DEVELOPING AND IMPLEMENTING A MIXED-REALITY TEACHING SIMULATION TO BE USED WITH PRESERVICE STEM TEACHERS

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ABSTRACT

Practice makes perfect…this saying is a popular cliché, but it has validity when referencing the abundance of practice necessary to learn and master a new technique or skill. Like playing a game, honing a skill, or using a new technique, teaching requires practice to learn and improve. Working with preservice STEM teachers (PSTs), my goal was to develop ways for PSTs to practice teaching to gain experience, hone skills, and learn new techniques. This narrative describes the process undertaken to create a virtual microteaching opportunity that will provide PSTs practice time and additional teaching experience.

Keywords: *preservice teachers; mixed-reality, STEM, problem-based instruction, Mursion, simulation*

INTRODUCTION

"Teachers are the single most important factor to influence student learning and academic outcomes, aside from the students themselves," making high-quality teacher training and development a vital practice (Dieker et al., 2017, p. 62). Microteaching is an opportunity for preservice STEM teachers (PSTs) to practice teaching in a safe, familiar, and nurturing environment (Amobi & Irwin, 2009; Fernandez, 2010). In face-to-face courses, microteaching typically involves students presenting short lessons to their peers in which specific pedagogical practices are rehearsed, peers may offer feedback, and individual or collaborative reflection may be accommodated related to what was taught and/or learned (Allen & Eve, 1968). Microteaching experiences make it possible for PSTs to practice engaging students and effectively conveying content in addition to practicing pedagogical skills (Fernandez, 2010). This narrative will look at how a mixed-reality Mursion simulation was developed to be implemented into a Problem-Based Instruction (PBI) course to provide additional teaching practice time for PSTs.

LITERATURE REVIEW

While microteaching promotes rehearsals for teaching and gives PSTs opportunities for reflecting on their emerging skills, technology can be used with microteaching experiences to accentuate PSTs' learning experiences and practicing opportunities. Earley and Porritt (2014) conducted a research project that resulted in the publication of 19 high-leverage practices (HLPs) for instruction that spanned all content areas and outlined skills that promote student learning. The TeachingWorks (2022) webpage provides an overview of each HLP as well as resources for exploring each of them. Examples of HLPs include attending to patterns of student thinking, leading a discussion, and coordinating and adjusting instruction (TeachingWorks, 2022). Grossman et al., (2009) defined high-leverage practice as "practices that occur with high frequency in teaching" (p. 277). Hurlbut and Krutka (2020) emphasized that high-leverage practices are teaching fundamentals that offer teacher educators and researchers a starting point for analyzing instruction. The TeachLivE team from the University of Central Florida then took these 19 HLPs and situated them in a virtual learning environment that simulates a small-group classroom setting in which PSTs can practice teaching (Dieker et al., 2017). Virtual simulations have been long used in medical, aviation, and technical training fields and are emerging as valuable components

of teacher preparation programs (Judge et al., 2013). Mursion is a commercialized version of the TeachLivE learning environment that can be used as a mixed-reality, virtual simulated teaching environment in which PSTs can both practice teaching and review specific teaching skills for growth and reflection (Hudson et al., 2018). Within the Mursion environment, avatars, i.e., simulated students, are controlled by simulation specialist actors who provide reasonably realistic student performances for PSTs to practice teaching (Hudson et al., 2018).

Mixed-reality teaching environments have emerged as a valuable teacher training tool. Vince Garland et al. (2016) conducted a study that used a mixed-reality environment to assist graduate students in preparing to work with autistic learners using a specific least prompts strategy. Least prompts is a procedure that uses varying levels of prompts to help promote learning (Ledford & Chazin, 2016). Prompts can range from noncontrolling levels, giving a small level of assistance, to controlling levels where significant assistance is provided. Vince Garland et al. (2016) found all students who engaged in the mixed-reality experience were able to successfully navigate the least prompts strategy, meaning they were able to complete their learning tasks with appropriate levels of prompting provided as needed. Dieker et al. (2017) investigated the use of a virtual teaching simulation to enhance teacher performance. Teachers in this study overwhelmingly agreed that the classroom simulator felt like a real classroom and that the avatar students represented "the kinds of students that existed in the real world" (Dieker et al., 2017, p. 76). Dieker et al. (2017) found as simulation experiences continued, the study participants had increased usage of HLPs, asked significantly more describe or explain style questions, and provided more specific feedback to students.

Seeking a means to facilitate practicing classroom management skills, Hudson et al. (2018) implemented a Mursion simulation in a course for students seeking special education teaching certification. The results of this study indicate Mursion successfully provided a learning environment in which classroom management strategies could be practiced, refined, and enhanced. Hudson et al. (2018) found most participants felt better prepared to manage classroom behaviors. These researchers also commented on their appreciation of the ability of the Mursion actors to scale up or down the level of disruptive behaviors present in the simulation. For students who are more novice in their classroom management skills, low or moderate behaviors could be presented as confidence and techniques mature. Similarly, students with stronger management skills could be further challenged with increased levels of disruptive behaviors. The fluidity of the Mursion experience enabled actors to modify and adjust the severity of behaviors in real time, providing authentic, realistic, and dynamic learning experiences catered to each PST.

Teaching is a work of art (Landon-Hays, et al., 2020). PSTs need a variety of opportunities to be immersed in classrooms and opportunities to work with students. Augmented reality experiences, like Mursion, provide a risk-free opportunity for PSTs to engage with students and practice the art of teaching. Each augmented reality experience must be carefully crafted according to instructional and student learning needs.

PROJECT BACKGROUND

The Problem-Based Instruction (PBI) course was one of the first at the host institution to institute a customized Mursion experience. Being one of the first instances required a new simulation to be crafted and foundational relationships to be built. The PBI course initially implemented the Mursion experience as an opportunity to explore user experiences with the Mursion program, and to gain insight into the value of Mursion relative to the course object of helping students learn to teach in alignment with a sustained-inquiry framework. Within the PBI course, PSTs learn to ask probing questions that point students back to self-inquiry and self-exploration of lesson content. A sustained-inquiry lesson framework stipulates that students self-investigate content to explore questions rather than relying on teachers to spoon-feed them information (Larmer et al., 2015).

At the university conducting this research, the PBI course is a junior/senior level course in the STEM teacher preparation program. Prior to taking PBI, students take three additional teacher preparation courses. Each of the prior three courses focuses on training PSTs to engage with students, teach in a student-centered format, and plan quality instructional activities. The PBI course expands teacher preparation instruction to include looking

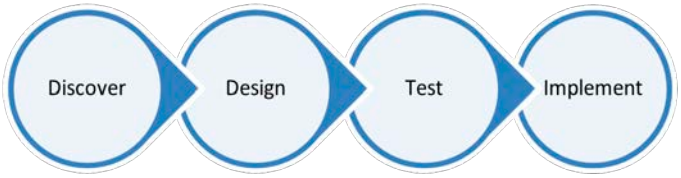
at both a PBI lesson model and a sustained-inquiry teaching framework. In alignment with a sustained-inquiry framework, it is important to teach PSTs to ask probing questions, not give away answers, and guide students toward helpful resources that promote continued learning and investigation (Larmer et al., 2015).

When designing the PBI Mursion experience, the predominant goal was to have PSTs practice engaging students in questioning to promote sustained inquiry. The simulation was developed from the mindset of creating an opportunity for PSTs to engage with avatars in a discussion format in which the avatars probe PSTs for direct question answers and the PSTs, ideally, respond by pointing the avatars back to their work, peers, or lesson content to self-inquire and work towards figuring out the correct solution process.

DEVELOPING A MURSION SIMULATION

To develop a Mursion simulation, there is a prescribed process to follow. Each simulation is developed around a specific set of objectives or desired outcomes (Hudson et al., 2018). Whoever is developing the context of the simulation takes on the author role and begins formulating their goals for the simulation. Once the author has their goals outlined, the four-part simulation process can begin. While Mursion simulations can be vastly different, each simulation is constructed using the same four-part process of discover, design, test, and implement.

Figure 1. Simulation Design Process



First, during the discover portion of the process, the author(s) meets with a Mursion simulation design specialist on a discovery call. The discovery call is a time for the author(s) and specialist to discuss the Mursion capabilities, such as designing levels of distractions for students and levels of student engagement, and discussing student on-task and off-task behaviors, that align with the session outcome objectives. The specialist helps the author(s) understand ways Mursion could enhance their simulation vision and together they construct a basic overview plan for the simulation. Once the Mursion capabilities are understood, the discovery call concludes with the Mursion specialist sharing a design template, which leads to the second step of the design process.

The design template is carefully designed to include prompts for each component of the simulation. During the design stage, the author(s) take the time necessary to carefully craft the simulation components. One aspect of the design stage is that the author(s) outline goals that indicate participants have hit or missed the learning objective targets and then comment on behaviors they would like the author(s) to implement based on students hitting or missing the objective. For example, this PBI simulation was designed as an opportunity for PSTs to practice teaching in a sustained-inquiry lesson format. The objectives for the simulation were:

- PBI students will be able to manage group dynamics efficiently and effectively for a student-driven inquiry learning scenario.
    - Managing the "I work alone student."
    - Managing the "Domineering group member."
    - Managing the "I'm just going to let them do all the work and I copy their answers group member."
    - Managing the difference pace learners/processors in a group.
    - Managing effective communication among group members.
- PBI students will be able to leverage inquiry-driven questioning/strategies within a learning activity to promote learning and discovery.
- PBI students will be able to effectively redirect students requesting teacher support or showing avoidance behavior throughout an activity.
- PBI students will be able to employ intervention strategies for students lacking prior knowledge skills or those feeling overwhelmed by the material.

Focusing on these objectives, two challenges were developed. Challenges, in this case, correlated

to the Mursion experiences. The first challenge, Challenge 1, was the first time PSTs engaged in the Mursion simulation and Challenge 2 was a second experience that followed a couple weeks later. The two-challenge design allowed time for PSTs to reflect on their experience and brainstorm ways to modify or enhance their teaching tactics. Each challenge was accompanied by a set of avatar behaviors. For example, Challenge 1 was identified as managing group dynamics and outlined actors should take on the persona of one of the following:

- "I work alone student"
- "Domineering group member"
- "I'm just going to let them do all the work and I copy their answers group member"
- Difference-paced learners/processors in a group
- Effective communication among group members

Once these details were orchestrated, the PST behaviors are labeled as a hit or miss to trigger specific reactionary behaviors of the actors. For example, the expected PST behaviors are listed beneath the "Learners will. . ." label and the actors controlling the avatars carry out corresponding hit-or-miss behaviors beneath the "Avatars will. . ." label (see Figure 2).

Figure 2. Hit and Miss Behavior Example

When learners...	Avatars will...
HIT	HIT
Provide individualized attention, explore the root of the "issue," communicate to students the importance of their role in the group, and redirect student behavior to being a viable group member.	Change their behaviors and effectively communicate/ collaborate with their group members.
MISS	MISS
PBI students ignore or subtly attempt to redirect the student's behaviors but use weak language or do not follow through with redirecting the behavior.	Avatar will return to the original behavior with little to no change in their actions.

The design template concludes with the inclusion of any specific materials needed for the session. For example, this PBI simulation focused on a specific teaching methodology of questioning to promote student-guided inquiry, and all PSTs were teaching the same content so student-guided inquiry was the focal point of the simulation and learning and not content. This was particularly important for this PBI simulation because the PSTs were secondary STEM (mathematics and science) PSTs. However, the simulation required specific content, and the customization materials provided a detailed description of the content, so the actors knew the material.

This PBI simulation content focused on graphing, which is important disciplinary content for secondary STEM teachers, independent of their disciplinary affiliation. The assumption was that students had spent the prior class session working with their peers to collect height and foot-length measurements. The topic for the simulation was intended to be reviewing what type of graph students thought would be best used to illustrate the collected data. With this learning sequence design, it was important for the actors to have the collected data and the sample graphs. The actors are not necessarily experts in the content, so any content, accurate or inaccurate, needed to be provided. For the PBI simulation, a chart of measurements, a bar graph, a scatter plot, a circle graph, and a line graph were provided.

The Mursion classroom is comprised of five students, and there are several limitations within the environment. One limitation of the Mursion platform is avatars are not able to move to form smaller groups or to discuss something among two or more avatars in a way that would mimic a real-life interaction. There is only one actor who controls all the avatars. Another limitation is that the avatars cannot display a worksheet or paper that they have created. The avatars and the PSTs may be provided samples of student work, but the avatar must describe the work in order for the PST to know which paper is being referenced. For the PBI simulation, the PSTs were instructed to think of the whole class as one small group.

Once the design template is complete and all necessary content components finalized, the design template is shared with the simulation specialist for testing. The design specialist reviews the design template in advance of a testing call to ensure familiarity with the content to enhance productivity during the call. During the testing call, actors and the design specialist role-play the simulation to make sure that is in the design template

is interpreted in accordance with the author(s)' desires. Modifications, clarifications, and additions are made to the template as necessary. The testing call is recorded and serves as "training" for the actors to understand how to role-play harmoniously relative to the author(s)' desires.

After testing, the simulation is ready to publish. Once published, the simulation is ready to implement. While implementation marks the end of the simulation design process, the simulation is by no means considered static. After PSTs go through the simulation, it might be necessary to implement further adjustments to reach the precise goals and objectives. For example, the PBI sessions were recorded and the videos were reviewed by both the students and the course instructor. In reviewing the initial PBI videos, the instructor noticed the first moments of the simulation were taken up by the actors engaging in nonessential dialog with the PSTs. The actors were commenting on the PSTs' shirts, shoes, or other articles as a momentary icebreaker, but the instructor felt this took away from the PSTs initiating conversation and was off-topic with the session objectives. Each simulation is designed to be very short. The PBI simulations were designed to be 6 minutes in length. Using even a few moments at the beginning of the session for unaligned chatter impacted the on-task time for the simulation. Therefore, the instructor requested a modification be made to eliminate the superfluous banter at the beginning of the session and requested that actors wait for PSTs to initiate conversations. These requests were noted, and revisions were made by the actors for the second PBI simulation experience.

PROJECT-BASED LEARNING COURSE RESULTS

Prior to engaging in their first Mursion experience, the PBI PSTs were purposefully told very little about Mursion. The purpose of this was to promote PBI PSTs approaching Mursion with an open mind. With a three-part teach, reteach, reteach experience, it was important to the PBI instructor that the PBI PSTs experience Mursion, reflect, and then decide on their own how to improve and better prepare for their second experience. In their reflective journal notes, the PBI instructor commented on the initial PBI PSTs' responses to their first Mursion experience. Comments ranged from "that was amazing" and "I loved it" to "that was different" or "wow, just wow." The thing the PBI instructor found interesting was that upon completing their first Mursion experience, the PBI PSTs began talking about specific students, how they were going to change their teaching strategies to better accommodate specific students, and how they had already identified key aspects relative to student learning needs after such a brief time of engagement with the students. For example, one PBI PST commented

> *I could clearly see the five students all had their own personalities, but not unlike those I would find in a classroom. One of my students was even flirting with his classmate and agreeing with her ideas just because he liked her.*

Hearing these conversations promoted a class-wide discussion about the importance of getting to know your students as learners so you can target their learning needs appropriately with your instructional plans and activities. The first simulation experience was just 6 minutes in length. In this short amount of time, PBI PSTs observed quite a lot about their students' personalities and learning needs. The PBI instructor used this observation as an opportunity to explain the importance of continuously "reading" students, knowing students' strengths and weaknesses, and interpreting student body language to assist with confusion, maintain engagement, and adjust lesson times lines and flow.

The PBI instructor developed the Mursion experience to provide questioning practice for the PSTs. After observing the PST recordings, the course instructor noted increased instances of PSTs redirecting students to their notes, peers, and resources for self-inquiry rather than the PST directly telling students answers. For example, comments from PSTs the in the first Mursion scenarios were more content directed with things like "I did not get a bar graph, do you want to try again?" In the second Mursion recordings the instructor noted comments moved towards "let's look back at our notes and see where we have used a bar graph before. How does that situation compare to this one?" and "I will give you 30 seconds to confer with a friend before we share ideas, see if you and your neighbor agree." Additionally, the PBI instructor noted that PSTs were asking questions like "what do you think?" and "can you explain your thought process?"

with greater frequency. Instead of just accepting an answer, the instructor noticed the PST asking, "who else got that?" and "(student name) do you agree with what (student name) shared?" The PBI instructor was well pleased with the improvements in student-centered questioning as well as redirecting students to other resources.

Relative to the teach, reteach design, one PBI student commented, "I went into this second experience relaxed and ready." A second PBI PST commented, "both experiences also exposed the depths of preparedness we must have as teachers." Another PBI PST commented, "I felt like the repetition helped because this time I could focus more on asking the right type of questions." Additionally, students commented that "I was less nervous, I knew of better ways to have the students interact and evaluate the information," "I felt a lot more confident going into the Mursion lab," and "I went into this Mursion experience with questions and talking points for the students." The PBI students commented on their appreciation of the Mursion activity noting that it was both fun and valuable. Having an opportunity to practice teaching in a student-inquiry mindset made them more comfortable teaching using this framework during their immersive field experience.

After completing their full, two-session, Mursion experience, PBI PSTs were asked to reflect on the experience and share their thoughts. The comments were overwhelmingly positive. One PBI PST commented, "the experience was definitely valuable" and "I wish I was able to do this even sooner." Another commented, "I think that the Mursion Labs were beneficial on helping me understand how to teach 'student driven' inquiries" and "this experience was valuable to my developing arsenal of teaching approaches that will absolutely help me in my future classroom."

PBI PSTs also commented on teaching strategy improvements, such as excluding the use of filler words (um, ah, uh, etc.) and improving question flow. A second PBI PST commented, "I went in prepared for an inquiry-based lesson and came out bettering my inquiry skills and my classroom management skills."

CONCLUSION

Developing a customized Mursion simulation involved a detailed process of planning, collaborating, and implementing. The Mursion simulation provided a unique opportunity to incorporate a mixed-reality teaching experience and afforded PSTs extra time to practice leading student discussions, using probing questions, and teaching in a sustained-inquiry framework. The mixed-reality teaching simulation was a risk-free option that was easily integrated into the Problem-Based Instruction course. The purpose of this article has been to give an overview of the Mursion development process while offering insights into using Mursion simulations as an opportunity to further practice opportunities for aspiring educators.

While outside the scope of this paper, additional work has been done to explore the efficiency, student preparation benefits, and drawbacks of using Mursion simulations. Additional works that explore the effects of using Mursion simulations should be conducted to support the exploration of this field of research.

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