Preservice Teachers Facilitating a Discussion With Elementary Student Avatars Before Facilitating It With Real Students

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Abstract

In this article, we share our innovation in which we used backward design to develop a scenario for use within the Mursion mixed-reality (MR) upper elementary simulated classroom environment to enable preservice teachers (PSTs) to practice facilitating an ambitious group discussion before facilitating that discussion to students in their field placement. The third-year elementary PSTs were enrolled in a course in which they taught a fourth-grade, NGSS-aligned unit that focused on the external and internal structures of sea turtles and how an injury to one or more of those structures could impact their growth, survival, behavior, or reproduction. To enhance the unit, we added a nonfiction text, *Karl's New Beak* (Nargi & Popham, 2019), that examines the ramifications on survival, behavior, and reproduction faced by an Abyssinian ground hornbill missing most of his lower beak. At the end of the unit, each PST facilitated a discussion to elicit connections their students made between key ideas in the unit and text about how an injury to an animal impacts its survival, behavior, or reproduction. We share key elements of scenario design and how the PSTs prepared for, implemented, and debriefed from the MR simulated discussion. We also summarize and provide examples from the PSTs' reflections on how the simulated experience prepared them to facilitate the same discussion with their small groups of fourth graders. For teacher educators who have access to the Mursion system, we provide our scenario and recommendations on how to begin utilizing this technology.

Introduction

Mixed-reality simulated environments, such as Mursion, have been utilized for several years to help preservice teachers (PSTs) learn to facilitate challenging discussions (Ade-Ojo et al., 2022). By *mixed reality* (MR), we mean an environment that uses both real people and a digital environment to create the simulated experience (Bondie et al., 2021). For Mursion, the real person in the simulation is a highly trained simulation specialist who voices and controls student avatars who appear in real time as digital students on a computer screen. The PSTs facilitate a discussion with these student avatars in the same way that they would have a discussion with a person through Zoom or other video conferencing services. To use this MR simulated environment effectively, both the PSTs and the simulation specialist must come to

the experience having been informed about the context of the discussion, including the purpose of the discussion and the prior knowledge and experiences students bring to the discussion. This context is provided by a scenario.

Mursion and others have created multiple scenarios for PSTs to practice facilitating ambitious discussions in science and other subjects. For example, Levin et al. (2019) used a Mursion scenario for PSTs to facilitate a discussion about “Why does grass smell when it is cut?” ETS has created multiple discussions for PSTs to learn to facilitate argumentation discussions about the conservation of matter in a Mursion simulated classroom (e.g., Mikeska et al., 2021). These scenarios typically serve to hone PSTs’ science discussion facilitation skills in preparation for future classroom discussions. What makes the innovation that we describe in this article unique is that we designed a scenario that emulated an ambitious discussion that PSTs would be facilitating in their field placement. In other words, we used backward design (Wiggins & McTighe, 2005), beginning with the discussion that PSTs would facilitate in their field placement, to craft our scenario. After facilitating the discussion in the MR simulated environment, the PSTs later facilitated the discussion with their students in the field placement. In what follows, we describe the field placement, the Mursion MR simulated environment we used, our scenario development process, the implementation of the simulated discussion sessions, and the PSTs’ reflections on their discussions with student avatars and students in their field placement.

Field Placement Course

Teaching Science in the Elementary School is a 3-credit course for PSTs in their third year of the elementary education program at Towson University (TU). The main component of the course is the field placement in which PSTs teach a single unit of instruction in an elementary school spanning 10 to 12 weeks of the semester in 1-hour-per-week lesson increments. For the remaining hours of this course, the PSTs learn best practices in science teaching and learning, learn to teach field placement lessons, and prepare for and debrief from instruction. This course, described in greater detail in an article in this journal by Sandifer et al. (2020), involves each of the PSTs teaching unit lessons to a small group of elementary students. In the spring 2022 course that is the focus of this article, 12 PSTs were spread across four fourth-grade classrooms with three PSTs in each classroom. Each PST taught seven or eight students and coplanned as part of a classroom team with the two other PSTs assigned to the same classroom.

Our field placement represents an approximation of practice for learning to teach science because it provides a scaffolded environment in which there is increased support and reduced complexity (Schutz et al., 2018). We reduce complexity for and provide support to our PSTs by spacing lessons a week apart and having PSTs teach a small group of students rather than a whole class. We also require that the classroom teacher be present during instruction to handle significant classroom management issues and provide substantive

feedback. Further, teacher educators and peers assist with planning, implementation, and reflection. With these scaffolds in place, our hope is that PSTs can learn to focus on their students' contributions and how they are making sense of science and engaging in the *Next Generation Science Standards* (NGSS) Science and Engineering Practices (NGSS Lead States, 2013). We also aim for the field experience to help PSTs learn high-leverage practices (HLPs) with particular emphasis on HLP 1, "Leading a Group Discussion" (TeachingWorks, 2023). In this HLP, "the teacher and students work on specific content together, using one another's ideas as resources . . . to build collective knowledge . . . and to allow students to practice listening, speaking, [and] interpreting" (TeachingWorks, 2023).

Approximations of practice such as this field placement are part of practice-based teacher education (PBTE), which includes "learning core practices through multiple opportunities to rehearse teaching" (Stroupe et al., 2020, p. 9). The broad idea encompassing our field placement is that it is meant to prepare PSTs for the science teaching they will do during their student teaching year and beyond. Our aim is for the skills they develop to transfer into other contexts that are more complex, address different content, or otherwise differ from this practice environment. That said, we saw an opportunity for another approximation of practice to help prepare our PSTs for a specific and challenging group discussion in their field placement.

The notion of using approximations of practice to prepare PSTs for their field experiences is not new (e.g., Lampert et al., 2013; Masters, 2020; Benedict-Chambers et al., 2020). For example, Masters (2020) found that using teaching rehearsals helped prepare PSTs in her science methods course for ambitious science teaching practices (e.g., helping students to analyze and interpret data) in their field placements. These rehearsals are similar to peer teaching experiences in which one or more PSTs play the role of the teacher and other PSTs and the teacher educator play the role of students. However, teaching rehearsals add the benefit of real-time coaching and feedback and the ability to pause, get help, revise, and restart the lesson.

The MR Simulated Classroom Environment

Mursion MR simulated environments represent other approximations of practice that have been used at TU since 2017. Our work utilizes Mursion's upper elementary classroom environment. This environment (Figure 1) consists of a small classroom of five student avatars, Mina, Will, Jayla, Emily, and Carlos, who appear on a computer screen in front of the PSTs on the Zoom platform.

Figure 1

Mursion Upper Elementary Avatars

As mentioned in the introduction, the avatars—in this case, all five avatars—are played in real time by a simulation specialist, also called an interactor or a human-in-the-loop (Bondie et al., 2021). This individual, often having a background in theatre arts, is in a location separate from the PSTs and voices and controls each of the avatars through Mursion software and hardware, including an Xbox controller, headset, and microphone connected to a gaming computer system. The simulation specialist can see the PSTs facilitating the discussion as well as instructional tools (e.g., a whiteboard). Simulation specialists receive extensive training on how to use Mursion, including how to voice and move the avatars, apply facial expressions to them, and have them converse with one another.

Research on the affordances of using MR simulated classroom environments to support PSTs' learning how to facilitate discussions is growing in science and other fields (e.g., Dieker et al., 2014; Mikeska et al., 2019; Mikeska & Lottero-Perdue, 2022). This approximation of practice is not meant to replace field placements and other teaching experiences with students but rather to enhance PST learning, particularly the discursive aspects of teaching science. As such, it represents another tool in the teacher educators' metaphorical toolbox to support PSTs in learning to teach science. The MR simulated classroom environment enables PSTs, supported by their teacher educators, to use talk moves to encourage student reasoning and sensemaking (Michaels & O'Connor, 2012) and to listen to students' ideas and be responsive to their contributions (Richards & Robertson, 2016). For example, the Mursion upper elementary classroom has been used to allow PSTs

to practice facilitating argumentation discussions through which PSTs learn to elicit students' initial arguments, encourage students to critique one another's arguments, and support students' construction of a consensus argument (Mikeska & Howell, 2020).

To use the Mursion MR simulation system in teacher education, it is essential to prepare a scenario that meets the learning goals the teacher educator has for the PSTs and works within the constraints of the simulation. The scenario includes (a) what the PSTs will receive relevant to the discussion and prior to facilitating it with the student avatars and (b) what the simulation specialist needs to know to effectively and accurately respond as the student avatars within the discussion. At TU, scenario design and implementation are collaborative and iterative processes between the teacher educators and the simulation specialist.

Scenario Development

The first part of scenario development is deciding the nature of the discussion that PSTs will facilitate and determining the associated learning goals for PSTs and their student avatars within the discussion. In the spring 2022 section of the course that the second author, Cimino, taught, the PSTs taught 11 1-hour lessons of an 18-hour unit, Turtle Trouble, which is a fourth-grade unit within the Baltimore County Public School (BCPS) system in Maryland (BCPS, 2022). The unit focused on the following NGSS performance expectation (PE): "4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction" (NGSS Lead States, 2013, p. 38). One of the fundamental discussions the PSTs were to facilitate towards the end of that field placement aimed to have them practice HLP 1, "Leading a Group Discussion" (TeachingWorks, 2023), with the goal of formatively assessing students' comprehension and application of the key science ideas addressed in the Turtle Trouble unit.

The Turtle Trouble unit largely focuses on the external and internal structures of a loggerhead sea turtle, their functions, and how those structures work together to ensure its survival. It begins with a nonfiction scenario about Calypso, a green sea turtle whose front left flipper was amputated to prevent an infection from spreading. An essential question of the unit was: How does an injury to a plant or animal impact its survival, growth, behavior, and reproduction? To address this question beyond the context of sea turtles, Lottero-Perdue and Cimino integrated a reading of *Karl's New Beak: 3D Printing Builds a Bird a Better Life* (Nargi & Popham, 2019) into the unit. This book describes the challenges an Abyssinian ground hornbill faces because nearly half his lower beak has worn away. Answering the aforementioned essential question—both with respect to this book and the unit—served as the basis for an ambitious group discussion PSTs practiced in the MR simulated environment and facilitated with students in their field placement.

During the discussion, the PSTs would elicit from students (1) ways in which Karl's shortened lower beak affects aspects of his survival, behavior, and reproduction and (2) how these aspects relate to the survival, behavior, and reproduction of sea turtles with injuries, including

Calypso with her amputated flipper. Although the PSTs addressed growth within the Turtle Trouble unit—along with survival, behavior, and reproduction—growth was not addressed with respect to *Karl's New Beak* because Karl was fully grown by the time his lower beak had significantly worn away; thus, we de-emphasized the growth aspect of this standard for the purposes of this discussion. The goal of the discussion was for the PSTs to use questions and other prompts to elicit from the students these big ideas about survival, behavior, and reproduction with respect to both *Karl's New Beak* and the Turtle Trouble unit. During the discussion, the PSTs would also record students' ideas on a graphic organizer drawn on a whiteboard. Table 1 shows an example of a completed graphic organizer.

Table 1

Example Graphic Organizer Showing Connections That Could Be Elicited From Students

Key idea	Problems with Karl's beak	Connections to the Turtle Trouble unit
Survival	• Karl's beak injury = can't eat insects and mammals • Zoo staff must feed him	• Turtle beak injury = can't tear and crush food • Could lose weight and die
Behavior	• Can't nibble and hunt for food which could make him bored	• Injured beak or flipper = can't hunt for food • Injured beak means can't smell so can't escape from predator
Reproduction	• Can't gather food for his family. • Not as attractive to mates	• If can't hunt for food, can't find a mate • Can't use smell to attract a mate

For the PSTs to be able to facilitate this discussion with the student avatars prior to them facilitating it with students, we set out to design a scenario for the Mursion MR simulated classroom environment. Our collaborative work was strengthened by our varied expertise and roles. Lottero-Perdue has extensive experience teaching the course as well as experience writing, using (as a teacher educator), and delivering (as a simulation specialist) science and engineering scenarios for Mursion MR simulated classrooms. Cimino also has substantial experience teaching the course and has guided her PSTs in the internship course to teach the Turtle Trouble unit over multiple semesters. The simulation specialist for this scenario, Brandeberry, is the lead simulation specialist for the university's College of Education and has considerable experience coauthoring and implementing multiple scenarios. At TU, it is typical for the scenario writing team to include one or more teacher educators who are experts in PST content and pedagogy and the university's lead simulation specialist. The scenario development process is iterative and collaborative in nature and is guided by standardized templates.

The scenario we developed, “Connecting Bird Beaks and Sea Turtle Flippers: Impacts on Animal Survival, Behavior, and Reproduction,” is written in the template-based format that we use at TU (see Appendix A). It includes standards for the PSTs (HLP 1; TeachingWorks, 2023) and the avatar students (PE 4-LS1-1; NGSS Lead States, 2013, p. 38). It also includes the portion of the scenario that the PSTs receive, which we refer to as the PST-facing vignette. This vignette informs the PSTs that prior to the discussion, the student avatars engaged in smaller group discussions regarding the impact of Karl’s shortened lower beak and wrote their ideas on group whiteboards. It states that their objective, as the students’ teacher, was for students to address how Karl’s beak impacts his survival, behavior, and reproduction. The PSTs receive the student learning objectives shown in Figure 2. These objectives are also summarized in the completed graphic organizer in Table 1.

Figure 2

Student Learning Objectives for the “Connecting Bird Beaks and Sea Turtle Flippers” Scenario

Objective 1: Identify the ways in which Karl’s shortened lower beak affects aspects of his survival, behavior, and reproduction as discussed in the book *Karl’s New Beak* (Nargi & Popham, 2019). Specifically, Karl’s shortened lower beak:

- Impacts his survival by making it difficult for him to eat,
- Impacts his behavior by making it difficult for him to hunt, and
- Impacts his ability to mate/reproduce because he is unable to provide food to his family, making him less desirable.

Objective 2: Connect these aspects to prior learning about animal survival, behavior, and reproduction in the Turtle Trouble unit.[a] Specifically, in the unit, students learned the following.

- **In general,** the structures of a sea turtle have specific functions to allow for their survival, behavior, and reproduction. Students learned this from an investigation in which they conducted research and made a model of a turtle.
- **A sea turtle’s beak** has a sharp cutting edge used to tear and crush food and contains nerves to help them smell predators or potential mates. An injury to the beak could impact their survival by making it difficult to eat, hunt, and attract a mate or making them more likely to be eaten by predators.
- **A sea turtle’s plastron (bottom shell)** is colored such that it helps to camouflage or hide the turtle’s body in the water, preventing their prey or predators from seeing them when they look up from below. An injury to the plastron could make it more difficult for them to catch and eat their prey and make it easier for predators to find and eat them.
- **A sea turtle’s carapace (top shell)** protects the turtle’s internal organs and is covered with scutes that help it blend in with the bottom of the sea (when viewed from above). An injury to the carapace could damage internal organs or make it easier for predators to find and eat them.
- **A sea turtle’s flippers** allow the turtle to dig and swim. An injury to their flippers could impact their ability to dig, swim, hunt, and reproduce.

[a] The Turtle Trouble unit is a fourth-grade science unit taught in Baltimore County Public Schools (BCPS, 2023).

Additionally, the PST-facing vignette provides evidence of student work for both avatar groups: Mina and Will (Group 1) and Jayla, Emily, and Carlos (Group 2). In the scenario, the PSTs learn that before the discussion, students had already worked in their groups to write their ideas on a whiteboard regarding the impact that Karl's shortened lower beak has on him. The information on those whiteboards, shown in Figure 3, is included in the PST-facing vignette. Of course, we generated this fictitious work, purposefully having each group identify a slightly different range of ways that Karl's lower beak impacts important aspects of his survival, behavior, and reproduction. Mina and Will focus on Karl's challenges with eating, which impact his survival, while Jayla, Emily, and Carlos focus on Karl's inability to hunt, with hunting as a key behavior or activity of hornbills. Neither group focused on how Karl's shortened lower beak may impact his ability to reproduce. This omission was intentional to provide an opportunity for the PSTs to address reproduction in their discussions even though neither student group attended to it in their prior work.

The PST-facing vignette includes other important information, including the goals for PSTs as they facilitate the discussion. Broad goals for the discussion include encouraging students to listen actively and respond to other's contributions and tracking student ideas throughout the discussion by using a graphic organizer. More specific discussion goals are as follows.

- Elicit each group's initial ideas about the impact of Karl's shortened lower beak (Nargi & Popham, 2019).
- Encourage each group to elaborate upon those ideas.
- Prompt students to consider an impact of Karl's shortened lower beak related to reproduction *not* included in the groups' initial ideas.
- Prompt students to connect these ideas to key ideas addressed in the Turtle Trouble unit (BCPS, 2023).

Figure 3

Student Avatar Work on Whiteboards

Mina and Will	Jayla, Emily, and Carlos
• It's hard for Karl to eat! • He can't eat like other ground hornbills. • He has to eat meatballs and mice the Zoo gives him. • Zoo staff weigh him to make sure he is eating enough.	• Karl can't hunt for food like other hornbills do. • Other hornbills roam up to 7 miles a day to catch things like spiders and lizards!!! • Hunting is important because it keeps hornbills busy and allows them to catch their own food.

Lastly, the scenario includes detailed information about how the simulation specialist will respond during the discussion. We refer to these materials as simulation-specialist-facing materials or sim-facing materials for short. These materials contain essential information for

the simulation specialist about the student avatars and how they would respond. For example, if a PST were to ask Jayla, Carlos, and Emily to elaborate on the ideas shown on their whiteboard, the sim-facing materials suggest that any one of them might explain that hunting is a behavior, so Karl couldn't act like other hornbills did, or because Karl couldn't hunt, he couldn't find his own food. Other possible responses to PSTs' questions, including questions about connections between Karl's beak and the Turtle Trouble unit, are provided in the sim-facing materials.

The sim-facing materials also provide multiple suggestions about how the student avatars—through the simulation specialist—would respond if the PST does not attend to the PST objectives as effectively. For example, if the PST asks closed-ended questions, the avatars are instructed to respond with one-word or otherwise short answers.

To prepare for the implementation of the scenario, the simulation specialist reviews the materials and practices acting out the roles of the avatars independently. Additionally, the simulation specialist practices the discussion in a session with the teacher educator acting as the discussion facilitator. This provides an opportunity for the simulation specialist and teacher educator to practice and finalize the PST- and sim-facing materials prior to implementation.

Implementation

Fishbowl Format

We implemented the discussion in a *fishbowl* format (Cummings, 2015). In this format, one or more PSTs facilitate the discussion while other PSTs observe and lend support. PSTs in both roles, those facilitating and those observing, learn from the experience (Reinking, 2018; Tricio et al., 2019). We had the class of 12 PSTs remain in their field placement classroom teams. Each three-person team prepared to facilitate a discussion with one PST volunteering to be the lead facilitator. While one teammate led the discussion, the other two would listen actively and assist.

Preparing to Facilitate the Discussion With Student Avatars

One week prior to facilitating their discussions with the Mursion upper elementary student avatars, the PSTs read and discussed *Karl's New Beak*, studied the PST-facing vignette, reviewed key science ideas presented in the Turtle Trouble unit, and had an opportunity to ask their instructor, Cimino, questions about the book and scenario. They then met in their classroom teams to cocreate a discussion frame, a document to help plan for the discussion (see Appendix B). The frame prompted each group to develop an outline of their discussion, including how they would launch, orchestrate, and close the discussion—the major components of a group discussion (TeachingWorks, 2023). On another part of the frame, PSTs brainstormed multiple questions they would ask to (1) elicit each student group's ideas

they wrote on their whiteboards (according to the scenario), (2) encourage students to share how Karl's beak impacts his ability to find a mate, (3) connect to the Turtle Trouble unit, and (4) encourage students to talk to one another. See Table 2 for examples of prompts for each of these categories from the PST groups. Additionally, the PSTs completed the graphic organizer (see Table 1) during the discussion.

Table 2

Sample Prompts From Each of the Four Prompt Categories in Discussion Frames

Prompts to	Examples
Elicit the ideas that each student group wrote on their whiteboards.	• "We will have each group share their ideas from the whiteboards, and we will restate them so the other students can hear and understand the group's ideas." (Team 1) • "Have students elaborate on what the other groups wrote on their whiteboards." (Team 2)
Encourage students to share how Karl's beak impacts his ability to find a mate.	• "Take a moment and reflect back on the information from our text as well as the insights you all gained from the other group. [*Wait time*.] How else did Karl's beak impact him, and why do you think so? Do you agree or disagree with what your classmate said?" (Team 3) • "So, we've listed examples of how Karl's survival and changes in his behavior are impacted. Can anyone think of another way?" (Team 4)
Connect to the Turtle Trouble unit.	• "What do we know about a [sea] turtle's survival, behavior, and reproduction? How is it similar or different from Karl's ability to survive, behave, and reproduce?" (Team 2) • "Does injury to an animal's structure impact one or multiple areas of an animal's life . . . ? Provide evidence from our Turtle Trouble unit and Karl's New Beak book to support your answer." (Team 3)
Encourage students to talk to one another.	• "Jayla, Emily, and Carlos, what questions do you have for Mina and Will on their claim that the zoo staff weighs him to make sure he is eating enough?" (Team 1) • "I want you all to turn and talk with your group and compare both the boards and find similarities that both groups came up with?" (Team 4)

Note. For each prompt category, two representative examples were selected. Not all prompts submitted by students aligned well with the categories.

MR Simulated Sessions

The sessions occurred on a day when the school system was closed for professional development 2 weeks prior to the PSTs facilitating the discussion with their students. For the first half hour of class, the PSTs met in the regular classroom to address other course content and to finish preparing for their discussions. At the scheduled time, two classroom teams (Teams 1 and 2; half of the class) proceeded to a room in which a computer system with a large screen was set up, while the other two classroom teams (Teams 3 and 4) stayed

in the classroom working on preparations for their field placements. In the first session, Team 1 facilitated the discussion first (one PST lead the discussion with assistance from their teammates) while Team 2 observed, and then the teams switched places. Then, Teams 1 and 2 returned to the regular classroom, and Teams 3 and 4 took turns facilitating the discussion. Figure 4 shows one PST leading the discussion with three PSTs from the other team observing (the two team members supporting the PST and the whiteboard are not shown in this picture).

Figure 4

PST Facilitating a Simulated Discussion Using the Fishbowl Format

Note. The PST from one team (standing) leads the discussion while the members of another team (seated) observe. Not pictured are the two supporting PSTs from the teaching team and the whiteboard.

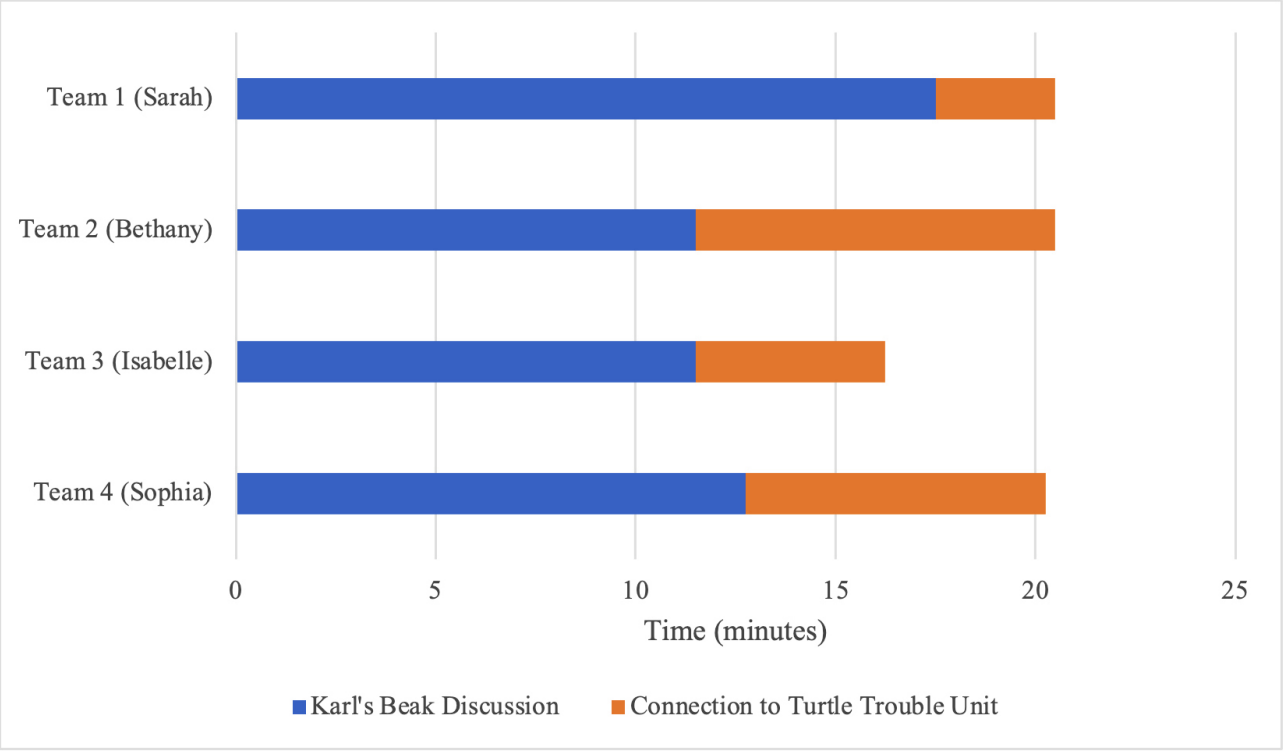
Each of the four discussions was video recorded through Zoom. The video captured the student avatars as well as the lead PST and the whiteboard on which the PSTs completed the graphic organizer with student input. The lead PST facilitated the discussion using their discussion frame as a guide while their teammates followed along. Several times across both sessions, the lead PSTs asked their teammates for support about how to proceed. The instructor did not interject with coaching moves during the discussion but was available to offer help if requested by the teams. Although we are aware of the benefits of teaching

rehearsals with coaching by the teacher educator (see Benedict-Chambers et al., 2016; Lampert et al., 2013; Masters, 2020), we opted not to interrupt the flow of the PSTs' discussion given that, for 75% of them, this was their first experience in the MR simulated classroom environment.

Although we aimed for the discussion to be about 15 minutes, we noticed during the discussions that PSTs seemed to need more time to address the connections between the book and the Turtle Trouble unit. Three were about 21 minutes long, and one was about 16 minutes (Figure 5). Across the discussions, lead PSTs spent most of the time eliciting ideas about the book and spent the remainder on connections between the book and the Turtle Trouble unit. All lead PSTs were able to elicit ideas about survival, behavior, and reproduction with respect to the book, and some were able to address one or more of these topics with respect to the unit.

Figure 5

Virtual Simulated Discussion Time for Each PST Group



PSTs who led the discussions elicited ideas from multiple students using a variety of talk moves, including asking for elaboration or reasoning, revoicing, asking students to restate others' contributions, and asking if students agreed or disagreed with one another (Michaels & O'Connor, 2012). Some of these moves (in ***bold italics***) are evident in the following exchange between the Sarah, the PST who led the discussion for Team 1, and Will and Mina, the student avatars in Group 1.

Sarah:	And that was your last one. Yes. So, Mina and Will, . . . for the details that you put, what category would that fall under? . . .
Will:	I think probably mostly survival.
Sarah:	You would think—the survival category, and why do you think that, Will? **[*Asking for elaboration or reasoning*.]**
Will:	Because, like, the eating and stuff. He really. If he doesn't eat, he—he's not going to live.
Sarah:	Right. So, he has a hard time eating. **[*Revoicing*.]** [*Writes on graphic organizer on board*.] Mina, do you also agree? **[*Asking about agreement*.]**
Mina:	So, yes, I think that it's mostly about survival . . . . Yeah, yeah.
Sarah:	Do you want to add anything else to that? **[*Asking for elaboration*.]**

As in the above exchange, the lead PSTs tracked students' ideas during the discussion by recording them on the graphic organizer, often asking the students where their contributions should be placed categorically (e.g., asking if their contribution was an example of the impact of Karl's or the turtle's injury on survival, behavior, or reproduction).

At times, PSTs used turn-and-talks to promote student-to-student talk. For example, Isabelle (Team 4) prompted a turn-and-talk after eliciting ideas about how Karl's shortened lower beak impacted his survival and behavior: "So I want you guys to take this time right now and discuss with your groups on how it [Karl's shortened lower beak] might affect his ability to find a partner and mate." Note that the content of those turn-and-talks is not comprehensible in the MR simulated classroom, sounding like a murmur among the students. That said, the intent of their use by PSTs was to create time for students to talk to one another about a topic, which is then followed by the PST inquiring about what the students shared.

Reflecting on the Mixed-Reality Simulated Session

After the second session was over, the whole class met again in their regular classroom to debrief. The debriefing focused mainly on how the PSTs felt about the simulated discussions and whether these were helpful to them and why. Overall, during this verbal debrief, the PSTs mentioned both positive and negative aspects of their experiences in the MR simulated classroom environment. These ideas were echoed and shared in greater detail in the written reflections they wrote after facilitating the discussion with their students, which is discussed in the following section.

Preparing for and Facilitating the Same Discussion With Students

The PSTs' facilitation of the discussion with students was a component of their eighth lesson in their field placement. For this and all other lessons in the field placement, each teaching team submitted a Lesson Plan Assignment (or LPA). This LPA included the read aloud of *Karl's New Beak* as well as the discussion that was practiced in the MR simulated classroom. Prior to submitting their LPAs, we asked the PSTs to review their video-recorded discussions in the MR simulated classroom environment. Their LPAs included student actions and teacher questions for each section of the lesson. Student actions for the discussion included that students would "share their thoughts" with other students (Team 3), identify where on the graphic organizer an idea shared by students about Karl belongs (i.e., in the survival, behavior, or reproduction category; Team 2), and share similarities and differences between Karl and Calypso (Teams 1 and 4). Teams provided between three and seven teacher questions, some of which had multiple parts, to use in the discussion in this part of the LPA (Table 3). All 12 PSTs facilitated the discussion with students in their field placement. We did not collect data regarding their teaching at the school.

Table 3

Teacher Questions Provided in Lesson Plan Assignments for the Discussion With Students

Team	Teacher questions
Team 1	• After reading this book, we read that Karl needed to tilt his head sideways to eat; what do you think Calypso had to do with digging? • How did Calypso's missing flipper impact her ability to find a mate? • How did Calypso's missing flipper impact her behavior and how she interacted in her environment?
Team 2	• Would that fall under survival, behavior, or reproduction? Why? • Does everyone agree? • What are some ways Karl adapted to his environment without his beak? • How did Karl learn how to use his new beak? • What impact did Karl's broken break have on him? In regards specifically for survival? Behavior? Reproduction? • How does the book relate to what we have learned so far in the Turtle Trouble unit? • How does Karl relate to Calypso?
Team 3	• How is life different for Karl because he lives at the zoo rather than in the wild? • Is Karl's life harder or easier compared to the hornbill that lives in the wild? • What is life like for the injured hornbill in the wild? • What do both hornbills have in common? • What role can humans play in injured animals' lives? Provide an example. Also, what areas of life do humans impact? How? • How can we relate this to Calypso? Explain how Calypso might've experienced life differently compared to a sea turtle in the wild with the same injury as her.
Team 4	• Who remembers the turtle with only three flippers? • A while back in our Turtle Trouble unit, we talked about Calypso, the turtle with the missing flipper. What is a connection you can make between Calypso and Karl? Turn and talk with a partner. • How are Karl and Calypso similar? Any differences between the two animals? • Are the circumstances as to how Calypso lost her flipper the same as how Karl's beak got damaged? • Is the way Karl grow[s], survive[s], and reproduce[es] similar to turtles? • How does our discussion about Karl's beak relate to the topics we have talked about during our Turtle Trouble unit? If no response: Karl's beak injury affects his ability to eat food. How does this connect to our discussion about the interior parts of a turtle?

PSTs' Reflections on Their Discussions With Student Avatars and Students

After facilitating the discussion with students in their field placement, each PST responded to the following prompt in a written reflection: "How did preparing for and leading (or observing) the discussion with the upper elementary avatars help you lead the actual discussion with

your students for LPA8? If it wasn't helpful, explain why it wasn't helpful." We qualitatively analyzed the PSTs' reflections to identify distinct reasons the PSTs provided about why the MR simulated classroom environment was helpful or not helpful to their facilitation of the discussion with students in their field placement. This process was iterative with respect to the generation of helpful and unhelpful codes and their application to the written reflections (Saldaña & Omasta, 2018). All PSTs provided reasons why the discussion with student avatars was both helpful and unhelpful in preparing to facilitate the discussion with their students. Half of the PSTs also provided suggestions about how the MR simulated teaching experience could be improved.

Most PSTs found the MR simulated experience to be a helpful precursor to the discussion with their students. Based on the number of reasons that PST found the experience helpful vs. unhelpful, eight of the 12 PSTs identified more reasons for the simulated experience being helpful, two identified an equal number of reasons for each side, and two identified more reasons for it being unhelpful. We identified a total of 67 reasons and suggestions across the 12 PSTs' reflections. Of those, 63% were reasons why the MR simulated experience was helpful, 29% were reasons why it was not helpful, and 9% were suggestions for improvement.

Table 4 shows reasons mentioned by two or more PSTs why the simulated experience was helpful. The two most frequently mentioned ways in which it was helpful were that the experience helped them to practice and prepare for the discussion with their students (mentioned by 75% of PSTs) and try out and refine questions for use with their students (75%). Table 5 shows reasons mentioned by two or more PSTs why the MR simulated experience was not helpful. The most frequently mentioned ways in which it was not helpful were that the student avatars responded or behaved differently than their students (75%) and that the length of the discussion or the expectations for the LPA differed from the MR simulated environment to their field placement (33%).

Table 4

PSTs Reflections on How the Mixed-Reality Simulation Was Helpful (*n* = 12)

Mixed-reality simulated discussion helped PSTs to:	Number of PSTs	Two example statements from reflections
Practice/prepare for the discussion with real students	9 (75%)	• "It was nice to practice before we actually did the discussion with actual students so we can try out different questions and strategies to teach. We were able to do a trial discussion and make sure everything is perfect before we did it with real students." (Brianna, Team 2) • "Working with the avatars was a cool experience that helped me prepare for working with my students." (Kayla, Team 4)
Try out and refine questions prior to the discussion with real students	9 (75%)	• "I was able to see what questions the students were more interested in and wanted to respond to. It also helped with the wording of my questions because I was able to see if the avatars were confused or not with how I asked certain things." (Bethany, Discussion Leader, Team 2) • "Using the avatars helped me prepare for the actual lesson when it came to the questions I asked my students. For instance, it made me extend my questioning habits and use questions like, 'Can you extend on your thoughts? . . . These questions were more specific and did help me in the actual conversation because I found myself asking these questions more often than I have in other sessions." (Raven, Team 3)
Get a sense of the types of student responses and questions they might get from real students	7 (58%)	• "By working with the avatars, we had ideas written down by the students on the whiteboard that would give us common answers that we may see in our classroom with the real students." (Alexandra, Team 1) • "Leading the avatars helped me get a better understanding of the students' responses and how they think." (Isabelle, Discussion Leader, Team 3)
Learn from watching their peers facilitating the discussion	2 (17%)	• "I enjoyed being able to observe another student in our class lead their avatars . . . as it gave me a different teaching perspective. I am used to my group and our teaching styles, so it was nice to watch another group and listen to how they lead their classes." (Rebecca, Team 1) • "Being able to also observe another group after we did our discussion with the avatars helped us see other things we can do. For example, when we planned ours, we did not include a turn-and-talk, but the other girl groups we observed did, and then we did one when we did the discussion with our students." (Kara, Team 2)
Feel more comfortable and prepared for the discussion with real students	2 (17%)	• "Leading the discussion with the avatars definitely made me feel more comfortable doing it with real students . . . I felt less nervous leading a discussion with the students because of the experience I had with the upper elementary avatars." (Isabelle, Discussion Leader, Team 3) • "I felt more prepared going into teaching it because I had already basically seen the lesson taught once before." (Jenna, Team 4)
Plan for the lesson with the real students	2 (17%)	• "I was able to 'map out' the structure of the entire lesson." (Sarah, Discussion Leader, Team 1) • "I think it was also helpful to see the flow of the lesson and if it naturally flowed or not during the avatar session so we could tweak it if need be . . . . We noticed the progression of things that we initially planned worked out well during the simulated discussion." (Jenna, Team 4)

Note. The only categories included in this table are those mentioned by two or more PSTs.

Table 5

PSTs Reflections on How the Mixed Reality Simulation Was Not Helpful (*n* = 12)

Mixed-reality simulated discussion was not helpful because:	Number of PSTs	Two example statements from reflections
Student avatars respond or behave differently than real	9 (75%)	• "As I went back to watch the video with the avatars, I noticed that the avatars enjoyed working in smaller groups to discuss questions.

Note. The only categories included in this table are those mentioned by two or more PSTs.

Two PSTs (17%), who had experienced peer teaching in prior classes, suggested that peer teaching was better because, they argued, PSTs knew how to play students more accurately. PSTs also suggested giving each PST the opportunity to lead all or part of the discussion, having the avatars' behavior "set to difficult" to emulate real classrooms, only using the MR simulated classroom if the course was fully online, and having the simulated discussion occur closer in time to when PSTs would facilitate the same discussion in their field placement.

Implications and Our Path Forward

This experience and the responses from the PSTs, as well as other work at TU and elsewhere, have motivated us to continue developing discussion scenarios that align with the field placement units. We are privileged to have access to the Mursion system at TU and to collaborate with Brandeberry, TU's dedicated simulation specialist who helps create and implement these simulated approximations of practice to benefit PSTs across multiple classes. However, if readers are at an institution where these resources are not available, it is possible to rehearse discussions in a similar fishbowl model with peers playing the roles of students (e.g., Benedict-Chambers, 2016). (Note that this format was suggested by two PSTs in the present work.) This is yet another approximation of practice that we can use in our teacher-educator toolbox to support PST learning and practice. In this case, however, resources need to be developed not only to help PSTs prepare to facilitate discussions as the lead teacher but also to prepare them to be students in the scenario.

For those with access to the Mursion system, we have provided our scenario in the Appendices. Some readers may be at institutions that have access to Mursion but have yet to use it. For those individuals, we recommend creating scenarios collaboratively, as we have described here. We also recommend that teacher educators and simulation specialists practice discussions prior to implementing them not only to troubleshoot any technical challenges that may arise but also to further refine the PST- and sim-facing materials. Additionally, it is wise to help frame the purpose of the simulations for PSTs. Some of this framing might include that MR simulated approximations of practice:

- Can help PSTs learn to facilitate discussions in a low-risk environment in which students are not being impacted;
- Enable PSTs to focus on a challenging part of their practice without having to attend to other distractions that go hand in hand with real settings (e.g., classroom management);
- Are meant to be one of the many tools that teacher educators use, including other approximations of practice such as field placements, to help PSTs learn to teach; and
- Utilize a highly trained human in the loop to play the avatars (not a "computer student" controlled solely by artificial intelligence, as some participants suspected).

Although engaging in a classroom simulation like Mursion may feel unusual for many PSTs, simulations have been around for a long time in various fields in which practicing in a real setting could cause detrimental consequences (e.g., aviation and medicine).

We plan to continue to create new MR simulated classroom scenarios to help our PSTs prepare to facilitate challenging discussions that align with the units they are teaching in their field placements. For example, at the time of this writing, Cimino implemented the *Karl's New Beak* scenario in the MR simulated classroom environment with another cohort of PSTs prior to each of them facilitating the discussion with their field-placement students. Unlike the prior cohort, all 19 PSTs had worked with student avatars in the MR mixed classroom environment during their time at TU and were aware that a sim specialist was playing the role of the student avatars. Improvements included allotting 20 minutes for each discussion and pausing the simulation for peer and instructor coaching. The ability to pause the discussion is a key feature of MR simulated environments that is mentioned by Straub et al. (2015). Cimino also asked each PST to use the Zoom recording to reflect on talk moves and questions their team's facilitator used that were most effective at eliciting thoughtful student responses.

We will continue to support the PSTs in our courses with multiple approximations of practice, including MR classroom simulations, to help them learn to facilitate ambitious discussions that promote critical thinking and encourage student-to-student talk. Through repeated practice in our methods courses and field placements, we anticipate that PSTs will grow in their skill and confidence in facilitating these discussions as they move on in our program and become teachers.

Supplemental Files

Lottero-Perdue_etal-Appendices-v8_i4_2023.pdf

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