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Comparative Effects of Participation and Observation in Mixed Reality Simulations on Preservice Teachers' and In-Service Teachers' Ability to Deliver Meaningful Feedback

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Empirical

Comparative Effects of Participation And Observation in Mixed Reality Simulations on Preservice Teachers and In-Service Teachers Ability to Deliver Meaningful Feedback

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Abstract
This article highlights the feasibility and efficacy of using simulated experiences with preservice teachers and in-service teachers across instructional modalities with a specific focus on developing skills to provide differentiated feedback to young children. Research questions sought to examine differences among participants who engaged in simulations compared to those who observed their peers and compared performance based on instructional modality (in person versus over Zoom). The study employed a quasi-experimental pre- post-design using quantitative measures from selected rows of a well-known performance assessment. Results indicated statistically significant growth for all participants, regardless of instructional modality or being a participant or observer of the simulated experience. Findings provided additional support for using simulated experiences for rehearsals of core teaching practices, such as delivering feedback to learners. Implications for practice and future research are discussed.

Keywords

High Leverage Practices, Teacher Preparation, Professional Development, Practice-Based Teacher Education, Instructional Feedback

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Introduction

Preparing teachers to effectively support K-12 learners requires pedagogies that extend beyond traditional instruction and course work. These approaches should provide authentic opportunities to practice in safe and structured environments with gradual release before implementing instruction in actual schools and classrooms. Specifically, using a quasi-experimental pre- post-design, we seek to answer the following research questions: What are the effects of participating in simulated experiences compared to observing simulated experiences on preservice teachers'/in-service teachers' knowledge and skills for providing effective feedback? What are the effects of simulated experiences in a face-to-face setting compared to a virtual setting on preservice teachers'/in-service teachers' knowledge and skills for providing effective feedback? Do preservice teachers/in-person participants improve more than preservice teachers/in-person observers? Do in-service/virtual participants improve more than in-service/virtual observers?

One established PBTE strategy with evidence of effectiveness is the use of simulation, where teachers engage in structured scenarios to refine high-leverage practices such as giving differentiated feedback to young children (Dieker et al., 2023; Teaching Works, n.d.). Simulation provides opportunities for preservice teachers to practice teaching skills, receive feedback and coaching, and reflect on practice without the immediate pressures and risks of practicing in live classrooms (Dieker et al., 2017; Dotger, 2015). Furthermore, rapid advances in digital tools create new opportunities for simulation in virtual spaces. Platforms such as Zoom now provide accessible, flexible, and scalable environments where preservice and in-service teachers can participate in real-time interactive simulations (Randolph et al., 2024). This article highlights the feasibility and efficacy of using simulated experiences with preservice teachers (PSTs) and in-service teachers (ISTs) across instructional modalities with a specific focus on developing skills to provide differentiated feedback to young children. The literature review below summarizes empirical evidence on the effectiveness of simulated experiences on a variety of PST/IST outcomes and applies recommendations from prior research to guide the current investigation. Therefore, the study employed direct measures of candidates' performance to compare the effects of simulated experiences across settings (virtual or face to face), experiences (PST or IST), and type of experience (observation or participation).

Simulated Experiences Situated within PBTE

Simulated experiences are structured, intentionally designed opportunities for preservice teachers and in-service teachers to rehearse, enact, and reflect on discrete aspects of teaching in a safe, controlled environment that approximates real classroom practice (Dieker et al., 2014; Teaching Works, n.d.). Simulated experiences are designed to bridge the gap between theoretical knowledge and real-world teaching practice by allowing PSTs /ISTs to learn by doing. Simulated experiences provide supportive opportunities to actively engage in instructional tasks, make real-time decisions, and experiment with teaching strategies. This hands-on engagement enables PSTs/ISTs to apply their knowledge and skills, develop professional judgment, and refine classroom

management and instructional skills through repeated practice and structured reflection (Grossman et al., 2009; Wang & Li, 2024).

Simulated experiences can include a range of low- to high-tech approaches, such as low-technology paper-based scenarios that focus on specific teaching tasks (Nichol, 2025), peer-to-peer role-play (Scharfenberg & Bogner, 2019), chat-based role-plays for practicing classroom discourse (Lottero-Perdue et al., n.d.), and immersive virtual or mixed-reality simulations that use digital avatars and interactive platforms to replicate classroom environments (Dieker et al., 2014; Freeman & Lee, 2024). Virtual and mixed-reality (VR/MR) simulations are technologically enhanced forms of practice-based teacher education that allow preservice teachers to engage in realistic classroom scenarios through digital avatars, interactive software, or immersive 3D environments (Dieker et al., 2014). Mixed-reality simulations combine elements of the physical and virtual worlds, enabling candidates to interact with virtual students, which increases authenticity while still allowing for repeated rehearsal and targeted feedback (Luke et al., 2023). Moreover, VR/MR platforms can be used remotely, making them particularly useful for online teacher education or graduate programs in addition to situations where field placements are limited (Dieker et al., 2016; Freeman & Lee, 2024; Mikeska et al., 2022a). Although additional research in this area is needed, these simulations represent a high-impact pedagogical tool that aligns closely with the goals of practice-based teacher education (Billingsley et al., 2019).

Literature Review

Numerous studies have examined the effects of VR/MR simulations with preservice teachers across a variety of core teaching skills using affective or cognitive measures such as beliefs, perceived learning, and teaching self-efficacy collected through surveys and/or interviews (Ade-Ojo et al., 2022; Bautista & Boone, 2015; Budin, 2024; Dalinger et al., 2020; Ersozlu et al., 2021; Ferguson & Sutphin, 2022; Fischetti et al., 2022; Gundel et al., 2019; Kaplan et al., 2025; Wang et al., 2025). Overall, these studies suggest that simulated experiences positively impact PSTs self-reported self-efficacy and beliefs regarding impact on their learning from the experiences over traditional observation and coursework. For example, in a study involving social studies PSTs, Waychunas (2024) found that candidates valued simulations and rehearsals as more authentic and active than theoretical coursework. Furthermore, it was determined that simulations cultivated communities of practice, promoted equity considerations, and helped candidates engage in productive problem solving (Waychunas, 2024). Systematic reviews of research also collectively suggest that PSTs view simulated experiences favorably and that these experiences overall are not a source of stress or anxiety as part of their teacher preparation (Ersozlu et al., 2021; Theelen et al., 2019).

An emerging body of research shows promising effects on candidate outcomes using direct measures of knowledge and observable teaching skills collected by way of performance assessments (Dawson & Lignugaris/Kraft, 2017; Mikeska, 2022b; Walters et al., 2021). Dawson

and Lignugaris/Kraft (2017) investigated the effects of simulated experiences with four conditionally certified teachers participating in an alternative route to certification program in special education. The researchers employed a multiple-baseline design across targeted skills (behavior specific praise and error correction) measured by observational data. Results indicated that all participants improved the targeted skills with repeated practice using the simulation with feedback and that there was evidence of transference to the classrooms based on observational data following the intervention. These findings provide preliminary evidence that participants transfer their knowledge and skills into live classrooms for these types of discrete skills with a small sample of participants. Similarly, Peterson-Ahmad (2018) studied the effects of simulated experiences on preservice teachers' implementation of opportunities to respond (OTR) using an exploratory case study. Among the eight participants, all increased the rate of OTR based on observational data. Together, these studies show promise for VR/MR simulation, in these cases TeachLive™, as a tool for increasing the rate of specific high leverage teaching practices.

Walters and colleagues (2021) studied the effects of simulated experiences on preservice teachers' implementation of system of least prompts, an evidence-based practice for supporting students with disabilities (Shepley et al., 2019). The authors used a randomized pre/post design with a control group who received business as usual instruction in the system of least prompts and an experimental group who participated in the simulated experiences. Participants' implementation of the practice was measured on a rubric that included the hierarchy of the system of least prompts. Results indicated that the simulation group made statistically significant gains in their implementation of least prompts on post-measures. Authors note that additional research is needed to examine how these gains translate to actual practice in the classroom (Walters et al., 2021).

Mikeska and colleagues (2022b) studied the effects of integrating simulated teaching experiences into elementary mathematics and science methods courses on preservice teachers' skills for facilitating argumentation-focused discussions. Participants' skills pre- and post- simulation were measured using rubric scores containing levels of proficiency for facilitating the targeted discussions with math and science content. Post-rubric scores indicated statistically significant growth in candidates' ability to facilitate argumentation-focused discussions. The authors concluded that the simulated experiences were effective for achieving their desired outcomes in their methods courses and recommended additional research using this approach as a professional development tool for in-service teachers (Mikeska et al., 2022b). Similarly, Moody and Finkelstein (2024) examined how simulated experiences using Mursion™ technology impact PSTs' ability to lead book discussions that elicit student thinking. Mursion™ technology uses a simulated classroom with avatar students. Qualitative coding procedures were applied to measure candidate performance after engaging in simulated practices. Findings indicated that candidates made progress on the intended learning target of eliciting student thinking, but the study also highlighted the need for additional practice to achieve mastery for the high leverage practice of eliciting. In another recent study that applied direct measures of candidate performance, Randolph and colleagues (2024) compared the effects of two different simulated experiences, TeachLive™ and

Zoom with actors, on PSTs' classroom management skills. TeachLive™ uses a simulated classroom with avatar students and/or adult avatars, depending on the intended instructional outcome. PSTs' performance was measured using surveys of knowledge about how to respond to inappropriate student behavior and coding of PSTs' correct responses to student behaviors during simulations. For example, the percentage of correct responses observed by the PSTs was calculated by dividing the number of correct responses by the number of opportunities to respond to inappropriate behaviors during the simulation. Results indicated that simulation with avatars using the TeachLive™ technology was more effective on PSTs' ability to respond to inappropriate behaviors (Randolph et al., 2024). This study provided evidence that the controlled environment of a simulation lab with instructor coaching is beneficial for PSTs to practice challenging classroom management skills.

Teacher Preparation and Feedback

Why Feedback?

Effective feedback represents a critical component of classroom instruction that significantly enhances student learning outcomes. Researchers have included feedback among "high-leverage practices" (HLPs) for teaching, which are a set of practices that equip preservice teachers with knowledge and skills necessary to support successful student learning (O'Flaherty & Beal, 2018; Teaching Works, n.d.). It is well documented that feedback serves as one of the most influential factors affecting student learning and achievement (Gan et al., 2021), yet it is a core practice in which PSTs continue to face significant challenges. Although extensive research has focused on teaching in-service teachers how to implement effective feedback practices, there are few studies that explore the pedagogical approaches used to prepare PSTs to deliver effective feedback to students (Kong et al., 2022). Preservice teachers require specialized training and practice to provide real-time feedback effectively, as this skill is critical to fostering student learning and engagement. The Educative Teacher Performance Assessment (edTPA) serves as a key assessment tool in this context. Developed by the Stanford Center for Assessment, Learning, and Equity (SCALE), the edTPA is a performance-based assessment that evaluates a PST's readiness to teach by requiring them to submit a portfolio of materials, which include lesson plans, video clips of instruction, student work samples, and reflective commentaries during their student teaching experience (SCALE, 2021). Both research and national data from the edTPA suggest that feedback is one of the most challenging aspects of the instructional process for new and aspiring teachers (Gary et al., 2020). Preservice teachers consistently earn the lowest average scores on Rubrics 12 and 13, which focus on providing feedback (Rubric 12) and supporting students in using that feedback (Rubric 13), compared to other rubrics in the assessment (Gary et al., 2020). Furthermore, Rubric 13: Student Use of Feedback was identified as a common area for condition codes (unable to score), which demonstrates that PSTs experienced challenges in effectively supporting students' understanding and application of feedback (SCALE, 2021). These findings suggest that PSTs may require additional preparation and support in developing effective feedback techniques.

The PBTE process includes using representations and approximations to observe, analyze and rehearse core teaching practices (McDonald et al., 2013; Teaching Works, n.d.). Approximations are described as "activities that allow PSTs to work on a particular teaching skill in a low stakes environment, where successes and failures can be discussed and scaffolded" (Moody & Finkelstein, 2024, p. 2). When learning to provide high leverage teaching practices such as providing feedback, PSTs benefit from these approximations, as they can focus intensely on a single core practice without the competing demands of classroom management, curriculum coverage, or school logistics. Through PBTE approaches such as observing and participating in VR/MR approximations of teaching, (specifically Mursion™ using student avatars), PSTs can experience repeated rehearsals of the adaptive expertise needed to provide feedback that is timely, specific, and differentiated for individual student needs, all with the real-time support of teacher educators and peers (Moody & Finkelstein, 2024).

Taken together, simulated experiences support several of the defining features of PBTE. They allow preservice teachers to engage in rehearsals or approximations of practice with reduced risk, offer opportunities for immediate instructor feedback and reflection, and can be designed for repeated practice opportunities that address a variety of core teaching skills. Recommendations from prior research highlight the importance of structured coaching during simulated experiences and maximizing instructional time/resources to address core teaching practices (Budin, 2024; Freeman & Lee, 2024; Gravett et al., 2023; Wang & Li, 2024). For example, this has important implications for educator preparation programs if IST/PST achieve similar benefits from observing their peers during simulated experiences. Therefore, the purpose of this study is to examine the feasibility and efficacy of implementing simulated experiences for implementing an HLP, in this case, providing feedback to K-12 learners, across different modalities, particularly face to face in a university classroom simulation lab compared to a fully virtual environment by way of Zoom. The study also addresses a gap in previous studies by including in-service teachers in the sample and compares observation versus participation in simulated experiences. The study was guided by the following research questions:

1. What are the effects of participating in simulated experiences compared to observing simulated experiences on preservice teachers'/in-service teachers' knowledge and skills for providing effective feedback?
2. What are the effects of simulated experiences in a face-to-face setting compared to a virtual setting on preservice teachers'/in-service teachers' knowledge and skills for providing effective feedback?
3. Do preservice teachers/in-person participants improve more than preservice teachers/in-person observers? Do in-service/virtual participants improve more than in-service/virtual observers?

Method

The study employed a quasi-experimental pre–post design to examine changes in preservice teachers' and inservice teachers' instructional performance when delivering feedback following participation in a simulation-based intervention. A quasi-experimental design allows for the investigation of relationships between an intervention and outcomes when random assignment is not feasible, which is common in educational settings (Creswell & Creswell, 2018; Shadish et al., 2002). Quantitative data were collected from selected rubric rows of a nationally recognized performance assessment, the edTPA, which is widely used to evaluate teacher readiness through evidence of planning, instruction, and assessment practices (Peck et al., 2015). The pre–post design enabled analysis of change in performance across time, providing evidence of how the simulated experiences influence PSTs'/ISTs' ability to deliver the high leverage practice of providing feedback to K-12 learners.

Participants and Setting

This study was conducted at a large public teacher preparation program located in the mid-Atlantic region of the United States. Participants were drawn from two sections of an undergraduate literacy assessment course (PSTs) and one section of a graduate-level gifted education curriculum course (ISTs). The undergraduate sections included 26 pre-service teachers pursuing degrees in Early Childhood Education and initial teacher licensure. An additional eight participants were enrolled in a Master of Education program in Early Childhood Education and were currently employed as in-service teachers working with students from prekindergarten through third grade.

Procedures

All study procedures were reviewed and approved by the Institutional Review Board (IRB). Prior to data collection, participants were assigned readings and received instruction in components of effective feedback based on a published feedback framework (see Hooks & Pett, 2023).

Pre and Post Assessment

Participants were provided with two student performance scenarios for reading comprehension of a text at a second grade reading level. For each scenario, participants were asked to provide instructional feedback that they would give students regarding their performance. Participants composed individual written feedback responses both before and after engagement with the Mursion™ avatar simulations.

Scenario Design

The investigators developed avatar academic performance profiles to assign to Mursion™ avatars. Five second grade student avatars were used in simulated teaching sessions focused on reading comprehension instruction and assessment. Each avatar was associated with a unique performance

profile reflecting diverse learning needs, including characteristics of giftedness, characteristics of learning challenges, and a typically developing student. The investigators collaborated with the university Mursion™ coordinator to provide appropriate responses to questions for each avatar, including scripted responses, personality traits, and hits and misses.

Treatment

Using randomized procedures, participants were assigned a student avatar and placed into one of five small groups. Within these groups, a participant was randomly chosen to interact with one avatar (participant) and the remaining group members were required to observe the interaction (observers). ISTs/PSTs were provided with a visual representation of metacognitive comprehension strategies prior to the interaction to assist in addressing the comprehension needs of the student avatar (Duke et al., 2021; Pressley et al., 1992). Each participant was instructed to do the following:

1. Ask the assigned Mursion™ student avatar the randomly assigned comprehension questions.
2. Develop a working theory regarding the student avatar's comprehension strengths and needs.
3. Choose the most immediate comprehension need demonstrated by the student avatar.
4. Provide meaningful, actionable, and relevant instructional feedback to the student avatar based on the demonstrated comprehension need.

The participants were invited and encouraged by the teacher educator to pause the avatar simulation at any time to confer with observers and the investigators regarding their working theory about the student avatar's needs and the most effective instructional course of action. The observers collaborated with the participant, often working together to craft language to use when delivering feedback or determining the most helpful metacognitive comprehension strategy to suggest that the student avatar apply to the reading task. Consistent with prior studies involving MR/VR with coaching (Gravett et al., 2023; Randolf et al., 2024), each participant received individualized coaching based on their performance. For example, if the IST/PST provided student avatars with the answer to a comprehension, they were redirected with a reflective question and asked to rephrase their feedback to put the learning responsibility back on the student avatar.

After each interaction, observers scored the participant's performance using edTPA Rubric 12: Providing Feedback to Guide Further Learning and Rubric 13: Student Use of Feedback. The participants self-evaluated their performance using the same framework (Figure 1).

This procedure was repeated for all five of the different Mursion™ student avatars, with a new group interacting with a new avatar each time.

Figure 1

Participant and Observer Scoring Form (SCALE, 2021)

Providing Feedback to Students with Diverse Learning Needs: Mursion Observation Form

Observer (you) _____ Candidate _____

What did the candidate do well?	What you suggest for change or improvement?

Please rate the observation using the edTPA rubrics on the following page.

Rubric 12: Providing Feedback to Guide Further Learning

What type of feedback does the candidate provide to focus students?				
Level 1	**Level 2**	**Level 3**	**Level 4**	**Level 5**
Feedback is unrelated to the learning objectives OR is inconsistent with the analysis of the student's learning. OR Feedback contains significant content inaccuracies. OR Feedback is expressed in a way that is disrespectful to students or is developmentally inappropriate.	Feedback addresses only errors OR strengths generally related to the learning objectives. OR Feedback is inconsistently provided to focus students.	Feedback is accurate and primarily focuses on either errors OR strengths related to specific learning objectives, with some attention to the other. Feedback is provided consistently for the focus students.	Feedback is accurate and addresses both strengths and needs related to specific learning objectives. Feedback is provided consistently for the focus students.	Level 4 plus: Candidate describes how s/he will guide focus students to use feedback to evaluate their own strengths and needs.

Rubric 13: Student Use of Feedback

How does the candidate provide opportunities for focus students to use the feedback to guide their further learning?				
Level 1	**Level 2**	**Level 3**	**Level 4**	**Level 5**
Opportunities for applying feedback are not described. OR Candidate provides limited or no feedback to inform student learning.	Candidate provides vague explanation for how focus students will use feedback to complete current or future assignments.	Candidate describes how focus students will use feedback on their strengths and weaknesses to revise their current work, as needed.	Candidate describes how s/he will support focus students to use feedback on their strengths and weaknesses to deepen understandings and skills related to their current work.	Level 4 plus: Candidate guides focus students to generalize feedback beyond the current work sample.

Measures

Participants' pre and post assessment measures were scored using rubrics 12 and 13 from the Educative Teacher Performance Assessment (edTPA). Rubric 12: Providing Feedback to Guide Further Learning evaluates the quality of feedback provided to students, with high-scoring responses characterized by specificity, alignment with instructional objectives, and actionable suggestions for improvement. Rubric 13: Student Use of Feedback assesses the strategies used by

candidates to help students understand and apply feedback to future learning tasks. High-quality responses on this rubric demonstrate clear instructional support, including opportunities for revision and guidance on using feedback (see Table 1).

Table 1

edTPA Rubric Criteria (SCALE, 2021)

Rubric 12: Providing Feedback to Guide Further Learning	Rubric 13: Student Use of Feedback	
Level 1: Feedback is unrelated/contains inaccuracies/ is disrespectful/developmentally inappropriate.	*Level 1: Opportunities for applying feedback are not described/limited or no feedback for learning.*	Not passing
Level 2: Feedback is generally related but addresses only errors or only strengths/is inconsistently provided.	*Level 2: Candidate provides vague explanation for how students will use feedback.*	
Level 3: Feedback is accurate and primarily focuses on errors or strengths related to specific objectives, with at least some attention to both strengths and errors.	*Level 3: Candidate describes how students will use feedback on their strengths and weaknesses to revise work as needed.*	Passing
Level 4: Feedback is accurate and addresses both strengths and needs related to specific objectives/is consistently provided.	*Level 4: Candidate describes how s/he will support students to use feedback to deepen understanding.*	
Level 5: Level 4 plus candidate describes how s/he will guide students to use feedback to evaluate their own strengths and needs.	*Level 5: Level 4 plus candidate guides students to generalize feedback beyond the current work sample.*	

Data Analysis

Due to the relatively small sample sizes and non-normal distribution of scores across variables, non-parametric tests were used. Within group comparisons of change were conducted with the Wilcoxon signed rank test for matched pairs (test statistic V) and comparisons between groups were made using the Wilcoxon rank sum test (test statistic W) which is equivalent to the Mann-Whitney test for independent groups. Data analyses were conducted using R version 4.4.3 (The R Foundation, 2025). Pre-post assessment change tests were conducted using one-tailed tests and between group tests were conducted using two-tailed tests. P-values were adjusted to account for multiple comparisons using the False Discovery Rate (FDR; Benjamini & Hochberg, 1995).

There were N = 34 participants; however, two students' participant/observer status was indeterminate, and two students did not complete the pre-test. These students are omitted from the data analysis, leaving a sample size of N = 30.

Interrater reliability was established by having the first and second author independently double score approximately 30% of the written responses using the study's coding rubric. Percent agreement was calculated by dividing the total number of agreements by the total number of coding decisions. Disagreements were identified when scorers assigned different rubric levels to the same response. Disagreements were resolved through discussion of rubric levels until consensus was reached and 100% agreement was achieved.

Results

Research Questions

1. What are the effects of participating in simulated experiences compared to observing simulated experiences on preservice teachers'/in-service teachers' knowledge and skills for providing effective feedback?
2. What are the effects of simulated experiences in a face-to-face setting compared to a virtual setting on preservice teachers'/in-service teachers' knowledge and skills for providing effective feedback?
3. Do preservice teachers/in-person participants improve more than preservice teachers/in-person observers? Do in-service/virtual participants improve more than inservice/virtual observers?

Table 1 contains a description of the level of performance reflected by each of the rubric scores 1-5 separately by Rubric 12: Providing Feedback to Guide Further Learning and Rubric 13: Student Use of Feedback of edTPA. Scores of 1-2 are considered not meeting expectations by university departmental standards, and scores of 3 and above are considered meeting or exceeding expectations.

Pre-Assessment Differences

If there are differences in scores at the pre-assessment between students/scenes, this affects interpretations of changes from pre- to post-assessment. However, if there are no pre-assessment differences, interpretations of pre-post changes are more straightforward. Two group comparisons were made. First, participants and observers' rubric scores were compared across permutations of student level/mode for each Rubric (12 and 13). Second, differences between student level (Preservice Teachers/In-person and In-Service Teachers/Virtual) across participant/observer status and Rubric (12 and 13) were tested for significance. No statistically significant differences were found between students assigned to be participants and students assigned to be observers prior to the beginning of the simulation experience. One statistically significant difference in pre-assessment rubric scores were found between TC/In-person students and IST/virtual students. For those students assigned to the observer role, undergraduates/in-person students had higher median Rubric 12 scores at the pre-assessment than their graduate/virtual peers. With this exception, no other pre-assessment differences were found. Therefore, no pre-existing differences among

students assigned to participant or observer roles were found prior to their instructional experiences (Table 2).

Table 2

Pre-assessment Rubric Score Differences Between Participants and Observers, and Between Preservice Teachers (PST)/In-person and In-Service Teachers (IST)/Virtual Students by Rubric

	Group comparison				
Rubric	Group1	Group2	Median difference	*W*	*p*
Participants (n = 7) vs. Observers (n = 15) Pre-assessments Among PST/In-person Students					
12	Participant	Observer	0.00	70.0	.16
13	Participant	Observer	-0.50	34.5	.18
Participants (n = 4) vs. Observers (n = 4) Pre-assessments Among PST/In-person Students					
12	Participant	Observer	1.12	14.5	.16
13	Participant	Observer	1.00	14.0	.16
TC/In-person (n = 7) vs. IST/Virtual (n = 4) Pre-assessments					
12	PST/In-person	IST/Virtual	-0.09	12.0	.76
13	PSTIn-person	IST/Virtual	-1.00	4.0	.13
TC/In-person (n = 15) vs. IST/Virtual (n = 4) Pre-assessments					
12	PST/In-person	IST/Virtual	0.50	58.5	.005
13	PST/In-person	IST/Virtual`	0.50	42.0	.28

Note: p-values adjusted by FDR.

Pre-Post Simulation Change

edTPA Rubric 12: Providing Feedback to Guide Further Learning (SCALE, 2021)

Table 3 contains pre and post medians and Wilcoxon signed rank one-tailed test results for all change comparisons. PST/In-person students demonstrated significant increases in Rubric 12 scores whether they were participants ($V = 0$, $p = .03$) or observers ($V = 0$, $p = .003$). IST/Virtual students' improvement was also statistically significant in both participant ($V = 0$, $p = .043$) and observer roles ($V = 0$, $p = .049$).

edTPA Rubric 13: Student Use of Feedback

As with Rubric 12, TC/in-person students demonstrated significant increases in Rubric 13 scores whether participant ($V = 0$, $p = .022$) or observers ($V = 0$, $p = .002$). The same finding was true for

IST/virtual students. Significant improvement in Rubric 13 scores was found under both conditions (participant: $V = 0$, $p = .049$; observer: $V = 0$, $p = .049$).

Table 3

Pre-Post Median Rubric 12 and 13 Scores by Participant Status and Student Level

Participant Status	Level	n	Pre	Post	*V*	*p*	*r effect size*
Rubric 12							
Participant	PST/In-person	7	2.00	3.50	0	.034	.87
Participant	IST/Virtual	4	2.50	4.50	0	.049	.92
Observer	PST /In-person	15	2.00	3.00	0	.003	.87
Observer	IST/Virtual	4	1.50	4.00	0	.049	.92
Rubric 13							
Participant	PST /In-person	7	1.50	3.75	0	.022	.90
Participant	IST/Virtual	4	2.50	4.50	0	.049	.92
Observer	PST /In-person	15	2.00	3.50	0	.002	.88
Observer	IST/Virtual	4	1.25	3.75	0	.049	.92

Note: p-values adjusted by FDR.

Table 4

Sample PST/IST Responses Scored by Rubric 12: Providing Feedback to Guide Further Learning (SCALE, 2021)

What type of feedback does the candidate provide to focus students?	SAMPLE RESPONSE
Level 1: Feedback is unrelated/contains inaccuracies/ is disrespectful/developmentally inappropriate.	*After the student responds "Um, I think the character is a dog?" I would then ask, "What makes you think that?" in hopes to informally gain more insight into her thought process*
Level 2: Feedback is generally related but addresses only errors or only strengths/is inconsistently provided.	*I was happy you participated today during reading. I noticed you had some trouble answering questions about the different characters, settings, and what was happening in the story. I wanted to take some time to review the different story elements. What is a character? That is who the story is about. It can be a person, an animal, or even sometimes a food! The main character is the character in the story the most, who the story is mainly about. What is the setting? That is where the story takes place. Now let's think back to the story I read today. Who was the story mainly about? Where did the story take place? As we read next time, think who is this story about? Where is this story taking place?*
Level 3: Feedback is accurate and primarily focuses on errors or strengths related to specific objectives, with at least some attention to both strengths and errors.	*You made a great connection between what you read before to what happened later in the story. Can you elaborate on what choices the character made and what in their past caused it?* -Give the student a chance to explain more- *I am wondering if you can find any other connections between the character and their past when you are reading other books as well!*

What type of feedback does the candidate provide to focus students?	SAMPLE RESPONSE
Level 4: Feedback is accurate and addresses both strengths and needs related to specific objectives/is consistently provided.	*I am so proud of you for thinking deeply about the text you read. It is clear to me that you are enthusiastic about what you are learning, and it is helping you to make connections. I hope that you are proud of yourself too! Having a passion for reading is important and you will continue to expand your understanding of the world as you read.* *While you were talking to me about what you read, I noticed you using a comprehension strategy we have practiced in class, which is making connections to the real world. You made a great connection when you used you and your friends standing in a room to explain your understanding of how the universe is expanding. This strategy can be great when there is a topic, we are having a hard time understanding, because it can help us to picture it in a way that makes more sense to us.*
Level 5: Level 4 plus candidate describes how s/he will guide students to use feedback to evaluate their own strengths and needs.	*I liked how you made connections with the story. You gave me a personal connection with our friends, and you gave me another personal connection with the stickers on the balloon. I also liked how you used what we learned yesterday about visualizing. You came up with a scenario with the balloon to match what is happening to our universe, good job! One strategy we can work more on is inferring. Could you think about what could happen to the universe if it keeps expanding, what will happen, and what could change? Since the scientists are still trying to figure out why and how fast, maybe you could predict or infer what would happen if it kept expanding! This is a great strategy to use when the authors don't answer our questions, we must infer. This can be used anytime you read when you have more questions that the author doesn't answer in the story.*

Table 5

Sample PST/IST Responses Scored with Rubric 13: Student Use of Feedback (SCALE, 2021)

How does the candidate provide opportunities for focus students to use the feedback to guide their further learning?	SAMPLE RESPONSE
Level 1: Opportunities for applying feedback are not described/limited or no feedback for learning.	*As Mr. Johnson was reading the story, I noticed you looked confused. And you even seem to not want to answer the question that was being asked. Reading can be hard sometimes, but a good way to be able to tackle reading is by practicing. I think if we practice together, reading will get easier. I can definitely find books and games that can both help you practice reading and relates to all these things you told me you like.*
Level 2: Candidate provides vague explanation for how students will use feedback.	*I heard what you said about your book in class. I was wondering what made you say that the main character was a dog? (Student response) When I was reading this story, I thought the main character was a girl because there are certain words like "she" that tell me she is a girl (point to the word she in book text). Also, some things she does and says made me think of myself when I was little, like [read something from text] Do you do that, too? (Student Response) Does your dog do that? (Student Response) I noticed during reading time today that the questions about the book were a little tricky. Did you feel that some of them were kind of tricky? (Student Response) I would love to read this story again with you and work together to learn more about this little girl and her life. Except, this time I want to do things a little differently. Do you like drawing and coloring? (Student Response) Let's work together to make a poster about the things we learn about her, drawing pictures for the most important parts! This way we have our own little learning tool to look back on whenever you want to talk about this story!*
Level 3: Candidate describes how students will use feedback on their strengths and weaknesses to revise work as needed.	*I am not sure our main character is a dog. Let's look together! Let's look at this page right here.* Action: Circle page with hand to redirect student to focus on a particular page *Remember, we are looking for our main character. A main character is the person we see throughout the story and the story is about them or something in their life. Do we see a dog or a human on this page?* Student (hopefully): I see a human *Okay! I see a human too, since we see a human on this page, do we think our main character is a dog or a human? Remember to look here, this is our main character* Action: Circle page again or point to main character to maintain focus/attention Student (hopefully): Our main character is a human! *Great job! Our main character is a girl named ____. We will keep looking at stories to find their main characters and main events throughout the year so we will get plenty of practice.*

How does the candidate provide opportunities for focus students to use the feedback to guide their further learning?	SAMPLE RESPONSE
Level 4: Candidate describes how s/he will support students to use feedback to deepen understanding.	*I want to first point out to you that I noticed how, as you read, you used your finger to point to each word to help you read the text! I love how you were able to use that strategy to help you read each individual word in our text on your own. I noticed that you were having trouble answering some of the questions I asked you about our story, though. Do you remember yesterday during our whole group reading I was struggling to understand the text that I was reading to you? As I read, one strategy that I used to help myself understand the book was that I asked myself questions aloud as I read. I asked myself what the book was about, what each part of the book was telling me, and how each part supported the main idea. I think that this strategy would help you out, too. Next time you read, I want you to practice asking yourself questions about the text to help you understand it. You can start by asking yourself what the main idea of the book is. Let's read the first page of the book together. I'll read it aloud, and you can follow in your text as I read.* **Read the first page together* Now, to help you understand what we read, we could ask ourselves what the text is about. Can you tell me what it is about after reading that first page?* **Prompt student to respond** *Nice work! I want you to reread the next few pages and keep asking yourself questions about what you are reading to help you make sure that you are understanding. You can use this strategy now with this book, and with any other books you read in the future that you need to understand. After you read, I want you to tell me some of the different questions you asked yourself. I can't wait to hear more about what you learn!*
Level 5: Level 4 plus candidate guides students to generalize feedback beyond the current work sample.	*I like how you connected the text to what you know about life cycles. Since it is the first stage, just like humans start as babies you guessed it was a baby frog. I want you to think about how the past couple of days in small groups we have been discussing how to support our answers using evidence from the text. Here's what I want you to try. When asked a question, I want you to look in the book and point to where you found your answer. This helps us make sure we are using evidence from the text to support our answers. You can even mark the page or sentence with a sticky note and write the answer. Let's practice together. Where in the book does it talk about the first stage of the frog's life cycle? Let's turn to that page. What is the name of the first stage of the frog's life cycle? Can you point to it? Super job using the text to find our answer! You can use this strategy all the time when reading. It helps build our comprehension and make sure we are using the text to find our answers.*

In summary, there were virtually no differences between groups of students (Participant vs. Observer, PST vs. IST) in pre-assessment scores, suggesting students started the study at similar levels of knowledge and performance. The one exception to this finding was for Rubric 12 among observer participants. For research question 1, whether participant or observer status affected the amount of improvement students made, the answer was that all students improved in feedback skills irrespective of participant or observer status. For research question 2, whether student level/mode of instruction affected feedback skill improvement, the answer was similar: both groups of students improved. Research question 3 concerned the magnitude of improvement and whether participants changed more than observers or whether PST/in-person students improved more than IST/virtual students. The answer to research question 3 was that all subgroups across both rubrics improved significantly, with large effect sizes as indicated by Table 3 effect sizes. These are all large correlation coefficients, exceeding .80. Furthermore, median post-assessment scores all met or exceeded departmental expectations (score of 3). Therefore, there was evidence of statistically significant improvement in performance across all subgroups and as assessed by both rubrics.

Discussion

The first research question sought to explore the effects of participating in simulated experiments compared to observing simulated experiences on STs'/ISTs' knowledge and skills for providing effective feedback to students. The results indicate that prior to participating or observing the simulated experience, there were no meaningful differences between the degree of competency within the two groups. All participants improved their ability to provide substantive feedback to students as measured by edTPA Rubrics 12 and

13 after participating and/or observing the simulations. These findings provide initial evidence that observers achieve the same benefit as active participants. This can be attributed to the active engagement of the randomly selected observers, who were required to provide real-time assistance and support to the participants as well as completing a rating and review of the participants' performance. However, it cannot be concluded that observers would yield similar performance results in a less structured observation task. Additionally, both participants and observers were exposed to real-time coaching and intervention from the university instructor. These findings are consistent with prior research in educational simulation in other fields such as medical training (Ham et al., 2024) where observers achieve the same benefit as participants. The present study is the first to compare observation to participation in simulated experiences and provides initial evidence that candidates achieve similar benefits regardless of their role in the experience.

The second research question examined the effects of simulated experiences in a face-to-face setting compared to a virtual setting on PSTs'/ISTs' knowledge and skills for providing effective feedback. As with the first research question, there were no significant differences across settings on the pre-assessment measure. Furthermore, all candidates, whether in a virtual or in-person setting, demonstrated statistically significant growth in their ability to deliver substantive feedback to students. These findings can be attributed to the fact that the facilitation by the university instructor remained consistent in both settings, allowing for real-time coaching and support. Consistent with prior research, the findings illustrate that simulated experiences are viable and feasible in a virtual setting with both preservice teachers and in-service teachers (Mikeska et al., 2022a).

The third research question concerned the magnitude of improvement and whether participants changed more than observers or whether undergraduate/in-person students improved more than graduate/virtual students. While research questions 1 and 2 showed that whether students were Mursion™ participants or observers, or whether they were PST/in-person, or ISTs at a distance, was not related to whether there was significant improvement in feedback skill. All participants improved. Research question three asked about the magnitude of those changes, or effect size, which was indexed by using a correlation coefficient measure of effect size for non-parametric paired tests (Fritz et al., 2012). Effect sizes were all large, exceeding .80 for all subgroups, suggesting that not only were improvements non-zero, but they were also large improvements. The magnitude of change suggests that other variables, such as setting (virtual or in person), order, or experience did not impact the results. For context to interpret the effect sizes, Dunst et al. (2020) published a synthesis of meta-analyses for pre-service teacher instruction methods. After converting their effect sizes from standardized mean differences to rank biserial coefficients, simulated instruction with deliberate practice had an effect size of r = .64 (95% CI: .41-.79) on teaching quality outcomes, simulated student teaching practices had an effect size of .17 (95% CI: .15-.19) on teaching outcomes, and simulation based instruction had an effect size of r = .09 (95% CI: .06-.11) on knowledge acquisition. Although effect sizes were larger (.80 and above) in this study, it is important to emphasize that sample sizes were small for all current comparisons whereas the Dunst et al. syntheses are based on more than 100 meta-analyses.

Limitations

Although the authors received training for applying criteria to make rubric level scoring decisions based on PST/IST responses, neither investigator is a nationally trained edTPA scorer. However, both have received university training and/or edTPA professional development. The authors attempted to maximize reliability of scoring by double scoring 30% of responses to determine agreement. The small sample (N=30) warrants

replication with a larger sample size. Due to enrollment considerations, partnering with other departments at the institution or possibly participating with other universities would be beneficial in order to increase participant numbers. Lastly, the authors acknowledge potential threats to internal validity, including test/retest effect and practice effect based on the order in which participants interacted with or observed simulations. However, the magnitude of effect suggests that the simulated experiences caused the significant change.

It should also be noted that this study was conducted within one institutional context, which limits generalizability. Replication across diverse institutional contexts is warranted to strengthen the findings.

Implications for Practice and Future Research

These findings have significant implications for practice-based teacher education, specifically those institutions that may have limited resources for VR/MRs simulations or those with large class sizes. For example, one could anticipate a level of oversaturation or learning fatigue if all students were expected to participate directly with the avatars during class time. These findings support the efficacy of a participant/observer paradigm, which results in the ability to maximize the use of the instructional time to address a variety of high leverage practices. These findings also add to the literature-base on the effect of preservice teacher outcomes, in this case, providing substantive, meaningful feedback to students in learning contexts as determined by direct measures of candidate performance.

Moreover, these findings show that the same effects can be achieved in a virtual setting. This allows PBTE practices to be expanded into online and hybrid learning environments and professional development opportunities for partner schools. Virtual simulations built within a PBTE framework can mitigate limitations on learning experiences that were once hampered by distance.

While this study shows promise for enhancing preservice teachers'/in-service teachers' ability to apply components of effective feedback to learners, future research is needed to determine the impact of mixed-reality simulations on PSTs'/ISTs' ability to transfer instructional strategies to actual classroom settings. Future research may also explore PSTs'/ISTs' ability to deliver feedback across diverse learner characteristics, other aspects of literacy development, and/or across content areas. Other important considerations highlighted in prior research include scenario authenticity, validity, and implementation fidelity (Ade-Ojo et al., 2022).

Based on these findings, we recommend teacher educators consider adopting mixed reality simulations for teacher candidates to apply their knowledge and practice their skills prior to implementing in actual classrooms. While this study focused on improving candidates' ability to provide real-time feedback to virtual students with a range of learning needs, this practice-based approach can be used across a variety of high leverage teaching practices. We offer the following guidance to other teacher educators:

1. Use observation and participation in scenarios strategically to maximize resources. The current study provides evidence that teacher candidates can benefit from observing as well as actively participating in simulations. Candidates were randomly assigned in this study to control for potential threats to internal validity of the research. However, teacher educators can seek volunteers or intentionally select candidates who might serve as strong models and/or candidates who need

more support. Regardless of the candidate's role (observer or participant), VR/MR experiences should include opportunities for reflection and formative feedback, and observations should be structured and focused on the learning outcome. Therefore, teacher educators can use this approach to accommodate larger cohorts or optimize limited simulation resources without sacrificing learning outcomes.

2. Align simulations with high leverage teaching practices and clearly defined objectives for candidates to intentionally practice their skills. Scenarios should be designed around practices that have the greatest impact on candidates' learning and/or address an area of need within the program. In the present study, we chose to focus on feedback since this was an area of need identified by institutional data on candidate performance across cohorts over time. Focusing on feedback allowed us to target a high-leverage teaching practice that is critical for supporting student learning and for developing teacher candidates' ability to respond effectively to diverse learner needs.

3. Implement MR/VR across instructional formats to increase accessibility and to reduce barriers for candidates. Given the comparable effectiveness of virtual and in-person simulations in the current study, teacher educators can implement VR/MR across instructional modalities, including fully online, hybrid, or face-to-face learning environments. This flexibility allows programs to offer practice opportunities despite logistical or geographic constraints.

Conclusion

This study adds to the growing body of research on simulated learning experiences on direct outcomes for teaching practices for preservice and in-service teachers. It also shows promise for simulated experiences in virtual settings for online programs. Lastly, this study provides initial evidence that structured observations of simulated teaching experiences yield similar benefits to active participation in simulation experiences.

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