Innovate: Journal of Online Education

Volume 1
Issue 6 *August/September 2005*

Article 4

9-1-2005

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Today's current teacher preparation system is facing a crisis: a severe teacher shortage (Ingersoll and Smith 2003). The National Center for Education Statistics notes that of the two million new teachers who will enter the profession over the next decade, 666,000 will leave sometime during the first three years of teaching, and one million new teachers will not make it past five years (cited in Center for American Progress 2005). A major factor contributing to these high attrition rates is the fact that too many new teachers enter the classroom unprepared to make a wide range of decisions and manage a classroom of 24–31 students (Darling–Hammond and Skyes 2003). In response to this trend, researchers have stressed the crucial role of effective mentoring practices (Ingersoll and Kralik 2004); similarly, in 2003 the National Science Foundation (NSF) noted that the nation's "teacher preparation programs are disconnected from classroom practice" and put out a call for innovative ways to prepare teachers for the tasks they will face in their work (NSF 2003)

One such an innovation is *simSchool*—a classroom simulation program funded by the Preparing Tomorrow's Teachers to Teach with Technology (PT3) program of the U.S. Department of Education. Just as a flight-simulator immerses a player in the complexities of flying a plane, simSchool immerses novice teachers in some of the complexities of teaching 7th-12th grade students who possess a variety of different learning characteristics and personalities. The simulation is designed to serve as a "virtual practicum" that augments teacher preparation programs by supporting the development of teaching skills prior to field experience in real classrooms.

simSchool is what Shaffer (2005) defines as an "epistemic game." A player enters the simulated classroom perhaps with a limited understanding of teaching practice; through repeated cycles of decision-making, experimentation, and refinement, the player builds expertise by developing new strategies and thinking like a teacher. *simSchool* thus introduces future teachers to some of the teaching community's "ways of doing, being, caring, and knowing" (Shaffer 2005, para. 5). Immersed in a simulated classroom, *simSchool* players must analyze student needs, make instructional decisions, and evaluate the impact of their actions on student learning in order to succeed at the game.

With computer- and network-based expert feedback, the *simSchool* program can also be seen as providing a form of "simulated apprenticeship." The tacit processes, mental models, and professional skills of an expert that are needed to succeed in teaching are embedded in the structure, rules, choices, and environment of the game; through such a design, the simulation "coaches" a player through feedback, hints, and scaffolding during gameplay—thus fostering what researchers have described as a "cognitive apprenticeship" approach to instruction (Lave and Wenger 1991; Collins, Hawkins, and Carver 1991). As players advance in their ability, the complexity increases, pushing them to new levels of challenge just as in apprenticeship-based learning.

This article outlines why simulations are needed in teacher preparation. Then, it gives a brief tour of *simSchool*—what one would see in the virtual classroom, the outlines of the artificial intelligence engine that underlies the interactions between the teacher and the students, and the psychological and learning theories behind the student personalities and teacher actions. We invite critical review of our basic assumptions and the components and connections we've designed to create an educational, epistemic game of teaching.

Innovation in Teacher Preparation

Current teacher preparation programs do their best to prepare students through methods courses, which often include a mixture of lecture, hands-on activities, and lesson plan development assignments. These courses predominately deal with the visible parts of knowledge—the "know-what" of teaching mathematics, language arts, science or history. Yet this knowledge is too often disconnected from the tacit knowledge—the "know-how"—required when teaching diverse, second language, special education, or gifted students. Know-how, even more than know-what, is essential to becoming a professional (Orlikowski 2002).

Before becoming licensed and getting classes of their own, future teachers observe classrooms and get a chance to practice teaching briefly. Observing a class, however, does not give novices access to the cognitive decision-making process a teacher uses when questioning students, making suggestions, or noticing signs of understanding. An observer is not a participant. Nor is a semester of practice-teaching enough to internalize the range of skills and strategies a new teacher needs to feel confident. A new teacher entering the classroom is like a novice pilot flying an airplane for the first time. With everything happening all at once, which indicators should get the most attention?

There are far too few apprenticeship opportunities, not enough expert feedback, and too little time to adequately prepare enough teachers to fill the growing teacher shortages. Simulations can play a part in meeting these needs, not as a replacement for real classroom experience, but as a way to better educate and prepare people for their first encounters. *simSchool* is being developed to fill the need in teacher education for more practice time, quicker and more relevant feedback, and a reliable experimental platform for trying out new teaching methods and strategies. While the simulation is certainly a simplified model of a real classroom (as all models are simplifications of real systems), it nonetheless offers focused training possibilities—just as a flight simulator, while not a real airplane, is an adequate environment for training pilots.

How can we assert that *simSchool* could model anything of interest to teaching? In what follows, we share the broad outlines of our thinking by taking readers on an imagined tour of the game, which is still in the early stages of design.

A Tour of *simSchool*

simSchool is a "first person" game where the player, assuming the role of a teacher, is responsible for the success of students. Players design tasks, and simulated students respond to the tasks, teacher interactions, and their own internal emotional states according to their diverse personalities and learning preferences. The player's choice of interactions affects the students' academic and behavioral responses. By interpreting signs of performance and behavior, the player makes decisions about how to help students on a given learning task. Increased understanding of the factors that improve learning leads to better decisions about matching tasks and interactions and better game-play; this in turn leads to higher levels of success for more students.

Example Scenario

Before entering the virtual classroom, a player chooses a teaching environment—urban, suburban or rural—which results in *simSchool* generating an appropriate demographic population similar to the one illustrated in Figure 1. In turn, a laptop on the desk in the front of the classroom opens to reveal students' profiles, descriptions typically found in a school's student record (Figure 2). These descriptions give clues to students' abilities and include phrases such as "Has delays in analyzing and interpreting information" or "Writes organized compositions with vocabulary and sentence structures directed to audience and purpose." Players might choose to read about students before selecting a task that will match the learning preferences of as many students as possible. Aspiring teachers gain skills in interpreting student characteristics—both behavioral and academic—to better guide their expectations about student performance.

As class begins, the player immediately gauges students' reactions by observing their posture (Figure 3). How many are sitting face-forward? How many have their hands raised? Which ones are talking with their neighbors? The player clicks on a student who is talking in class and accesses a controller that allows the player to select a phrase—a question, an assertion, or an observation—that interacts with the student. Perhaps the player chooses "*Do you understand?*" (Figure 4).

Still under development, the *simSchool* conversation controller with its circular ring design can be seen in Figure 5. Clicking on one of the letters on the controller brings up potential conversational elements representing various interpersonal stances (explained below as the Circumplex Interpersonal Theory). Selecting a particular phrase reflects a particular stance with some mixture of dominant, submissive, hostile, and friendly questions pertaining to behavior or academics. Whatever the player chooses automatically triggers a variety of student responses.

To make an adjustment in the ongoing lesson, a player clicks on a pile of papers, and a menu of lesson-related tasks appears (e.g., reading a book out loud, reviewing mathematical concepts, or creating an art project). If the task exceeds the students' abilities but still lies within their zone of proximal development (Vygotsky 1978), students will learn. If the task falls short of this zone, students get bored, and learning declines. If the task outstrips the zone, frustration sets in. Graphical reports on student-growth over time provide the players with continual feedback about the impact of their choices. In Figure 6, the positive slope of the dark blue line indicates student learning caused by two teacher interactions.

As the clock on the classroom wall records the passage of time, the player recognizes that the lesson needs to be adapted for the lower-performing students and then sets up a modification for a subgroup of the class. In a few minutes, high-performing students have finished the task and begin to get bored; the player must devise an extra challenge for them. Teachers who have the know-how to engage a wide range of student abilities are critical to working successfully with today's diverse learners.

At the end of class, *simSchool* automatically generates a summative assessment for each student in the form of a grade book, accessible to players on the virtual laptop. If players play *simSchool* repeatedly with the same students and their teaching improves, the students' learning grows. *simSchool* also tracks the players' decisions and generates an assessment of their instructional problem-solving strategies and patterns of conversation.

simSchool **Engine**

As the example simulation indicates, *simSchool*'s engine populates the classroom, assigns student personalities, enables teacher actions and collects data. The complex computational model links many variables operating through the interplay of teacher actions and student personality, which results in academic performance and classroom behavior (Figure 7). Grounded in well-known theories of educational practice, *simSchool* synthesizes theoretical frameworks for instructional leadership, interpersonal psychology, and behaviorist teaching models.

Populating the Classroom

simSchool plans to populate the classroom with the exact demographic mix of a particular school by pulling the statistics from the National Center for Educational Statistics Common Core of Data. Each classroom will have a different racial mixes, performance profiles, and personalities, enabling the play of the simulation many times with many different results. Using real data exposes preservice teachers to the types of students they will meet in actual classrooms, forming a bridge to professional practice.

Assigning Student Personalities

The construction of the student personality is at the core of the program's computational model and is based on several well-known bodies of research related to personality and behavior as well as learning theories. In *simSchool*, each student's personality consists of three classes of components (with ten settings per component in each class): (1) five "Traits and Needs"; (2) seventeen "Learning Preferences," and (3) a variable for "Social Expectations." Students in *simSchool* have an effectively infinite number—in the trillions—of nuanced combinations of these factors (23^10 = 4.14E13). These elements determine what a student does during class (e.g., how the student acts and what the student says) and how the student performs when prompted (e.g., on performance-based and limited response assessments). The level of variability in a real classroom cannot be entirely reproduced in a game, but it can be simulated through a wide range of variables and settings that reflect the diversity of students a teacher may actually encounter.

Traits and needs are constructed from the Five Factor (OCEAN) Model of McCrae and Costa (1996). This model extends personality type theories with neurologically founded concepts such as Extroversion, Agreeableness, Conscientiousness, Emotional Stability, and Intellectual Openness. Each simulated student has a program setting for each dimension that varies between the extremes of –1 and + 1 with "0" being the norm. The player does not see these settings but instead sees signs of these states (e.g. descriptions, conversational hints, performance artifacts). For example, a student with a + 0.5 indicator for agreeableness might have descriptors like "sociable and friendly, analyzes well, is a logical, well-organized and objective thinker, values honesty and is interested in the needs of others and self, seeks resolution and harmony."

Each student also has settings that indicate demonstrated learning preferences and capabilities based on cognitive science theories and models such as Howard Gardner's theory of Multiple Intelligences (MI). Using MI theory, students have settings in domain clusters that represent different forms of intelligence: verbal (writing and oral), interpersonal, intrapersonal, logical-math, spatial, kinesthetic, and music (Gardner 1993). In addition, students have academic settings related to school subjects as measured by typical local and national assessments. For example, in mathematics, the subscores for computation, problem-solving, and communication all play a role in the students' mathematics performance capabilities.

Just as the engine incorporates various personality types, it dynamically creates descriptions of student learning preferences and capabilities from the numerical settings. As national and local databases make standardized test scores at the school level available, *simSchool* will incorporate real test performance data as part of the student profiles. In today's high stakes testing environment where teachers are held accountable for student performance, future teachers need to be able to analyze and use this data in their curriculum, instruction, and assessment decision making.

Lastly, students have settings for social characteristics that determine how they react when the teacher interacts with nearby students and also how they act when working in small or large groups. Using Cohen and Lotan's (1997) ideas about social expectations of students and the impact of a teacher's interventions, the social characteristics have been designed so that if a nearby student has a direct interaction with the teacher, it results in a fractional effect on neighboring students that decreases with distance. This mimics the real life situation where one student overhears praise or blame and seeks to attain or avoid a similar fate. In future models, the ideal setting for social characteristics will also include estimations of each student by neighboring students concerning his or her potential to contribute to a successful group task and will take into account whether the teacher's interaction raised the group's expectation for a particular student.

Enabling Teacher Actions

The player has two primary forms of action to influence student performance: (1) designing and adjusting tasks and (2) talking to students through selected phrases that appear in comic-type balloons.

Each task in a classroom has a unique profile of cognitive and emotional loadings that interact with the student personality. Being called upon to recite a poem or work alone at one's desk affects each student differently. If a task calls for a high degree of extroversion but the student is introverted, there is a gap in the student's ability to perform the task; such a performance gap can cause conflicts or academic failure if it is too large or if it occurs in concert with other factors. Small gaps call forth an appropriate challenge that the student then tries to achieve. Too large a gap results in behavior a player can identify as problematic—slumping in the chair, declining performance over time, or negative comments during interactions. The teacher can make temporary improvements by appropriately interacting with the student and can make more permanent improvements by re-designing the tasks facing the student.

Conversational interactions are guided by the Circumplex Interpersonal Theory Model. The model posits that we interact with one another by negotiating power and affiliation. For example, if a teacher and student are friendly with one another, the student will then react differently to the teacher than if the student did not have a level of trust already established. Conversely, if a student approaches a teacher submissively, then the student is likely to expect the teacher to assume a dominant role in his or her response to the student. In *simSchool*, representative statements for a wide range of such interactions are drawn from a database. Following Lambert et al.'s (1995) theory of leading conversations, the database includes questions, assertions, and observations. Each teacher phrase is linked to two possible student conversational responses, one for a positive student and the other for a negative one. Questions, assertions, and observations are subdivided into those that relate to "Understanding or Task" or to "Classroom Management." Under each subdivision are 16 possible phrases that represent an interpersonal characteristic on the "Interpersonal Circumplex" (Figure 8). For example, a dominant phrase might be "Sit down immediately." Students also have settings on the Circumplex to indicate how they react. As the player chooses phrases, the conversational stance reinforces or inhibits the student's personality positively or negatively. For example, when a player asks, "Do you understand?" a positive student might respond "I think so," and a negative student, "I never get it!"

Through the agency provided by the classes of variables outlined above and their large number of combinations, *simSchool* is designed to promote flexible, differentiated forms of interaction in a wide range of teaching scenarios and circumstances. The approximately 3000 written student profiles can be flexibly assigned to any gender, body type, and race. Each profile is supported by trillions of small but perceptible performance differences between those students and the tasks that teachers design. While perhaps not as nuanced or innumerable as the differences among real students, we hypothesize that there will be sufficient complexity and flexibility to avoid any simple "profiling" effect that would come from a less flexible framework. The interplay of teacher actions and student personality will hopefully help players make the connection between decisions they make and what results students display through academic performance and classroom behavior.

Conclusion

Much of what future teachers are taught about teaching before they enter the classroom can be likened to being told how to fly an airplane without ever having taken one off the ground. A simulation such as *simSchool* offers a potentially powerful way to connect learning about teaching with practice in representative environments and situations.

simSchool will allow teachers (and teacher educators) to test out pedagogical ideas to see what combination of strategies helps all students learn. The complexities of the students and the large number of variables in the game provide a realistically complex and dynamic solution set. No one particular solution will work for all classrooms. However, a handful of heuristic strategies can be developed to help teachers learn to "read the needs" and make clusters of decisions such as:

- Which kinds of tasks work and do not work in this particular setting?
- How often does a particular student need teacher interactions to stay on task?
- Where is the zone of proximal development for this student as defined by task content and difficulty?

We are rapidly moving toward a time when those entering teacher preparation programs will have grown up actively playing video games and will not think twice about learning through simulations. Although pilot-testing of *simSchool* is just beginning, we feel confident that much can be learned through the synthesis of models represented by the game. We hope that a community of researchers, teacher educators, and teacher-players will work together to improve on this game in order to create a realistic "flight simulator" for teachers.

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