditions, attractors, and multiple layers of dynamic interactions to simulate learning by individuals in a classroom.

To illustrate the dynamic modeling approach, imagine that the learner's profile is like a mountainous landscape, with valleys, winding roads, and peaks. A task, such as a request from the teacher to "read this passage and write a reflection" has its own landscape. To model learning, each student's landscape attempts to become like the task's landscape (e.g. each student does his or her best to learn); but of course, some cannot accomplish the task in the time available while others quite easily can do it. Where the two landscapes align and there is little difference (e.g. both the task and student have a mountain in the same place), the student finds it easy to perform the task; where the distance is great, the student finds it difficult. If there are large differences among many factors, then the difficulty of the task is quite large.

In this way, the simSchool model of learning makes cognitive load theory operational by a process of constant comparison of the requirements of a task and the current situation of the student on all factors. The students in simSchool give the teacher signs of both the ease and difficulty the students are facing. Teachers quickly learn that a single task placed in front of several students, will most likely not match each student's learning needs, but instead will have subtle differences with each one, and in different ways for each of the students. The simulation is dynamic because even if the teacher does nothing (e.g. does not adapt tasks or even simply change tasks), each student's factors continue to change over time in an attempt to meet the task requirements.

As a result of the dynamic modeling approach, there is a continuous production of moment-by-moment evidence of what the teacher candidate is attempting to do as he or she "teaches" the class. A conceptual assessment framework (Mislevy, Steinberg, & Almond, 2003) guides the analysis of that evidence so that inferences about the growth and development of teaching skill can be made based on the evidence of "game play" in simSchool (Figure 1). We've talked about the task model as well as the student model as "landscapes" of factors that are changing over time. The evidence model is comprised of the actions that each preservice teacher uses while playing simSchool, as well as the analysis we bring to understanding the teachers intention and their actions' impacts on the classroom.

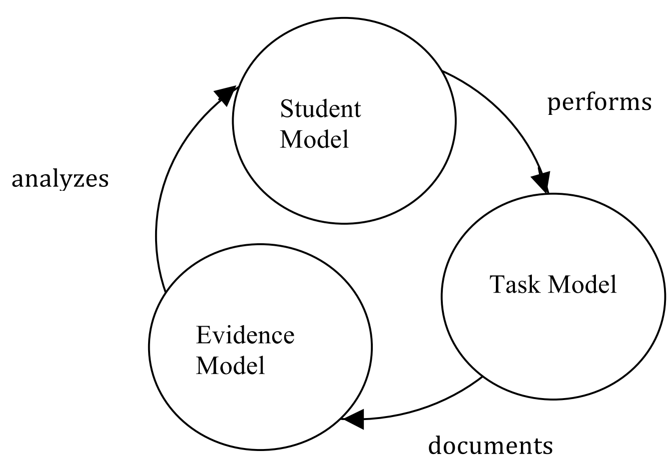

Figure 1. Conceptual assessment framework for analysis of user actions.

The cognitive model of the student in simSchool is built around a three-tiered model of the physical, emotional and academic performance variables of learning as explained above. No other hidden variables exist, so all of the effects of the user's decisions are directly attributable to interaction effects, as opposed to randomly generated settings as in Customer Satisfaction Degree (CSD) model. The down side of this approach is the extra cost in forming an analysis, because for any particular resulting end condition at any point in time, all of the previous actions have had some causative impact. Luckily, a simple visual interface can directly present the results of the pre-service teacher's actions on the simulated students for reflection and summation (Figure 2) where a quantitative analysis is sometimes less helpful.

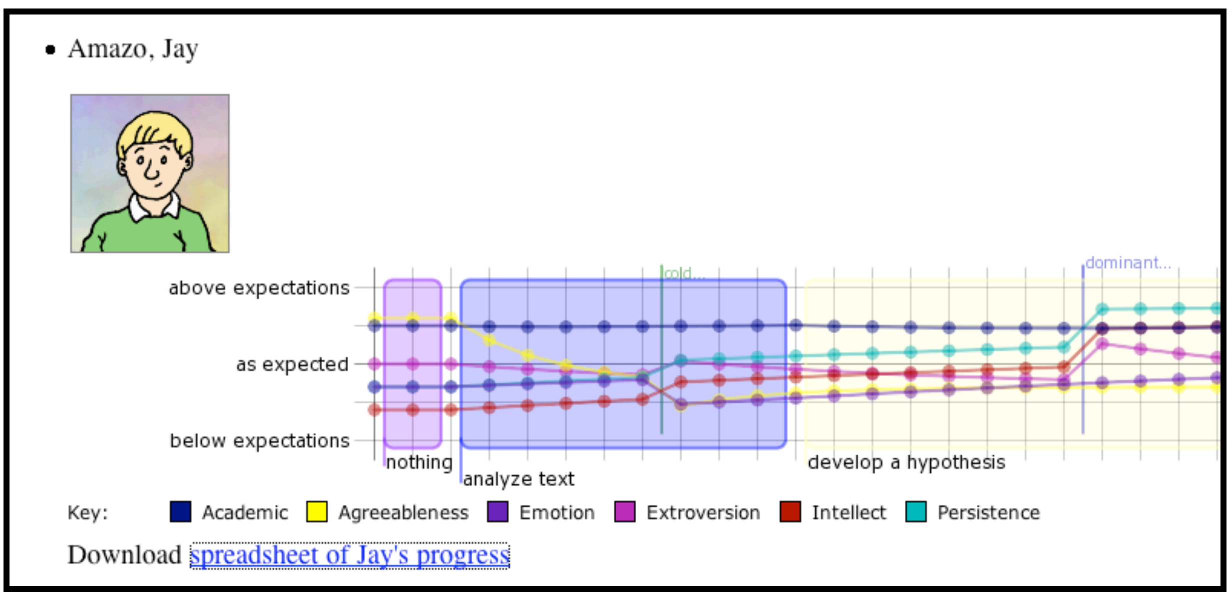

Figure 2. Post-game report of simSchool dynamics over the course of one simulation.

Enhancements to SimSchool

The simMentoring project expanded simSchool's capacity to address new audiences by expanding the simulator's range of components to be modeled to include "Create a Student" and "Create a Task". Feedback is provided to users (teacher candidates) regarding student progress during the simulation. The simSchool screen that allows a teacher candidate to use preset (system generated) simStudents or custom generated simStudents when preparing a classroom to teach, is shown in Figure 3. The full complement of "Create a Student" possibilities in the 2010 version of simSchool is shown in Figure 4.

Figure 3. User options for creating a simSchool classroom.

"Create a Custom Student" Variable Descriptions		
Below grade level	**Academic** -1……-.5……..0…….5…..1	Above grade level
Pays attention to private thoughts and feelings or expresses privately	**Extroversion** -1……-.5……..0…….5…..1	Pays attention to things going on around oneself or expresses publicly
Works alone or avoids others	**Agreeableness** -1……-.5……..0…….5…..1	Works with or depends on others
Works creatively or with abandon	**Persistence** -1……-.5……..0…….5…..1	Works ultra-carefully or with persistence
Shows unrestrained emotional response or is highly sensitive	**Emotion** -1……-.5……..0…….5…..1	Tempers emotions or is imperturbable
Solves well-defined problems or likes to do repetitive tasks	**Intellect** -1……-.5……..0…….5…..1	Solves ill-defined problems or likes to change approaches frequently
Complete absence of vision	**Visual** 0…….5…….1	Full use of vision
Complete absence of hearing	**Auditory** 0…….5…….1	Full use of hearing
Complete absence of movement	**Kinesthetic** 0…….5…….1	Full use of movement

Figure 4. “Create a Student” menu describing each variable that can be manipulated by the user to create a unique student with a cognitive or physical disability.

Both “Create a Student” (Figure 5) and “Create a Task” (Figure 6) options were launched to allow users to have more control over the characteristics of students as well as the types of teaching activities. These functions allow the users to create a student based on selected attributes that change how the simulated student reacts to given tasks and comments from the "teacher." Also users may create tasks of their own to assign to their simStudents. Both the created students and created tasks are saved in a simulated environment to be used in current or future simulations. Pre-service students who are currently working with students in a real classroom have created simStudents who mirrored attributes of actual students in those classrooms.

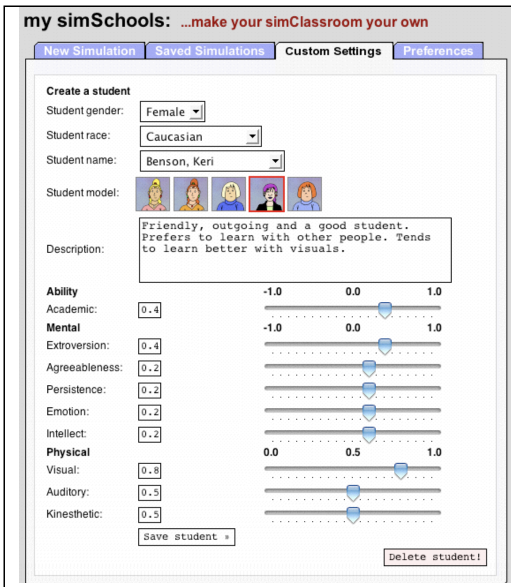

Figure 5. SimSchool users may create their own students based on nine sliding scale variables.

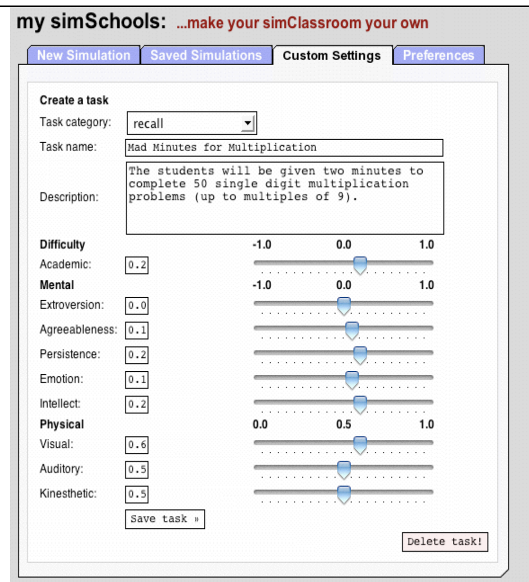

Figure 6. SimSchool users may create a task and assign levels of nine different variables that are required to successfully complete that task.

The initiative to help current and future teachers learn more about special populations was added to the initial initiative. The primary purpose of the project is to explore the effectiveness of simSchool for improving pre-service teachers' scores in teacher preparation and attitudes toward inclusion of special needs students. The project addresses the severe shortage of special education teachers and the compelling need to train educators in how to teach increasingly diverse student populations within an inclusion classroom. The Center on Personnel Studies in Special Education reported that, in the 2000-01 school year, around 98 percent of school districts in the United States (US) reported shortages of qualified special education teachers, noting that "approximately 47,500 special education positions were filled by uncertified personnel—a 23 percent increase from the previous year" (CPSSE, 2004, p.1). US federal legislation requiring schools to educate students with special needs in the "least restrictive environment" (IDEA, 2004) has led to an increase in the number of special needs students in general education classrooms, often with a special educator or paraprofessional present only parts of the day or not at all (Baker & Zigmond, 1995). Thus, the need to train regular educators how to teach diverse student populations is great. Teaching simulations show promise for preparing both special and regular educators for today's diverse classrooms. Attitudes toward inclusion are influenced by a teacher's perceived level of efficacy, and a teacher's pre-service training is one of the most critical periods for developing perceived self-efficacy (Hsien, 2007).

SimSchool's "Create a Student" feature was used by participants to input academic, personality, and physical attributes into the system to "create" a student with a disability modeled after a student found in their textbook readings or a real-life pupil in their classroom. The participants created their simStudent based on the nine dimensions available in simSchool, by moving sliders back and forth on a horizontal number line. Participants ran multiple simulation sessions with the virtual student, making changes in academic requirements based on prompt system feedback presented in a graph form (Hettler, Gibson, Christensen, & Zibit, 2008). Teacher candidates with prior experience working with actual K-12 students with disabilities found this activity especially rewarding. The behaviors that the constructed simStudents exhibited often mirrored those they had seen by the K-12 students the simulators were designed to emulate. In addition, teacher candidates felt free to try strategies they believed to be poor choices with simulated students, so they could analyze the resulting behavioral outcomes.

Future Prospects for Content-Grounded SimSchool

To guide pre-service students into content-based decision-making, curriculum units are being added to simSchool. A science unit has been developed to embed into simSchool so that users may teach science lessons with their created students. The unit allows users to make decisions regarding tasks to teach different types of students and see the outcome of their decisions – that is, what type of students learned content best through which teaching strategies. Design research is also currently underway to discover how best to incorporate any kind of content knowledge into the simulator, so that the simulated environment is one step closer to the content-grounded environment in which a normal teacher operates. Development of a prototype lesson builder is envisioned, which would incorporate into simSchool a lesson planning approach to instruction in content. When fully implemented this prototype could allow future pre-service educators to pre-select a series of instructional activities in sequence, and then observe how the simulated students react as the lesson runs.

Findings to Date: Assessment of Outcomes

One difficulty measuring the effectiveness of using a simulator for pre-service teacher preparation is the long lag time between pre-service teacher preparation, induction year activities and assessment of retention. It takes too many years to produce an authentic assessment of whether or not the simulator worked. Because of this difficulty, beginning in the early days of the simMentoring project, the leadership team began exploring alternative ways to assess learning within the simulated environment. The self-report instruments described in the following section were developed by the simMentoring team for the purpose of assessing learning that occurs within the simSchool environment.

Instrumentation for Measures of Pedagogical Style and Expertise

Few self-report measures for pedagogical expertise were available to the authors at the beginning of the simMentoring project. As a result, a decision was made to build upon the best reported measures that could be found in order to validate the project's own set of assessment instruments. The process began with the adaptation of key parts of a battery of surveys that had been used successfully in other projects (Vandersall, 2006). The result was the Teacher Preparation Survey (TPS), a 25-item, Likert-based instrument divided into two sections, one about perceptions of teaching situations, and the other about teaching skills. TPS items were adapted from Riedel (2000) of the Center for Applied Research and Educational Improvement.

Validation procedures were carried out on the instrument, in keeping with accepted test and measurement procedures (Marshall & Hales, 1972). Initial content validity was established through consultation with teacher education faculty at the institution hosting the simMentoring project and with the external evaluator for the project. This "face validity" was judged to be high by the university instructors and project staff.

Construct validity was established through factor analysis. An exploratory factor analysis of the 10 "perception of teaching" items on Teacher Preparation Survey (TPS) was carried out using data gathered from the 189 teacher preparation candidates during 2007. Two factors with eigenvalues greater than 1.0 were extracted by a principal components, varimax rotation procedure. Post hoc internal consistency reliability (Cronbach's Alpha) for the following five items loading on Factor 1, which was named Instructional Self-Efficacy, was found to be Alpha = .72. This is in the range of 'respectable' according to guidelines provided by DeVellis (1991). The items composing this scale are listed in the Appendix.

The remaining five items formed the second factor, labeled Learning Locus of Control (home or school). Post hoc analysis of internal consistency reliability for the scale produced from items loading on this factor was found to be Alpha = .57. This lower reliability would be deemed unacceptable (below .6) according to guidelines provided by DeVellis (1991). The items composing this scale are listed in the Appendix.

A second factor analysis (principal components, varimax rotation) was conducted on the fifteen items in part 2 of the Teacher Preparation Survey. These items ask the respondent to indicate how well prepared he/she currently feels for each teaching skill. The single item in part 3 of the survey (To what extent do you think computer games or simulations can be an important learning tool for K12 students?) was included in this analysis as well. The result was a two-factor solution with all 15 of the teaching skill items loading on factor 1, while the single item about perceived importance of computer games or simulations for K-12 students for learning, loaded on factor 2. Post hoc internal consistency reliability analysis for the 15-item factor produced a Cronbach's Alpha value of .97. This is beyond "very good" according to the guidelines provided by DeVellis (1991). The fifteen items composing the Teaching Skills scale are listed in the Appendix.

Reconfirmation of Pedagogical Scales in 2008

During the spring and summer of 2008, data were gathered from an additional 394 pre-service teacher education candidates at the same southwestern university. The 25 items from the previously-discussed scales were resubmitted to a single exploratory factor analysis (Principal Components, Varimax rotation). The three-factor solution converged in four iterations and all items loaded on the anticipated factors. Cronbach's Alpha values for these scales were Instructional Self-Efficacy = .77 (5 items); Learning Locus of Control = .68 (5 items); and Teaching Skill = .95 (15 items). These internal consistency reliability estimates were all in the range of "acceptable" to "very good" according to the guidelines provided by DeVellis (1991).

Study 1: Findings from Matched Treatment and Comparison Groups

Sample

During the spring of 2007, simSchool was introduced to 32 pre-service teacher candidates in one section of a Reading/Language Arts methods course for Professional Development School students. These students were in Early Childhood – Grade 4 or Grade 4-8 teacher preparation programs. Students at this intern stage, which precedes student teaching, spent two days per week taking courses and two days per week in a classroom, observing teacher and student activities and assisting the classroom teacher.

Pre-post instruments assessing teaching beliefs, perceived level of teacher preparation, level of technology proficiency, level of technology integration, and attitudes toward computers were administered at the beginning and end of the class.

Pre-post data were also gathered from a parallel section of the Reading/Language Arts methods course (30 students), taught by the same instructor, but not incorporating simSchool. This group was targeted as the comparison group for the simMentoring treatment class.

Intervention

Students in the treatment classroom took part in seven, 90-minute simSchool sessions in the computer lab (nine contact hours total) with their instructor and a simMentoring project staff trainer. This activity spanned approximately one half of the 15-week semester. Each session focused on a specific goal such as getting started in simSchool (session 1) with “Everly’s Bad Day”, matching instructional tasks to simulated student personalities and learning styles to improve student learning, initiating teacher dialog with the simulated students to assess reactions, and moving from a one student classroom to a five student classroom as proficiency with working in the simulator improved. Although sufficient computers were available for each student to run a simulation alone, sessions quickly evolved to have students working in pairs. Once the university instructor described and demonstrated the task, pre-service candidates planned in pairs and then carried out the tasks by having one participant function as the pilot, and the other as a navigator. A reflective discussion led by the instructor typically followed.

Frequently pre-service candidates were asked to record their reactions to a session in the class blog in journal entry style.

Findings and conclusion

Treatment Classroom

As shown in Table 1, according to the guidelines provided by Cohen (1988) of small effect = .2, moderate = .5, and large = .8, there were large pre-post gains on two of the three pedagogical indices for the treatment classroom. Teaching Skill (ES = 1.0) and Instructional Self-Efficacy (ES = .95) exhibited large gains. Learning Locus of Control, which appears to have a small-to-moderate negative effect, actually changed from a stronger agreement that "A teacher is very limited in what he/she can achieve because a student's home environment is a large influence on his/her achievement" (for example), toward the belief that the teacher can make a difference in the child's life. The overall image conveyed by changes in the three pedagogical indicators is very positive. However, it is important to examine changes in the matched comparison group before drawing conclusions regarding probable causality. Analysis of the comparison group will be presented in the following section.

Table 1.
Treatment Classroom Using SimSchool, Reading/Language Arts Methods Course Spring 2007

Measurement Indices		N	Mean	Std. Dev.	Signif.	Cohen's d
Instructional Self Efficacy	Pre	28	4.81	0.40	<.001	0.95
	Post	23	5.23	0.40		
Learning Locus of Control	Pre	29	3.49	0.79	0.37	-0.25
	Post	25	3.30	0.78		
Teaching Skill	Pre	28	4.73	0.56	<.001	1.00
	Post	23	5.35	0.52		

Comparison Classroom

As shown in Table 2, there was a large pre-post gain (ES = .96) in Teaching Skill for the comparison group. The gain in this area was almost identical to that of the treatment group. There was a small-to-moderate pre-post gain (ES = .40) in Instructional Self Efficacy for the matched comparison group. This gain was much smaller than the gain (ES = .95) displayed by the treatment group, and, in fact the gain was sufficiently small that it could likely have been due to chance (p = .14). There was almost no pre-post change (ES = .07) in Learning Locus of Control for the comparison group. The Learning Locus of Control group mean moved slightly in the direction of less belief that the teacher (rather than home and outside-of-school constraints) could influence the achievement potential of the student.

Table 2.
Comparison Group Classroom Not Using SimSchool, Reading/Language Arts Methods Course Spring 2007 (Same Instructor as Treatment Classroom)

Measurement Indices		N	Mean	Std. Deviation	Signif.	Cohens d
Instructional Self Efficacy	Pre	29	4.88	0.75	0.14	0.40
	Post	25	5.17	0.67		
Learning Locus of Control	Pre	28	3.20	0.63	0.80	0.07
	Post	25	3.26	0.95		
Teaching Skill	Pre	25	4.82	0.59	<.001	0.96
	Post	22	5.45	0.57		

The strongest findings from matched treatment versus comparison analyses for general preparation pre-service educators using simSchool were found in the area of Instructional Self Efficacy, a kind of resilience against "giving up" when a strategy or activity attempted by a teacher does not succeed in the classroom. The pre-post gain in this area for the treatment classroom (Pre-Post ES = .96) was sufficiently greater than the gain for the comparison group (Pre-Post ES = .40). Thus the effect of simSchool can be said to be educationally meaningful (Bialo & Sivin-Kachala, 1996). Treatment versus comparison gains are graphically displayed in Figure 6.

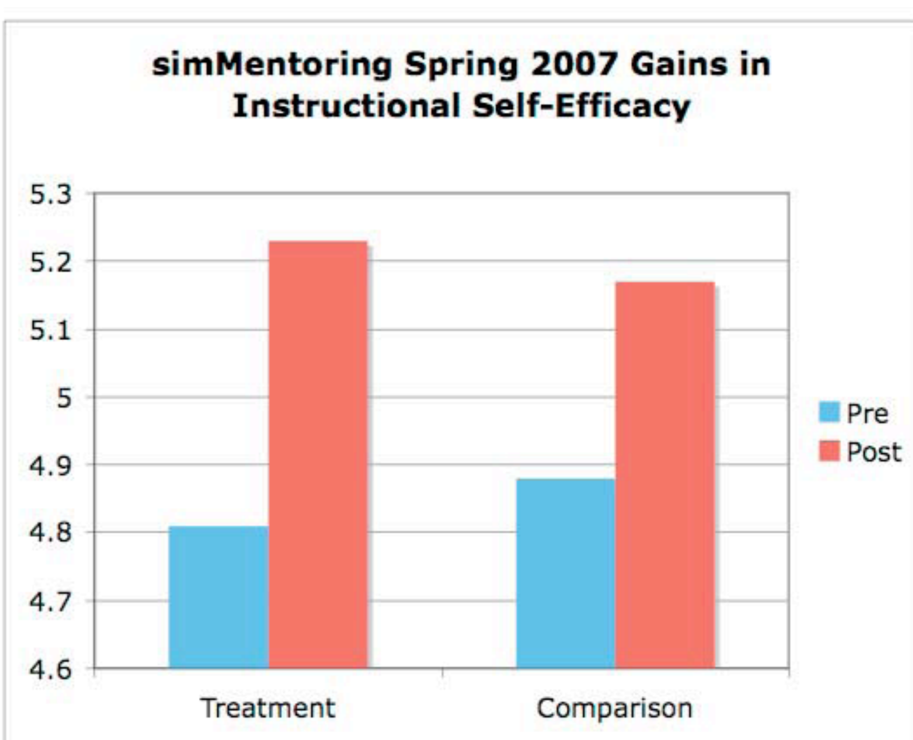

Figure 6. Treatment vs. comparison group pre-post gains in instructional self-efficacy

Viewing these findings collectively we conclude:

1. The teacher educator leading both treatment and control classes produced almost equally large gains in self reported Teaching Skills for treatment and comparison groups.
2. The simSchool centered activities (7 total for 90 minutes) of the treatment class produced gains in Instructional Self-Efficacy that were roughly twice as large as gains in the comparison group, when both groups had comparable class time exposure and duration between pre-and post questionnaires.
3. Using the simulator as a class activity was possibly responsible for Learning Locus of Control movement by the treatment group in the direction of stronger belief that the teacher can influence a student's achievement potential. Replication studies are needed in this area.

Study 2: Findings from SimSchool and Research in Disabilities Education

During the 2008-09 academic year, simSchool participants (n=157) exploring how to accommodate the unique learning needs of a simulated student with disabilities in an inclusion classroom setting, made significant gains ($p<.001$) in Instructional Self-Efficacy, with an effect size of .44. Additionally, findings confirmed significant gains from pre- to post-assessment in the Teaching Skills subscale ($p<.001$), with an effect size of .44. The comparison groups made no significant gains on either subscale of the Teacher Preparation Survey (see Appendix for subscales and items). These findings are generally consistent with the spring 2007 findings reported in the previous section. Findings for the disaggregated 2008-09 groups of undergraduate pre-service teachers, versus graduate students, are compared and contrasted in the following paragraphs.

Pre-service Teachers. A paired t-test revealed significant gains ($p<.001$) for undergraduate pre-service teachers (n=104) in Instructional Self-Efficacy, with an effect size of .68, and in Teaching Skills ($p<.03$), with an effect size of .47.

Graduate students (n=47) showed a significant gain in Teaching Skills (p<.01) but not in Instructional Self-Efficacy (NS). In sum, the undergraduates posted significant gains on two subscales, pre to post, whereas graduates exhibited significant gains on only one. Note that the graduate students were practicing classroom teachers taking courses for additional certification(s), and were acknowledged as having high Instructional Self Efficacy at the time of pretest assessment.

Overall, analysis of data from this study involving general preparation educators using simSchool to learn to accommodate learning disabilities, has shown that simSchool activities result in gains in teaching skills and instructional self-efficacy. We conclude there is potential for simSchool to help teachers train for inclusion classrooms, due to its capacity to depict a wide range of student characteristics within one classroom.

Discussion

The pre-service teacher preparation candidates involved in the simMentoring project during the spring of 2007 exhibited moderate to large gains (Cohen, 1988) on many of the teacher preparation indices produced from the data. The areas in which the treatment group of pre-service teacher candidates exhibited the largest gain in comparison to their peers who did not receive simSchool access and training, were on items related to instructional self-efficacy. Items comprising this indicator reflected pre-service educators' confidence in their competence to bring about positive learning outcomes even in adverse learning conditions. Findings imply that simMentoring activities were successful in fostering instructional self-efficacy in pre-service students.

SimSchool was designed to provide pre-service teachers with a safe environment for experimenting and practicing techniques, especially methods of addressing different learning styles, and wide variations in academic and behavioral performance of students. After completing simSchool training, the pre-service teachers were asked to reflect on their experiences with the simulation. Analysis of the pre-service teacher reflections indicate that one of the first revelations of a participant in the simulator is that K-12 students do not always react the way the teacher candidates think they should. For example, the girl (in the simulator) sitting with her legs crossed, chewing gum, seemingly disconnected from the task, might be learning. The student whom teacher candidates thought was a very good student, does not seem to learn very much from a task. The boy with headphones on, is he learning or distracted? These visible signs of student behavior may not be the best or only clues to performance found by observing pre-service teachers interacting with simSchool. As pre-service teachers learn how to read the student descriptions and learning style indicators better, and how to make appropriate adjustments in task sequence and complexity, they see better results and gain confidence in their abilities. The findings of different gains in treatment versus comparison group indicators on the scale of Instructional Self-Efficacy (confidence in their competence) can be interpreted not only as evidence that the instrument works, but also that the simulator is useful, as well.

Quantifying gains in learning how to teach is a difficult task. Self-report is a practical means of gathering data and has been shown through this analysis to yield reasonably reliable data. The instruments examined in this study have been found to have good construct validity and the ability to separate groups known to differ, as well. An instrument capable of showing gains from a simulator can help advance the field of teaching and learning, and especially the field of teaching and learning through technology.

Discussion

Comparisons With Other Simulators

Studies conducted with two other products similar to simSchool have produced findings generally consistent with those reported in this paper. In a study of the Virtual Kindergarten Classroom developed at the University of Wollongong, Australia, researchers found three features of the simulated environment were perceived as especially useful to the 24 pre-service teacher candidates in their study (Ferry, Kervin, Turbill, Cambourne, Hedburg, Jonassen & Puglist, 2004.). As a result of the study, several observations were made:

1. Safety of the Simulated Environment. Teacher candidates felt comfortable trying teaching strategies with simulated students without fear of serious consequences on the learning of actual children.

2. Support Materials. Information sheets, web resources, and textbook resources were perceived by the teacher candidates as useful in developing their own pedagogical knowledge and applying theory to classroom practice.

3. Embedded Thinking Tools. An open comment section allowed students to "blog" directly into the system and provide reflections on what they were learning.

Researchers examining the impact of the product simClass in Korea (Cheong & Kim, 2009; Cheong & Kim, 2008) found gains in teaching skills resulting from self-guided use of the simulator alone, and in combination with classroom instruction – to be greater than gains resulting from traditional classroom instruction not employing simClass ($F(1,87) = 9.94$, $p = .002$). Furthermore, the difference in pre-post gains between the self-guided teacher candidate group and instructor-guided teacher candidate group was not significant ($f(1,57) = 1.789$, $p = .186$). Both groups using simClass exhibited greater gains than the traditional classroom instruction group (Kim & Cheong, 2008).

When comparing the findings of the studies from Australia and Korea with those currently presented for simSchool use in the USA, one can observe the outcomes to be similar in most respects. The importance of being able to try out teaching strategies without fear of "breaking a real student" was strong in both Australia and the USA. The importance of support materials was also apparent in both the Australia and USA implementations; however, one nuance in the USA was the added importance of human instructor guidance during the post-simulation debriefing stage. In the area of embedded thinking tools, the Australia implementation had a window explicitly included in the simulator for questions and reflections, while the USA simSchool applications used blogging after a run as a means of addressing this area. Both were deemed valuable. Regarding assessment of measureable gains, the Korea simClass study found extensive improvements in self-reported teaching skills, compared to traditional instruction, while the US simSchool study of a similar design found the classroom methods instructor was just as effective in fostering gains in teaching skills, with or without the simulator. The most noticeable difference in the USA was the added value of the simulator in the area of instructional self-efficacy (resilience to giving up as the result of having a bad day). Further research is needed to determine whether these differences were due to local factors such as the instructors or the local culture; or due to differences in the simulators and procedures followed. Overall, the major findings were similar across different simulators.

Prospects for Virtual Field Experiences

SimSchool has recently been approved by the National Council for the Accreditation of Teacher Education (NCATE) for use by the southwestern university noted in this paper as a pre-observation, virtual field experience tool. Teacher candidates are permitted to count use of the simulator for up to ten hours of their internship / classroom observation block which typically immediately precedes a teacher preparation candidate's practice teaching term. This type of utilization falls in the category that Hixon and So (2009) have referred to as Type III field experiences for preservice teachers. In this classification scheme, Type I field experiences are concrete, direct experiences in reality – the type that involves preservice teachers being physically present in schools and / or classrooms as part of their teacher preparation programs. Type II field experiences are vicarious, indirect experiences with reality – such as watching pre-recorded videos of classroom lessons, or participating in classroom observations via videoconferencing. Type III field experiences are abstract experiences with a model of reality. One limitation of a Type III environment is the lack of interaction with real teachers and students (Hixon & So, 2009). However, benefits include exposure to multiple teaching strategies and learning styles in a short period of time, and better understanding of how the conceptual and theoretical knowledge presented in preservice teachers' college classes relates to actual classroom practices and student behaviors. Technology-enhanced virtual field experiences can support preservice teachers' abilities to see the theories they are learning in practice (Frey, 2008). These latter types of benefits were observed as outcomes of the preservice educators working in the simSchool environment, both by the researchers and the preservice educators' college instructors (Christensen, 2008).

Several other researchers in addition to Hixon and So (2009) have explored the possibilities of linking simulations with field experiences. Among these are Foley and McAlister (2005), Ferry, Kervin, Turbill, Cambourne, Hedburg & Jonassen (2005), and Girod and Girod (2006). The latter two groups were involved in the early discussion and design stages of simSchool, and hence it is not surprising that one of the intial formalized uses of simSchool is in this area. Hixon and So (2009) have pointed out that much more research is needed to determine the optimum mix of model-based explorations versus face-to-face observation and interaction with real students, during the preparation of preservice teachers.

Conclusion

Using a game to teach teachers? The idea challenges conventional thinking and may involve some risks. However, if we succeed in reducing teacher attrition and provide an opportunity to rapidly increase a new teacher's knowledge and skills in areas such as differentiation, special education issues, individualization of learning and grouping practices, simulation could play an important role in preparing tomorrow's teachers. The most prominent feature of our project is that it adds an entirely new learning opportunity for both pre-service and in-service teachers. Teacher educators can use simulations to improve teaching and ultimately influence the skill level of new teacher's entering the classroom. Indeed, during the four years since the inception of the simMentoring project at the university, the use of simSchool has been approved by the U.S. National Council for Accreditation of Teacher Education (NCATE), and used extensively for pre-intern observation activity.

References

Aldrich, C. (2004). *Simulations and the future of learning: an innovative (and perhaps revolutionary) approach to e-learning.* San Francisco: John Wiley & Sons.

Baker, J. M., & Zigmond, N. (1995). The meaning and practice of inclusion for students with learning disabilities: themes and implications from the five cases. The *Journal of Special Education, 29*(2), 163-180.

Bialo, E. R. & Sivin-Kachala, J. (1996). *The effectiveness of technology in schools: A summary of recent research.* School Library Media Quarterly, 25 (1), 51-57.

Bloom, B., Mesia, B., & Krathwohl, D. (1964). *Taxonomy of educational objectives*. New York: David McKay.

Bull, G., Park, J., Searson, M., Thompson, A., Mishra, P., Koehler, M. J., & Knezek, G. (2007). Editorial: Developing technology policies for effective classroom practice. Contemporary Issues in Technology and Teacher Education [Online serial], 7(3). Available: http://www.citejournal.org/vol7/iss3/editorial/article1.cfm

Center on Personnel Studies in Special Education (CPSSE). (2004, February). *An insufficient supply and a growing demand for qualified special education personnel.* Retrieved October 12, 2008 from http://education.ufl.edu/copsse/research-spotlight/index.php#tpq

Cheong, D. U., & Kim, S. H. (2009). Developing a Simulation for Practicing Discipline Skills of Pre-service Teachers. *The Journal of Korean Association of Computer Education, 12(*3). 63-74.

Cheong, D. U., & Kim, B. K. (2008). A Simulation for Improving Teachers' Motivational Skills. In D. Gibson, & Y. K. Baek (Eds.), Digital Simulations for

Improving Education: Learning Through Artificial Teaching Environments (pp. 227-248). Hershey, PA: IGI Global. (U.S.A.)

Christensen, R. (2008). simMentoring Project Update. In *SimZine 1* (4), p. 1. University of North Texas: Institute for the Integration of Technology into Teaching & Learning.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences (2nd ed.)*. Hillsdale, NJ: Lawrence Earlbaum Associates.

DeVellis, R.F. (1991). *Scale development*. Newbury Park, NJ: Sage Publications.

Foreman, J., Gee, J., Herz, J., Hinrichs, R., Prensky, M., & Sawyer, B. (2004). Game-based learning: How to delight and instruct in the 21st century. *EDUCAUSE Review, 39*(5), 50-66.

Ferry, B., Kervin, L., Turbill, J., Cambourne, B., Hedburg, J., & Jonassen, D. (2005). Incorporating real experience into the development of a classroom-based simulation. *Journal of Learning Design, 1* (1), 22-32.

Ferry, B., Kervin, L., Turbill, J., Cambourne, B., Hedberg, J., Jonassen, D. & Puglisi, S., (2004). The design of an on-line classroom simulation to enhance the decision making skills of beginning teacher. Proceedings of the AARE International Conference. Melbourne, Victoria.

Frey, T. (2008). Determining the impact of online practicum facilitation for inservice teachers. *Journal of Technology & Teacher Education, 16* (2), 181-210.

Foley, J. A., & McAllister, G. (2005). Making it real: SimSchool a backup for contextualizing teacher preparation. *AACE Journal, 13* (2), 159-177.

Gibson, D. (2007). SimSchool - A complex systems framework for modeling teaching & learning. Paper presented to the National Educational Computing Conference, Atlanta, GA, June 2007.

Gibson, D. (2008). Modeling classroom cognition and teaching behaviors with COVE. In D. Gibson & Y. Baek (Eds.), *Digital simulations for improving education*. Hershey, PA: IGI Global.

Gibson, D. (2009). Designing a Computational Model of Learning. In R. Ferdig (Ed.), *Handbook of research on effective electronic gaming in education* (Vol. 2, pp. 671-701). Hershey, PA: Information Science Reference.

Gibson, D., Baek, Y., Knezek, R., & Christensen, R. (2007). Cognitive and conceptual assessment frameworks for simulating teaching and learning. Paper presented to the American Educational Research Association Annual Conference, Chicago, Illinois, April 13, 2007.

Girod, M., & Girod, G. (2006). Exploring the efficacy of the Cook School District Simulation. *Journal of Teacher Education, 57* (5), 481-497.

Hettler, L., Gibson, D., Christensen, R. & Zibit, M. (2008). simMentoring: Guiding development from virtual to real teaching! Stowe, VT: CurveShift, Inc.

Hixon, E. & So, H. J. (2009). Technology's role in field experiences for preservice teacher training. *Educational Technology & Society, 12* (4), 294-304.

Hsien, M. L. (2007). Teacher attitudes towards preparation for inclusion - in support of a unified teacher preparation program. Post-Script: *Postgraduate Journal of Education Research, 8*(1), 49-60.

Individuals with Disabilities Education Act (IDEA) of 2004, 20 U.S.C., 401 *et seq.* (2004).

Kiesler, D. (1983). The 1982 interpersonal circle: A taxonomy for complementarity in human transactions. *Psychological Review, 90*, 185-214.

Kim, B. K., & Cheong, D. U. (2008). simClass: Simulate Your Class Before You Teach. In D. Gibson, & Y. K. Baek (Eds.), *Digital Simulations for Improving Education: Learning Through Artificial Teaching Environments* (pp. 289-307). Hershey, PA: IGI Global. (USA)

Marshall, J. & Hales, L. (1972). *Essentials of testing*. Reading, MA: Addison-Wesley.

McCrae, R., & Costa, P. (1996). *Toward a new generation of personality theories: Theoretical contexts for the five-factor model*. In J. S. Wiggins (Ed.), The five-factor model of personality: Theoretical perspectives (pp. 51-87). New York: Guilford.

Mislevy, R. J., Steinberg, L. S., & Almond, R. G. (2003). On the structure of educational assessments. *Measurement: Interdisciplinary Research and Perspectives, 1*, 3-67.

Prensky, M. (2001). *Digital game-based learning*. New York: McGraw-Hill.

Riedel, E. (2000). Teacher Beliefs & Preparation Survey. Univ. of Minnesota: Center for Applied Research and Educational Improvement.

Srivastava, S. (2006). *Measuring the Big Five Personality Factors*, from http://www.uoregon.edu/~sanjay/bigfive.html

Vandersall, K. (2006). Teacher Survey Battery. Los Angeles, CA: Arroyo Research Services.

Zibit, M., and D. Gibson. (2005). simSchool: The game of teaching. *Innovate 1* (6).

http://www.innovateonline.info/index.php?view=article&id=173 (accessed April 24, 2008).

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Appendix

Teacher Preparation Survey (TPS) Instructional Self-Efficacy Scale (5 Items)

- TSP 1I. If I really try hard, I can get through to even the most difficult or unmotivated students.
- TSP 1G. If a student in my class becomes disruptive and noisy, I feel assured that I know some techniques to redirect him/her quickly.
- TSP 1C. When I really try, I can get through to most difficult students.
- TSP 1H. If one or more of my students couldn't do a class assignment, I would be able to accurately assess whether the assignment was at the correct level of difficulty.
- TSP 1F. If a student did not remember information I gave in a previous lesson, I would know how to increase his/her retention in the next lesson.

Teacher Preparation Survey (TPS) Learning Locus of Control Scale (5 Items)

- TSP 1D. A teacher is very limited in what he/she can achieve because a student's home environment is a large influence on his/her achievement.
- TSP 1J. When it comes right down to it, a teacher really can't do much because most of a student's motivation and performance depends on his or her home environment.
- TSP 1B. If students aren't disciplined at home, they aren't likely to accept any discipline.
- TSP 1E. If parents would do more for their children, I could do more.
- TSP 1A. The amount a student can learn is primarily related to family background.

Teacher Preparation Survey (TPS) Teaching Skill Scale (15 Items)

Below is a list of different skills you may use in teaching. Please choose the response that indicates how prepared you feel currently to do each one. The responses are on a scale of 1 = strongly disagree to 6 strongly agree.

a. Describing the teaching context.
b. Stating objectives clearly.
c. Stating objectives so they are aligned with goals.
d. Selecting objectives aligned with student needs.
e. Selecting varied and complex objectives.
f. Selecting a broad array of teaching strategies.
g. Sequencing teaching strategies.
h. Allotting time for instruction realistically.
i. Developing high-quality adaptations.
j. Developing a wide array of adaptations.
k. Interpreting on-task behavior accurately.
l. Interpreting assessment results accurately.
m. Connecting teaching and learning.
n. Analyzing my own teaching performance.
o. Making decisions based on the assessment results from my students.