Using a Simulated Teaching Environment to Improve Teaching Effectiveness as Measured by Core Teaching Standards

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Abstract: Twenty-seven teachers and teacher candidates completed two to five iterations of a simulated teaching module in simSchool, an online "flight simulator for teachers" environment. The system recorded instances of pedagogical practices as educators completed each trial. Analysis of data revealed that as a group, gains in addressing core teaching standards across simulated teaching trials where significantly ($p < .05$) improved, when judged by changes in aggregate scores from first trial to last. Further analysis indicated that three trials are good, but five trials are better for maximizing gains. Limitations of the study include the small sample size (n = 27). Replication with a larger group of participants is planned.

Keywords: simulation of teaching, measures of outcomes, addressing core standards

Introduction

Teacher Quality

Teaching quality is what matters most for students' development and learning in school (Hanushek, 2014). The effectiveness of a teacher is progressively greater at higher grades, indicating a cumulative impact of the qualities of teachers in a school on the pupil's achievements and teacher quality applies even more to minority student (Goldhaber, 2016). Effective teachers can also overcome deficits that might come from poorer learning conditions in the home (Hanushek, 2014). Quality teachers tend to remain quality teachers and those who are successful with students one year tend to be successful in other years; this allows predictions of how well future students might be if assigned to a successful teacher (Goldhaber, 2016).

Teacher Standards

The Interstate Teacher Assessment and Support Consortium (InTASC) teaching standards outline ten standards of the knowledge, dispositions, and skills expected of effective teachers needed to prepare K-12 students for the workforce. The core teaching standards have been updated to include cross-disciplinary skills (communication, collaboration, critical thinking, use of technology) that are important for learners (CCSSO, 2011).

Simulation to Improve Teaching Effectiveness

Badiee (2012) identified advantages to simulation based learning that include classroom decision-making, practice through repeating strategies after feedback, improved self-efficacy in classroom teaching, and better collaboration and social interaction. Fischler (2006) added that simulation based learning improved educators' learning by allowing educators to practice within virtual environments while applying theory to realistic yet controlled settings.

SimSchool is a dynamic, online simulated program that allows preservice and inservice teachers the opportunity to practice teaching. SimSchool was designed to provide future and current 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. Simulated teaching environments provide users many learning trials with simulated students, thereby increasing teacher confidence and competence within a diverse classroom. Research on the use of simSchool has shown improved understanding in important teaching skills (Christensen, Knezek, Tyler-Wood, & Gibson, 2011; Collum, Christensen, Delicath, & Johnson, 2019). Educator bias is a recently confirmed area in which simulated teaching activities can improve educator preparations (Collum, Christensen, Delicath, & Knezek, 2020).

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. simSchool's underlying artificial intelligence model includes research-based psychological, sensory and cognitive domains

similar to Bloom's Taxonomy of Educational Objectives (Bloom, Mesia, & Krathwohl, 1964). simSchool's foundation model (McCrae & Costa, 1996) includes the characteristics of extroversion, agreeableness, persistence, emotional stability, and intellectual openness. A simplified sensory model component with auditory, visual and kinesthetic perceptual preferences comprises the physical domain. Together the physical, emotional and academic factors were demonstrated to represent salient elements of classroom teaching and learning (Christensen et al., 2011; Gibson, 2007).

Methods

For data available as of December 2022, 27 teachers and teacher candidates completed two or more simulations within a module. Numbers were assigned to the ratings from simulation data output, with each participant scored on relevant teaching skills within the simulator (Figure 1). Simulator-assigned scores were: 1 (Needs Attention), 2 (Satisfactory), or 3 (Good) for the degree to which each of Interstate Teacher Assessment and Support Consortium (InTASC) teaching standards were addressed by the individual during a single simulation. These were summed for each individual on one run. Summation scores reflecting extent to which standards were addressed typically ranged from low 20s to mid-30s for one individual on one run.

Analysis of First to Last Trial

First, an overall analysis was conducted to determine whether participants tended to increase in the degree to which they addressed the standards, based on the change from their rating on their first run to their last run. When all 27 participants were included, with last runs including those with at least two and up to five runs, the results were 19/27 (70.4%) went up, three tied, and five went down in terms of standards-addressing summation scores. In taking the conservative approach of the 3 ties being counted as "not up" and therefore not a success, then the probability of 19 successes in 27 trials is p = .0261 (binomial p, one-tailed) (Graphpad, 2021). Simulation activities resulted in significant ($p < .05$) gains in teaching skills as defined by degree of successfully addressing teaching standards, and as measured by gains in participants' scores from first to last runs on an individual teaching module within simSchool.

If the research team considered only the participants that completed three or more trials, then the sample was reduced to n = 24 with 17 successes (70.8%) in 24 trials, still rare by chance at p = .0320 (binomial p, one-tailed) (Graphpad, 2022). If the research team considered only the participants that completed five trials, then the sample was further reduced to n = 20 with 14 successes (70.0%) in 20 trials, borderline-rare by chance at p = .0577 (binomial p, one-tailed) (Graphpad, 2022) but still maintaining the 70% success rate consistent across all three types of data reductions.

Preliminary Analysis of Optimal Number of Trials

Differences between each participant's score on the first run and the same individual's score on each subsequent run were computed, then averaged across the 27 participants that completed at least two trials. As shown in Table 1, the largest average gain (2.15) was from Trial 1 to Trial 5. However, the second largest gain was from Trial 1 to Trial 3. This implies that either three trials or five trials might be optimal training repetition completion points (basic requirements) for simSchool participants.

Table 1. Average gains in addressing standards across 27 simSchool participants

Time Interval		Gain or Loss	ES (Gain T1_2 vs 1_3, 1_4, 1_5)
T1 to T2	0.26		
T1 to T3	0.75	.11	Small
T1 to T4	0.59	.09	Small
T1 to T5	2.15	.47	Moderate (Cohen, Zone of Desired Effects, Hattie)

Note: At the $p = .056$ (one-tailed) level, the gain of 2.15 from T1 to T5 is significantly greater than the .26 gain from T1 to T2 (Graphpad, 2022).

Effect size calculations (Cohen's d) (Lenhard & Lenhard, 2016) reinforce the observation reported in the previous paragraph, that five repetitions appear to result in notably more proficiency (compared to baseline) than trials 2, 3, or 4. As shown in the third column of Table 1, Effect sizes for the gains from Trial 1 to Trial 3, and Trial 1 to Trial 4, were small (Cohen, 1988) while the effect size for the gain from Trial 1 to Trial 5 vs. Trial 1 to Trial 2 was moderate (d = .47) according to guidelines by Cohen (1988). Improvements of this magnitude would fall within the Zone of Desired Effects according to guidelines by Hattie (2009). The likelihood of this great a gain happening by chance was calculated to be $p = .056$, which would be considered marginally significant (very near to $p = .05$). These findings are consistent with the long-standing beliefs based on observations by the research team and simSchool leadership that the first trial should be considered just a

baseline, and two trials are often inadequate to achieve meaningful lasting gains. Additional research with a larger data set is needed to reconfirm these trends.

Implications for Teacher Education

The importance of being able to estimate the value added by the professional development of teachers cannot be overstated in terms of implications for policy and research into best practices. The adage that *practice makes perfect* has long been accepted among entities charged with preparing new teachers and/or continually refining inservice teachers' best practices. However, the question of *how much practice* has long been a complicated judgment call by public servants such as school leaders and legislative bodies funding teacher professional development days. The verification that increased practice within a simulator results in simulated teaching behaviors that better comply with teaching standards is one step toward validating the simulator as a practical means toward improving pedagogical practices. Additional research is needed to replicate these findings with a larger group of subjects, and to begin refinement toward a focus on specific types of teaching behaviors. One relevant future goal for this line of the authors' research is to determine if a simulator such as simSchool can help remediate implicit biases in teacher behaviors.

Standards

Report

	Description	Recommended Practice	N/A	Needs Attention	Satisfactory	Good
1	Regularly assesses individual and group performance.	Checks the class progress tab at a regular interval.		✓		
2	Uses information of differing student strengths and needs to further each learner's development.	Clicks on each student's profile and views their traits or progress at least once throughout the simulation.				✓
3	Designs, adapts, and delivers instructions to address each student's diverse learning strengths and needs and creates opportunities for students to demonstrate their learning in different ways.	User uses a variety of tasks during the simulation.				✓
4	Makes appropriate and timely provisions for individual students with particular learning differences and needs.	Assigns tasks in a way that maximizes students' performance (academic and behavioral).		✓		
5	Understands students with exceptional needs, including those associated with disabilities and giftedness, and knows how to use strategies and resources to address these needs.	User chooses appropriate strategies when students with accommodations are present.	✓			
6	Gives students adequate time to transition between instructional activities.	Selects the appropriate strategy 'give break', before assigning a new task.			✓	
7	Pacing maintains student involvement and engagement.	Changes task or makes a comment when students become distressed.				✓
8	Uses proximity control.	Walks by students who have been disruptive.		✓		
9	Uses praise and encourages positive behavior	Makes friendly conversation or the 'give praise' strategy for students who have moved up a behavior band.				✓
10	Demonstrates fair and equitable practices for students of varied genders, appearances, cultures, and learning needs.	Make comments equally distributed in tone and frequency to all students in the class.				✓
11	Feedback is given to students.	Makes observations, or the strategies 'give praise' and 'use private reminder' at least once during every assigned task.				✓
12	Uses appropriate discipline when necessary.	Uses discipline (assertions, teacher face, behavior reminder) for disruptive students		✓		
13	Makes effective use of non-verbal communication.	Uses non-verbal strategies when a student remains in the low performing.			✓	
14	Responds to observable needs of students.	Makes comments to students in distress, and calls on students with their hands raised.		✓		

Figure 1. Teaching standards included in simSchool.

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