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“Rahul is a Math Nerd” and “Mia Can Be a Drama Queen”: How Mixed-Reality Simulations Can Perpetuate Racist and Sexist Stereotypes

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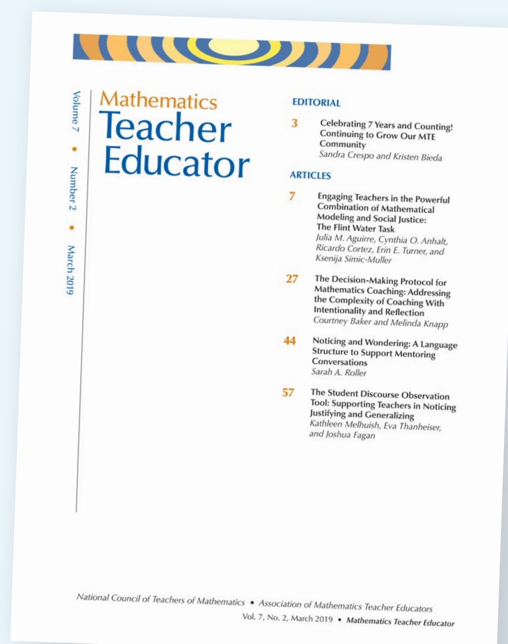
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NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS

“Rahul is a Math Nerd” and “Mia Can Be a Drama Queen”: How Mixed-Reality Simulations Can Perpetuate Racist and Sexist Stereotypes

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This article focuses on using simulations of practice in teacher education. We studied preservice teachers’ engagement with a popular simulations platform, which creates *mixed-reality simulations* of five digital avatars controlled by a single live interactor. Because simulations are only an approximation of real practice, our overarching goal was to understand how mathematical stereotypes might arise in simulated spaces. We used Discourse analysis to classify the stereotypes present and the EQUIP observation tool to understand how PTs made participation opportunities available. We found that the simulations might have perpetuated overtly racist and sexist stereotypes and that negatively stereotyped students were afforded lower-quality opportunities to participate. We discuss how to mitigate potential harm caused and offer guidance for redesigning more equitable and antiracist simulations. Our goal is to raise critical questions for our field around the use of simulations of practice.

Keywords: mixed-reality simulation; discourse analysis; equity; stereotype

Preservice teachers (PTs) benefit from authentic practice-based experiences during their professional preparation (Association of Mathematics Teacher Educators [AMTE], 2017; Ball & Forzani, 2009; Forzani, 2014; McDonald et al., 2013). *Simulations of practice* provide opportunities for teachers to try a variety of instructional methods; learn from their mistakes; and develop their teaching knowledge, skills, and practices (Girod & Girod, 2008; Grossman & Charmaraman, 2009). Simulations can occur fully in-person, with the instructor, fellow PTs, or trained interactors assuming the roles of students (Howell et al., 2019). Here, we focus on mixed-reality simulations, comprising a PT leading a discussion with digital avatar students controlled by a live interactor (Bondurant & Amidon, 2021; Mikeska et al., 2022).

Mixed-reality simulations[1] provide “on-ramps to professional practice” (Sweeney et al., 2018, p. 671), and are considered to provide a safe environment for PTs to practice complex interactions because they are not interacting with actual students (Dotger et al., 2014). Simulations grew in popularity during the COVID-19 pandemic and were endorsed by The American Association of Colleges for Teacher Education (AACTE) (2020). Fischetti et al. (2021) found that simulations helped PTs develop confidence, plan for diverse groups of learners, understand personalizing pedagogy, and engage with classroom management. Even in a postpandemic world, other barriers may exist (e.g., for students in rural areas, the high cost of field experiences) that make simulations a promising supplement to real field experiences (Mikeska et al., 2022).

Given the uptake of simulations, we believe it is critical for the field to grapple with unintended consequences that could arise from their use. In this article, we explore these potential issues in the context of a popular simulations platform. In this platform, a single individual serves as an interactor, resulting in the interactor portraying virtual students who have racial, gender, and disability identities that differ from their own. But could a single interactor—especially if it is one who is White and female—authentically represent complex and subtle racialized and gendered experiences in the mathematics classroom? Whether the interactor is following the prescribed protocol and portraying the avatars as designed in the simulation or adding in additional elements based on their personal perceptions or bias, could they reinforce problematic stereotypes about students of color that already permeate mathematics education (e.g., Shah, 2017)? Could such simulations work *against* the goals of a more socially just and antiracist schooling environment? These larger philosophical questions have yet to be taken up in the research literature. The present analysis focuses on these questions of crucial importance to the field, as the use of simulations is likely to remain, even in a postpandemic world.

The experiences of PTs engaging with simulations were studied over two semesters. Our analyses focused on the

1 For brevity, we use the term *simulations* to refer to *mixed-reality simulations* henceforth throughout this manuscript.

gendered and racialized behaviors portrayed in the simulations and, subsequently, how that may have affected PTs' engagement. Specifically, our investigation was guided by the following questions:

1. How did the mixed-reality simulations reinforce or disrupt dominant racial and gender Discourses in mathematics?
2. How did teacher candidates interact with the simulated students (e.g., through asking questions)?

To answer Question 1, we studied the avatars' visual appearance, written and spoken words, and behaviors. To answer Question 2, we used EQUIP (Reinholz & Shah, 2018) to code student–teacher interactions. Through these analyses, we push the field to think critically about the use of simulations.

Theoretical Framing

Race-Gender Discourses in Mathematics Education

To understand how stereotypes in mathematics can affect the teaching and learning process, we draw on a poststructuralist perspective. In poststructuralism, the abstract entity of Discourse comprises symbols, stories, language, and other cultural representations that produce the social world (Gee, 2014). Discourses create *subject positions*, defining what people can do within the Discourse (Sunderland, 2004). Even though they are immaterial, Discourses exert power over people by dictating what types of behaviors are deemed acceptable (Foucault, 1977). In this way, narratives are a key element of Discourses, because they define stereotyped behavior of how people *should* behave.

Broadly speaking, we draw on the conceptual framing of Shah and colleagues, who studied the interaction between societal Discourses and student opportunities to learn (Shah, Herbel-Eisenmann, et al., 2020). This framing highlights how broader racialized and gendered Discourses operate in subtle yet measurable ways, for example, when the Discourses silence Latinx women as a result of stereotypes positioning them as quiet and compliant (Niemann et al., 1994). In contrast, White and Asian men are positioned as intelligent, academically focused, and likely to succeed in mathematics (Reinholz, 2021; Shah, 2017). These framings have pernicious consequences, as we now elaborate.

Consider the narrative, "Asians are good at math" (Shah, 2019). This narrative creates an expectation that all Asian students should excel at mathematics, and those who do not are seen as anomalies or failures (Wu & Battey, 2021). The narrative simultaneously positions non-Asian students of color as bad at mathematics (Shah, 2017). Thus, even though this narrative is false, it reinforces dominant Discourses that non-Asian students of color—especially Latinx and Black students—are disruptive and unlikely to succeed in mathematics (Leyva et al., 2021). These Discourses produce material consequences in classrooms through mechanisms including low teacher expectations, limited opportunities to participate meaningfully, microaggressions, and stereotype threats (Larnell et al., 2014; Martin et al., 2017; McAfee, 2014). In this way, Discourses do not describe reality, but rather *produce* it.

These Discourses also intersect gender (Lubienski & Ganley, 2017; Voigt & Reinholz, 2020). White women are stereotypically characterized as innocent, whereas young non-Asian women of color are often seen as manipulative, violent, and hypersexualized (López & Chesney-Lind, 2014).[2] These problematic narratives can create a status quo that promotes the superiority of White and Asian men in mathematics. Even though these narratives are false, by contributing to the dominant Discourse of who can and cannot do mathematics, they reinforce a racist and sexist status quo. Notably, the material consequences of Discourses are not uniform across students and their intersectional identities (e.g., Black women face unique forms of gender oppression that White women do not; Gholson, 2016).

Equitable Participation

Classroom participation, typically defined through verbal talk, is a recurrent theme in the mathematics education literature (Hufferd-Ackles et al., 2004). Verbal participation is important for a variety of reasons. First, through explaining their thoughts, students develop deeper ideas about important disciplinary concepts (Chi et al., 1994). Second, verbal participation provides meaningful learning opportunities through opportunities to receive feedback from peers or the instructor (Reinholz, 2016). Third, opportunities to participate contribute to a sense of belonging and self-concept as a competent mathematician (Lewis et al., 2016; Nasir, 2002). Thus, considering who gets to participate and how is a key element of promoting racial and gender equity in mathematics.

However, there is a body of research showing that minoritized students often do not receive a fair share

2 As noted above, Latinx women are sometimes characterized by "good girl" stereotypes, as they can be perceived as "passive" or "babymakers" (Niemann et al., 1994).

of participation/learning opportunities (Ernest et al., 2019; McAfee, 2014; Reinholz et al., 2022; Reinholz & Wilhelm, 2022). Given the connection between participation and student performance (Banes et al., 2019; Ing et al., 2015), a lack of participation opportunities can further contribute to marginalization and reduced performance. Thus, classroom talk can be a key site for instructional intervention to improve educational equity. Nonetheless, we recognize that other forms of participation (e.g., listening, gesture, using manipulatives) also create opportunities for learning, but they are beyond the scope of this study. In other contexts, we used the EQUIP tool to study nonverbal contributions (Yeh et al., forthcoming).

The EQUIP tool describes classroom participation at the level of an individual student, and with the use of demographic information, aggregate analytics can be developed about various groups of students (e.g., Black women; see Reinholz & Shah, 2018). These analytics allow EQUIP to answer questions such as: What percentage of high-level questions were asked to Latinx boys? Or how often did Asian students get called on? Such analytics can be used for both research and professional development (Reinholz et al., 2020).

The basic unit of analysis in EQUIP is a contribution. A single student contribution consists of all student talk (and corresponding teacher talk) that is uninterrupted by another student. Each contribution is coded along several customizable discourse dimensions. Dimensions such as the length and type of student talk, teacher questions, and teacher responses to questions have been commonly used in prior studies (Bondurant, 2020; Bondurant & Amidon, 2021; Reinholz et al., 2019; Shah, Christensen, et al., 2020). In this article, we focus on Student Talk Type and Teacher Solicitation Type because of the affordances these dimensions provide for understanding both teacher and student contributions to discourse patterns.

The Student Talk Type is controlled by the interactor and therefore provides a strong indication of whether the simulation experience is reinforcing or disrupting racial and gender stereotypes. Students who provide justifications for their answers demonstrate a deeper understanding of the material (Chi et al., 1994; Henningsen & Stein, 1997; Lombrozo, 2006). EQUIP classifies student talk into the following hierarchically levels: Why, How, What, and Other (Braaten & Windschitl, 2011; Henningsen & Stein, 1997). *Why* talk provides an explanation or justification about why the mathematics works (e.g., “I don’t think there is a real-valued solution, *because* there is a negative under the square root”). *How* talk describes a process (e.g., “My process involved completing the square”). *What* talk provides an answer or recalls a fact (e.g., “My answer was seven”). *Other* talk consists of questions or statements that do not fit the why-how-what hierarchy (e.g., “Can you explain how you got that answer?”).

The Teacher Solicitation Type can regulate how challenged students will be and may provide evidence of the teachers’ beliefs about the students’ abilities. The cognitive demand of a task can be altered by the type of questions the teacher asks (Boyd & Rubin, 2002; Henningsen & Stein, 1997). Although asking a high-level question does not guarantee students will engage at a high level, low-level questions rarely result in high-level engagement (Smith & Stein, 2011). We used EQUIP to code the PTs’ solicitation type into the following hierarchical levels: Why, How, What, and Other. These solicitation types generally mirror the student talk types. For example, a *why* solicitation asks students to justify the math (e.g., “How do you know seven is correct?”), a *how* solicitation asks students about the process (e.g., “What steps did you take to get to your answer?”), a *what* solicitation asks for an answer (e.g., “What answer did you get?”), and an *other* solicitation is anything that does not fall into these three categories.

Method

Author Positionality

In keeping with the poststructuralist perspective we adopted for this study, we acknowledge that our subjective positionality shapes our understanding of and outlook on the world, including our analysis and interpretation of data in the study. Both authors of this manuscript identify as White (one woman and one nonbinary person), and the first author was the teacher educator who designed the task sequence that we analyze below. The genesis of this work was the first author’s use of the platform provider’s software to provide field experiences for her students throughout the COVID-19 pandemic. Although the first author was initially hopeful about the use of the simulations to provide meaningful student learning experiences, over time, possible pitfalls of such software became evident. As a result, she contacted the second author, a creator of the EQUIP tool, to study and interrogate virtual simulations in a more scholarly way, beyond gut impression. Although we use the platform provider’s software to ground this work in empirical data, overall, our goal is to bring up critical questions for the field as we grapple with virtual and hybrid environments in a pandemic and postpandemic world.

We recognize the limitations of an authorship team composed solely of White scholars, and as such, made effort to draw on the work of critical scholars of color in our framing and conceptualization of the work. Nonetheless, we recognize that there are facets of the simulations and stereotyped behavior that we may not have picked up on because of the limitations of our own identities and lived experiences. Moreover, our identities and commitments to equity in mathematics education may have led us to notice racial or gendered stereotypes that others may not have noticed. Nonetheless, whether or not an individual is consciously aware of a stereotyped situation, research shows that it still affects them through the development of implicit biases (Yogeeswaran et al., 2016).

Context

The simulations we studied occurred in two sequential pedagogical content courses taken by undergraduate junior and senior PTs enrolled in a secondary mathematics education program at a small rural public university in the southern United States (during AY20–21 and AY21–22). Each course includes 15 hr of field experience. Teaching Secondary Mathematics I (MAT 486) occurred during the COVID-19 pandemic and was fully online; thus, all field experiences were virtual. PTs engaged in three simulations, including one 10-min introduction to the environment and two facilitations of mathematical discussions each lasting up to 20 min. The simulations counted for 3 hr of field experiences because PTs spent significant time preparing for and debriefing each session. For the remaining 12 hr, PTs observed and assisted in Grades 7–12 virtual classes. Of the 15 hr of field experiences in Teaching Secondary Mathematics II (CUR 487), a hybrid course taught after a COVID-19 vaccine was released, 12 hr were in-person and 3 hr were simulations, including one 10-min introductory simulation and one facilitation of mathematical discussion lasting up to 30 min.

The university and the school district where the in-person and virtual field experiences occur established a partnership plan 2 years prior to the study. The school district is racially diverse (50% Black, 45% White, 3% Hispanic, 1% Asian, and 1% Mixed), has a high free and reduced lunch percentage (87%), and has a low percentage of students demonstrating proficiency on state math (28.7%) and English (29.2%) assessments. During the in-person field experiences, PTs began observing and assisting but gradually assumed planning, instructing, and assessing responsibilities. While teaching was virtual, the PTs did not have the opportunity to gradually assume these responsibilities. The simulations occurred in the middle of the semester; thus, PTs had completed roughly 6 hr of their virtual (in MAT 486) or in-person (in CUR 487) field experiences at the time of their simulations.

Participants

The demographic, implicit association (IAT) data, and course data for the PTs can be found in Table 1. Of the eight PTs who participated in the simulations, three participated in the simulations in two courses. Six PTs identified as female, and two identified as male. Six PTs identified as White, and two identified as Black. At the beginning of the semester, PTs completed gender and race IATs (Greenwald et al., 1998). The possible outcomes of the Gender-STEM IAT are strong, moderate, slight, or no automatic association of males or females with STEM. The possible outcomes of the Race IAT are strong, moderate, slight, or no automatic preference toward White or Black people. The goal of this study was not to look for connections between PTs' IATs and participation patterns. Therefore, we did not position the PTs on the basis of their IAT results, but we provide

Table 1

Preservice Teachers

PT	Gender	Race	Gender IAT[a]	Race IAT[b]	Courses taken
Cassie	Female	White	None	Strong White	MAT 486, CUR 487
Emma	Female	White	Strong male	Moderate White	MAT 486
Hayden	Female	White	Moderate male	Slight White	MAT 486, CUR 487
Kendra	Female	Black	None	Moderate White	MAT 486
Meg	Female	Black	None	Moderate White	MAT 486, CUR 487
Ben	Male	White	Moderate male	Slight White	CUR 487
Jay	Male	White	Moderate male	Moderate White	CUR 487
Jen	Female	White	Slight female	Slight White	CUR 487

[a] The possible outcomes of the Gender-STEM IAT are strong, moderate, slight, or no automatic association of males or females with STEM.
[b] The possible outcomes of the Race IAT are strong, moderate, slight or no automatic preference toward White or Black people.

the IAT scores as relevant contextual information about the PTs. A few PTs initially became defensive about their results and questioned the accuracy of the IAT. The teacher educator discussed how everyone has implicit biases, ways teachers' biases may influence their teaching and grading practices, and strategies for mitigating biases (e.g., using a randomized system to call on students, holding high expectations for every student, and deidentifying papers prior to evaluation). The classes also discussed how colorblind ideology tends to advantage the dominant group, sparing them the discomfort of considering their own unearned advantages (Grossman & Charmaraman, 2009). Finally, the teacher educator asked the PTs to reflect on three historic views of equity: equality of input, equality of output, and issues of fairness (Makar, 2004). These efforts were intended to motivate reflection and plant seeds for the PTs' journey to use more equitable teaching practices.

Both courses are taken before PTs' student teaching internship. MAT 486 was added to the program the year of this study. Three of the PTs (Ben, Jay, and Jen) did not take MAT 486 because they chose to remain under the previous year's catalog. Two PTs who took MAT 486 did not take CUR 487. One was a senior (Emma) and had taken CUR 487 the previous semester. The other (Kendra) changed their major to Mathematics and therefore did not need to take CUR 487.

Simulations Software

The provider's software was the mixed-reality simulation platform through which PTs interacted with student avatars. We chose this platform because it is widely used in hundreds of teacher education programs across the country, was used to deliver over 20,000 teacher education simulated experiences in 2021, and was forecasted to be used to deliver over 40,000 teacher education simulation experiences in 2022 (Marketing Communications from platform provider, February 9, 2022). The simulation platform creates a virtual classroom environment, in which five simulated students are controlled by a human-in-the-loop called an interactor (or simulation specialist), who uses voice-modulation and other technology to sound and move like secondary students and to respond in real time, intending to create a realistic experience for the PTs. Teacher educators interested in using this simulation platform have the following three options: (a) contract with the platform provider and use their simulation scenarios delivered by their interactors, (b) purchase a site license and be responsible for designing their own scenarios and managing their own interactors, (c) contract with an institution that has a site license. The implementation we studied was supported by a local university that contracted with the software provider (Option 3). According to the simulation coordinator at the university, they have had a total of 16 different students play the role of interactor (all interactors were White, three were men, and 13 were women). The first couple of interactors were trained by the software company directly, and subsequent interactors were trained by prior interactors. The training lasts approximately 60 min and includes a combination of technology and improvisation. We do not know which specific interactors played the avatars in our study, only that they came from this larger pool, and were both White women majoring in education (personal communication, April 13 and 14, 2022).

Each student avatar has an associated character profile that the interactor is trained to enact. The platform provider does not provide a specific script for the avatars to follow; rather, interactors are trained to enact particular student profiles across a variety of settings. Thus, in the current study, it was the role of the interactors to perform as students in a mathematics classroom who had worked on specific tasks provided by the teacher educator. The teacher educator corresponded with the interactors and their manager before the simulations to explain the task, the strengths and weaknesses of each avatars' work sample, and the aim of the simulation, which was to provide opportunities for the PTs to practice equitably facilitating a discussion. Thus, the behaviors we observed were an amalgam of the platform provider avatars' character profiles, the interactor training program, the particular interactors' improvisation, and the tasks and student work samples provided by the teacher educator. We cannot disentangle the role of any of these specific ingredients in producing the results we found, and as such, it is not our goal to make claims about the software, the training program, the interactors, samples of student work, or the tasks in isolation. According to the coordinator for the simulations, if the PT asks a question without calling on a specific student, the student avatars take turns. If a student avatar is not engaged, some exhibit misbehavior. Some avatars (e.g., Rahul) are designed to stay on task no matter what (personal communication, October 7, 2020). The interactors receive impromptu feedback and collegial sharing of ideas continuously, and they meet formally with the coordinator and manager a couple of times per semester to recalibrate their acting on the basis of the feedback they receive from various parties. In these meetings and trainings, they receive guidance on voice and speech profiles, personality traits, and typical behaviors for each avatar (personal communication, December 16, 2022).

According to the platform provider, the avatars are designed to be racially ambiguous (personal communication, February 10, 2020). Further, the racial/ethnic background of each character is not explicitly defined in their character profiles. We asked PTs to share their perceptions of each avatar's race. This information can be found in Table 2. We report on the extent to which the PTs perceived the student as White or as a student of color. Within the student of color categories, racial classifications were mixed, with no single dominant description of the students by the PTs. The student avatars' contributions during the simulations were transcribed.

Here we provide a brief excerpt from the Having Kittens task (described below) to illustrate what the interactions between a PT and the interactor looked like:

> **T: Did you guys work together well or was there any problems? Did you guys agree with each other or have separate opinions?**
>
> **Mia: I mean, Rahul, let me draw the cute little kitties. So, I was happy, but he did like all of the math because, you know, he likes that stuff.**
>
> **T: Oh, OK, well, Rahul, how did you think it went?**
>
> **Rahul: Well, I really did enjoy doing all of the math. I wanted to do it.**
>
> **Mia: It was great working with, you know, a nerd.**
>
> **T: All right, well, that's not very nice. We don't need to call people nerds. But next time, we do need to make sure we're working together and both doing the math together so that everybody gets a chance to do it.**
>
> **Rahul: Yes, I think that's a really good idea, because I probably could have used some collaboration, otherwise I would have liked to work with Samantha better.**

As this excerpt shows, the avatars had well-defined personalities that were enacted by the interactor. The specific statements made here are generated by the interactor's interpretation of the character profiles in the given context of a math classroom. This excerpt is representative of the majority of interactions in the context of our study, across episodes. We provide the full transcript of this episode in the **Appendix**.

Task Design and Procedures

Prior to the virtual session, the PTs received a task packet and, with the support of the mathematics teacher educator, planned to facilitate a discussion with five student avatars. During their simulation session, the PTs facilitated a discussion with the avatars surrounding their work on the Having Kittens task in MAT 486 and Buying Cars task in CUR 487. Each task was adapted from Mathematics Assessment Project (MAP, 2014) lessons. Sample work for the avatar's solutions was taken directly from the MAP packets. Each of these solutions is partially but not completely correct. We wanted the PTs to leverage the correct parts of each avatar's work to address the areas of improvement, because highlighting each avatar's strengths would help the avatar develop a positive math identity.

Two weeks before the simulation, the interactors and the PTs were provided with a task packet that included the task, student avatars' solutions, and guidance and exemplars on facilitating a mathematical discussion. The MAP materials included three samples of student work. Each sample was partially correct. The teacher educator assigned one sample of student work to Samantha, one sample to Rahul and Mia, and one sample to Regina and Will. PTs were asked to first solve the task themselves. Next, they analyzed student work, and the whole class discussed the strengths, weaknesses, and student conceptions in the sample work. Subsequently, PTs prepared a list of follow-up questions to ask each student avatar during the simulation. This list was

Table 2

Student Avatars

Name	Personality profile[a]	PTs' perception of race
Samantha Adams	An introvert with a great memory, who is shy about connecting with classmates.	100% White
Rahul Sharma	A brilliant student who likes to work hard and enjoys challenging problems. May come across as arrogant.	100% student of color
Mia Lopez	A strong, charismatic personality who knows what she wants and does not like when someone else gets in her way. Often pleasant with teachers but can be disrespectful with her peers.	82% student of color
Regina Davis	An intelligent, well-behaved student who tries to keep everyone happy.	100% student of color
Will Tucker-Hall	A risk taker who struggles staying focused, and who seeks external validation by making jokes.	73% student of color

[a] We replaced avatars' names with pseudonyms. We paraphrased the avatar profiles provided by the software creator. The provider specifies that the profiles are only meant to be shared with account owners or facilitators, not with learners, which is why we do not share direct quotes.

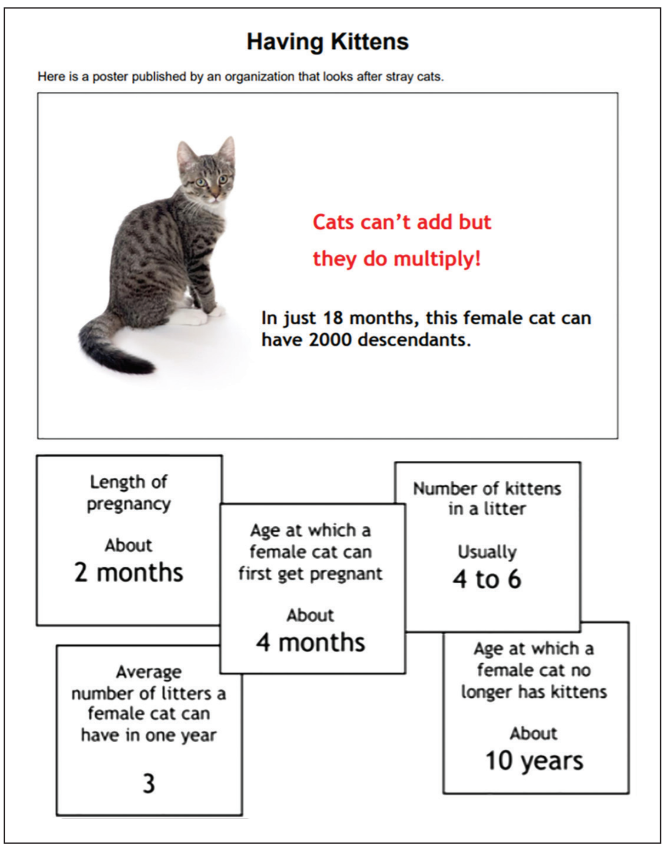
reviewed by the teacher educator, who provided feedback to the PT on how to deepen rote questions into critical thinking questions. For example, if a PT wrote, "What is the fuel consumption of each person's car?" the teacher educator suggested revising the question to focus on the students' reasoning and problem-solving process.

Having Kittens

The Having Kittens task (MAP, 2014) focused on modeling exponential growth by estimating how many descendants a stray cat could have. Students were presented with a poster, made by a cat charity, encouraging people to have their cats spayed so they cannot have kittens (see Figure 1). The task asked students to decide whether it is realistic that one female cat would produce 2,000 descendants in 18 months. Students were also given the following facts: (a) The average pregnancy length is 2 months; (b) a cat can reproduce after being 4 months old; (c) cats have four to six kittens per litter; (d) cats typically have three litters per year; and (e) cats stop reproducing at 10 years old.

Figure 1

Having Kittens Task



Note. Task is modified from the Mathematics Assessment Project (2014).

Buying Cars

The Buying Cars task involved modeling a real-world rate of change problem in which students create, compare, and evaluate different representations of functions. Students were presented with the current fuel consumption of three people's cars (see Figure 2). The task asks students to determine which car is the least expensive to run, how much Bill will save if he buys Sue's car, how much Sue will save if she buys Fred's car, and the fuel consumption of a new car that will save Fred the same amount as Bill.

Data Sources

Our primary data sources were video records of PT interactions with the avatars. We analyzed ten 20-min recordings of the Having Kittens task (each of the five PTs in MAT 486 facilitated a discussion based on the task twice) and six 30-min recordings of the Buying Cars task (each of the six PTs in CUR 487 facilitated a discussion based on the task once). Additional artifacts (e.g., task packet, preparation assignment, reflection/debrief assignment, and teacher educator narrative memos) served as points of triangulation with the video recorded simulation data. Finally, because one of the authors also designed the activity, we drew on aspects of retrospective analysis (Cobb et al., 2003), comparing our own memory of events against the data.

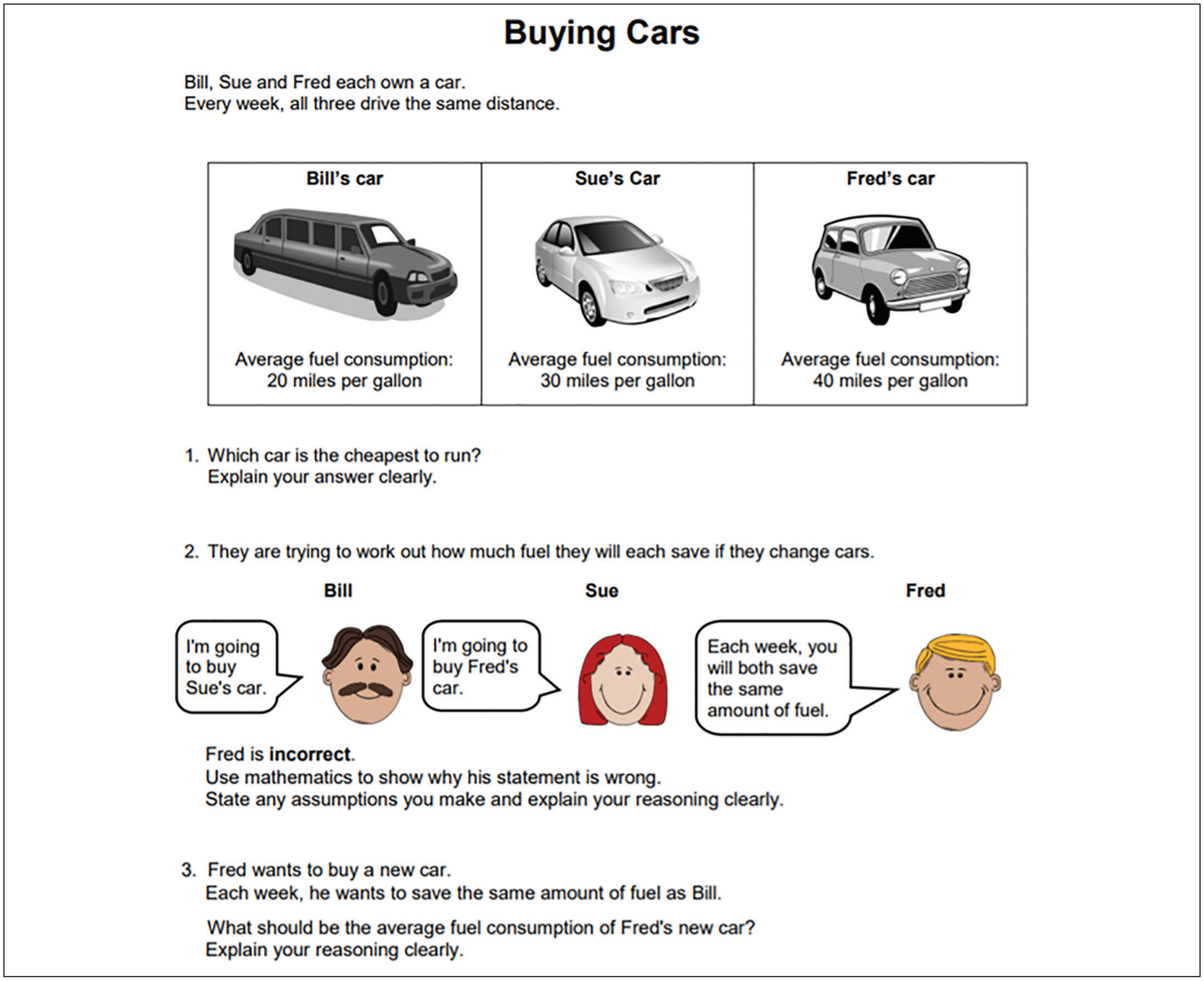
Analytic Procedures

Our primary analytic task was to understand if and how the simulations reinforced or disrupted racial or gender stereotypes. For this, we drew primarily on video recordings of the simulations and used task packets and the teacher educator's narrative memos as secondary sources for triangulation. We used the stereotypes present in the dominant Discourses as a comparison tool to consider a range of possible ways to view the student profiles and behaviors. We wrote narrative memos regarding the degree with which each data source aligned or did not align with stereotypes. We resolved any disagreements through discussion and consultation of the literature.

We also used EQUIP to analyze participation patterns in the simulation. We focused on the Student Talk Type and Teacher Solicitation Type, which were each coded at the following levels: Why, How, What, or Other. We used chi-squared tests of independence to explore if an association existed between the Talk Type (Why, How, What, Other) and the student (Samantha, Rahul, Mia, Regina, Will). We also used a chi-squared test of independence to investigate if an association existed between the Teacher Solicitation Type (Why, How, What, Other) and the student (Samantha, Rahul, Mia, Regina, Will).

Figure 2

Buying Cars Task



Note. Task is modified from the Mathematics Assessment Project (2014).

Results

Analysis of Student Profiles

Prior to their simulated experiences, PTs were shown the name and an image of each student avatar and asked what race and gender they perceived each avatar to be. All PTs perceived Samantha, Mia, and Regina to be women and Rahul and Will to be men. All PTs perceived Samantha to be White. However, the PTs inconsistently ascribed racial categories to the other four avatars, although they were overwhelmingly identified as students of color. What follows is our analysis of each avatar's profile based on the literature.

We concur with the PTs that Samantha appears to be a White woman. Her profile also conforms to stereotypes of White girls being "quiet and compliant," characteristics often viewed positively (Lubienski & Ganley, 2017). For example, the character profile describes her as being an introvert who struggles to connect with peers (see Table 2 for the character profiles). This description contributes to a sense of Samantha's innocence and conforms to the broad societal narratives that White women need to be protected (Morgan, 2021; Sesko & Biernat, 2010).

The PTs perceived Rahul Sharma to be racially ambiguous. However, we argue that Rahul strongly conforms to stereotypes of Asian Americans. His name is clearly an Indian name. Moreover, Rahul is described as intelligent and someone who likes to work hard, which strongly conforms to positive stereotypes of hardworking Asians and ultimately reinforce the idea that "Asians are good at math" (Shah, 2019).

Mia was also perceived as racially ambiguous by the PTs. We concur with the PTs. On the basis of the avatar and name, Mia appears to be a darker skinned woman of color (possibly Black or Latinx). She is described as charismatic but having a strong personality and not liking people who get in her way. These characteristics are consistent with a negative stereotype of a sassy or demanding Black or Latinx woman (e.g., López & Chesney-Lind, 2014).

The PTs also perceived Regina as racially ambiguous. We agree that Regina also appears to be a woman of color, with slightly lighter skin than Mia. Regina is described as intelligent and well-behaved. These characteristics generally align Regina with the positive stereotype of a Latinx woman who is quiet and compliant (in comparison with sassy and feisty; cf. Niemann et al., 1994).

The final avatar, Will, was also perceived as racially ambiguous by the PTs. We agree that Will appears to be a racially ambiguous person of color. He is described as struggling to stay focused and as making jokes to get external approval. This characterization puts Will squarely in the frame of a negatively stereotyped young man of color who is disruptive but not competent with the subject matter (Larnell et al., 2014).

Overall, the platform provider's claims that the avatars are racially ambiguous was partially supported by the data. All PTs agreed that Samantha was a White woman, and we agree with this classification. The PTs generally agreed that the other four students were students of color. We argue that Rahul Sharma fits neatly into well-defined stereotypes for successful Indian/Asian students. We generally agree with the PTs that the other three students were racially ambiguous students of color. The profiles themselves are an amalgam of negative stereotypes, and even though tracing the origins of the students exactly may not be possible, they are placed in the "collective other" of disruptive children of color, as shown below by their interactions (Abelson et al., 1998; Foote & Gau Bartell, 2011).

Interactions With the Avatars

Samantha's character was humble, polite, moderately competent with mathematics, and passionate about volleyball. When asked why she worked alone, she stated, "I wanted to work by myself, I hope I didn't hurt anybody's feelings" and "I am pretty good at math, so I am sure I can figure it out." When asked how she solved the problem, Samantha said, "I just did a little equation, nothing super fancy." When she learned that her work had some errors, she stated, "Sorry I got the wrong answer." When Samantha was not involved in the discussion, she fell asleep. When a PT asked her to wake up, she stated, "I'm so sorry, I am so tired, because I had volleyball last night." At the end of the lesson, she politely thanked the PT saying, "Thank you very much for helping me understand." These words could reinforce the racial and gender stereotypes that White women are quiet, compliant, and well-behaved (Lubienski & Ganley, 2017). Although she has some mathematical interest, her comments also supported the stereotype that White women are more interested in social activities than academics and weaker at math than men (e.g., Leyva, 2017).

Rahul's interactions are highly stereotypical, almost caricaturized. His words suggested that he was very intelligent, polite, hard-working, and well-behaved. When asked how he and his partner, Mia, solved the problem, Rahul stated, "Mia is a better artist than me so she did all of the drawing and I did all of the math" and "I enjoyed doing all the math." When asked if he agreed with Samantha's work, Rahul said, "Samantha, do you mind if I share a suggestion on how you can improve on your work?" When a small mistake in his work was detected, he stated, "Yes, I understand, I will be fully successful next time." When not called on, he continued to pay attention, and frequently raised his hand to share STEM facts, such as, "Yes, I have read about hybrid and electric cars, you plug them in your garage, and it only uses gas when you run out of juice" and "If you really want to save fuel, you could ride your bike, but then your hair might get messed up." These comments reinforced the stereotypes that Asian men are good at mathematics, driven, and well-behaved (Shah, 2017).

Mia's words indicated that she did not like mathematics, enjoyed art and social media, and was rude to her classmates and the PTs. When asked how she solved the problem Mia shared that "Rahul did all the math, he is a math nerd, I just drew the cute little kittens," "Math isn't my thing, I'm just not good at it, and I think math is pretty stupid, to be honest," "Do you have any crayons or markers so I can color the kittens in?," and "I told Rahul that we should have done the lines with colored pencils, but he said that math is black and white." When not called on, Mia immediately looked down at her cellphone and when corrected stated, "I am not in the mood to participate, I am signing off," "No, I am not paying attention, I hate math," "My Instagram followers are depending on me." Mia also frequently talked back and even threatened PTs with comments such as, "I don't care what the answer is," "Yeah, thanks for leaving us for like dead last," "Are you going to say anything positive or nice about our work," "I am texting my Mom, it is an emergency, the emergency is that I am so bored and you are bullying me, she said she wants to have a conference with you," "Do you even know the answer? I am looking up how to do this, because it doesn't seem like you know what you are doing," and "Um, I have some sad news for you, my mom is a teacher, and teachers don't make very much money." She insulted Will stating, "You are seriously repulsive, you need to get some help" and told Rahul, "Never say the word juice." These comments reinforced the stereotype that women are not good at mathematics, and that young women of color are sassy and manipulative (e.g., López & Chesney-Lind, 2014).

Regina exhibited quiet compliance. When Regina was not called on, she continued to pay attention, did not misbehave, and reread or reworked the problem each time a question was asked. She also made statements such as, "Honestly, to me it is hard to explain, because I let Will do the creative stuff on it," and "I am not sure how we got our answer. I just put the numbers in the calculator. I think we made a math mistake," which portrayed her as airheaded and incompetent with mathematics. Comments like, "This was a great lesson, thank you for helping me understand it better," "You are my favorite teacher," and "I don't want to speak ill about my partner" supported stereotypes that some women of color are passive and compliant but not mathematically successful (Niemann et al., 1994).

Will also exhibited stereotypical behaviors. When Will was not called on, he played air drums and looked out the window. His athleticism was evident with statements like, "I am just movin' and groovin', you know me," "Sweet, can we go to recess now? I want to play some soccer," and "I played basketball (last weekend)." He also tried to get the class to laugh, which could be perceived as disruptive, with comments such as, "I would get my dog to eat those cats for dinner," "Usually the runt dies, have you seen Charlotte's Web?" "Oh my God, she is a baby making machine!" "What the heck is going on?" "Peace out teach!" and "Math problems are like Billy Joe bought 300 watermelons." Moreover, he made some inappropriate comments like, "Mia can be a drama queen!" "Yo, teach, you look pretty young, you got a boyfriend? Do you love him? Are you going to make babies with him? I want to be your boyfriend, you won't be my teacher next year, age is just a number, you could be the next Mrs. Tucker-Hall. No? My heart is broken." These interactions portrayed Will as an athletic, nonacademic, sexist, and disruptive young man of color (Larnell et al., 2014).

Student Participation and Teacher Practices

Our Discourse analyses of avatar profiles and behaviors indicated that each of the students was strongly stereotyped. We were interested to see whether these stereotypes would play out in practice, so we coded interactions between PTs and avatars. As novices with no knowledge of best practices for sequencing student work (Hiebert et al., 2007; Lampert, 2001; Smith & Stein, 2011; Stein et al., 2008), in nine out of 10 simulations (90% of the simulations), the five PTs in MAT 486 solicited student responses in the order that their written work appeared in the task packet, which was also the left-to-right order that they sat in the simulated classroom. From left to right (in the simulated classroom), and from top to bottom (in the TE created packet), the students were Samantha, Rahul, Mia, Regina, and Will. This sequence provided the positively stereotyped students in the mixed-reality simulation the first and the most opportunities to participate.

After noticing the PTs' calling-in-order propensity in MAT 486, in the subsequent course, CUR 487, the teacher educator guided the PTs on alternative methods to solicit participation. For example, she modeled how to use a random method to call on students (drawing students' names from a cup) and advised the PTs use this method only after telling the student avatars why they were using it, that it is OK to make mistakes, and that they have "pass" and "phone a friend" options (Eddy et al., 2014; Grunspan et al., 2016). After providing the PTs with this recommendation, only two out of the six (about 33%) PTs initially solicited student responses from left to right. This data provides evidence that the teacher educator made progress toward her goal of PTs calling on students more equitably, but regardless of the order the student avatars spoke in, the content of their talk also matters. In our analyses below, we will illustrate that inequities remained.

Student Talk Type

We used EQUIP to code and analyze the 758 student contributions made by the interactors across all simulations (see Table 3 and Figure 3). A chi-squared test of independence revealed a significant association between

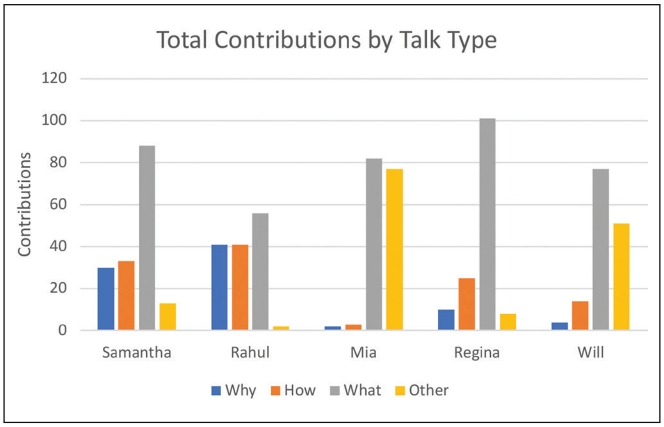
Table 3

Student Talk

Avatar/talk type	Samantha	Rahul	Mia	Regina	Will
Why	30	41	2	10	4
How	33	41	3	25	14
What	88	56	82	101	77
Other	13	2	77	8	51
Total	164	140	164	144	146

Figure 3

Student Talk Type



the Talk Type (Why, How, What, Other) and the student (Samantha, Rahul, Mia, Regina, Will), χ^2 (12, N = 758) = 256.10, $p < .01$. Most of the "Why" and "How" contributions were made by Rahul, reinforcing the stereotype that Asian males excel in mathematics (Shah, 2019). Samantha made the second most "Why" and "How" contributions, supporting the narrative that White students are academically more advanced than students of color (Shah, 2017). Mia, a woman of color, made only 2 "Why" and 3 "How" contributions and Will, a man of color, made only 4 "Why" and 14 "How" contributions. It is notable that Samantha offered about 43% more "Why" contributions than she was solicited (with "Why" questions) and Rahul offered 173% more "Why" contributions than he was solicited. This finding suggests that regardless of the questions the PTs asked, the interactor strongly overacted to reinforce stereotypes. Additionally, with 51 and 77 "Other," or off-topic contributions, respectively, Will and Mia were portrayed as disruptive and not strong in mathematics. In contrast, with 2, 8, and 13 "Other" contributions, respectively, Rahul, Regina, and Samantha were characterized as focused on the mathematical task.

Teacher Solicitation Type

Next, we used EQUIP to code and analyze the 758 teacher questions asked across all simulations (see Table 4 and Figure 4). A chi-squared test of independence revealed a significant association between the Solicitation Type (Why, How, What, Other) and the Student (Samantha, Rahul, Mia, Regina, Will), χ^2 (12, N = 758) = 87.36, $p < .01$. We noticed the PTs asked mostly "What" questions to each student avatar, a common practice of novice teachers (Sánchez et al., 1999). Samantha and Rahul were asked the most "Why" questions. Compared with their peers, they were asked about twice as many "Why" questions as Will and about three times as many as Mia and Regina. The positively stereotyped students were asked the most high-level questions. In contrast, Mia and Will were asked the most "Other" (off-topic) questions. Compared with their peers, they were asked about five times as many "Other" questions as Samantha, Rahul, or Regina. This data strongly supports the narrative that students of color are disruptive and not focused on mathematics (Shah, 2017).

Figure 4

Teacher Solicitation Type

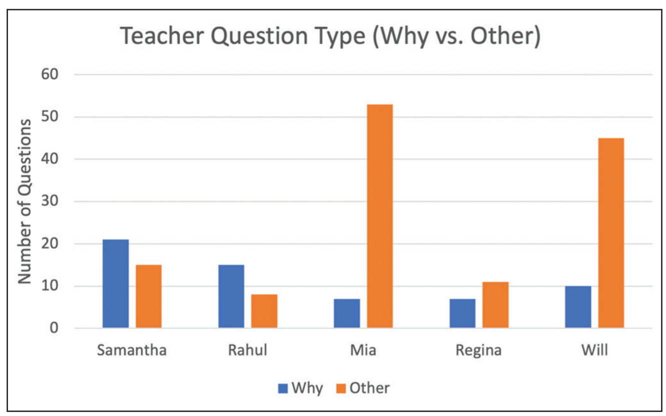


Table 4

Teacher Solicitation Type

Avatar/sol. type	Samantha	Rahul	Mia	Regina	Will
Why	21	15	7	7	10
How	40	37	21	35	28
What	88	80	83	91	63
Other	15	8	53	11	45
Total	164	140	164	144	146

Discussion

In this article, we sought to understand how mixed-reality simulations could disrupt or reinforce racial and gender stereotypes. As Howell and Mikeska (2021) point out, there is a need for more work that addresses the authenticity of simulations. Although the body of research on simulations is expanding, it currently says very little about whether these experiences could be reinforcing or disrupting racial or gender stereotypes. Our study utilized a popular platform provider because it is widely used, but we do not claim these issues are specific to the platform, and we suspect the issues we see may arise in other simulated experiences as well. Our overall goal is to raise critical questions for the field around the use of simulations.

First, we imagine that these simulated experiences may have reinforced whatever stereotypes the PTs have already been exposed to. Rather than providing students with nuanced depictions of students, the PTs were exposed to the same false cookie-cutter versions of students shown in popular culture and the media. When these types of behaviors are combined with White and Asian students showing higher levels of mathematical participation, competence, and interest, the virtual environment could have served to further the racist and sexist status quo, contributing to continued inequities in mathematics.

Second, we can see real harm done to PTs (especially PTs of color) who witnessed problematically stereotyped portrayals of students of color. Imagine being forced to participate in a virtual learning environment that portrays students whose racial/gender identities mirror yours as rude, abrasive, disruptive, and sexist. It may be a stretch to classify such an experience as traumatic, but certainly, this experience could have been problematic, hurtful, and even degrading for racially minoritized PTs to experience. Such an experience could be dehumanizing. Moreover, it is likely to exacerbate the dire shortage of qualified teachers of color if it contributes to further attrition from the field (U.S. Department of Education, Office of Planning, Evaluation and Policy Development, Policy and Program Studies Service, 2016).

Third, we recognize that some teacher educators may want or need to use simulations. In this case, we recommend following the guidance of Self and Stengel (2020). Prior to using simulations, Self and Stengel (2020) advise teacher educators to first carefully assess their program's readiness, write or revise the encounters, and recruit and train actors. Additionally, in Self and Stengel's (2020) SHIFT cycles, the simulated encounter is sandwiched within a sequence of instructional tasks that include the following stages: prepare, interact, react, review, and reconsider (Self & Stengel, 2020). During the *prepare* stage, PTs read the scenario, reflect on what it is about, develop a plan for the interact stage, situate the scenario within their other coursework, and describe any additional details related to the scenario that they are wondering about and would like to have. Next, PTs have a roughly 10-min interaction with live actors (*interact* stage), which is immediately followed by a small-group raw debriefing of their experiences (*react* stage) centered around three prompts: "What happened during your encounter? How do you feel about it? What do you want to talk about in the group debrief?" (Self & Stengel, 2020, p. 25). During the *review* stage, PTs have the opportunity to watch the video recording of their own encounters and reflect on what they now think the scenario is about, explain if and why they made any moves that differed from their original plans, select moments they consider critical, and list any lingering questions they have. During the final stage (*reconsider*) teacher educators engage the PTs in a group debrief designed to "leverage the various experiences in the course, the identities and positionalities present (including that of the instructor), and move together toward a clearer understanding of what is happening in the interaction, what can happen, and what must be considered when determining how to act" (Self & Stengel, 2020, p. 27). We feel that the critical analysis of the interactions and deconstructing of any stereotypical behavior that may be portrayed which occurs during the group debrief are urgently necessary to mitigate any potential future harm. Teacher educators can find additional discussion prompts to frame these conversations in the Catalyzing Change book series and companion book study guides (National Council of Teachers of Mathematics [NCTM], 2018a, 2018b, 2018c). We believe that the instructional sequences that adhere to the design principles of Self and Stengel's (2020) SHIFT cycle can productively support PTs' development of "political conocimiento" for teaching (Gutiérrez, 2017).

From our poststructuralist framing, we were able to document the presence of stereotyped behaviors, consistent with dominant Discourses about students in mathematics (e.g., Shah, 2017). Although we expected that some nuances of subtle racialized and gendered phenomena would be lost in the virtual setting played by interactors, what we found were overtly and problematically stereotyped caricatures of real students. From Rahul—the polite and overly enthusiastic embodiment of the successful Asian man in mathematics trope—to Mia—the rude, catty, and entirely uninterested in mathematics woman of color—we interpreted the enactment of these avatars likely to further perpetuate inequities. These prominent stereotypes seemed to align with the visual/physical appearances of the avatars, at least partially. What we find even more problematic is that a single White college student was portraying all these roles[3] (personal

3 As noted before, across the two semesters of study, it was a different student who served as the interactor, but in each case, it was a single White woman who enacted the avatars' personalities in context.

communication, April 13 and 14, 2022). Along with other prominent scholars in the field who are designing and studying antioppressive simulations (Self & Stengel, 2020), we believe a single person should never be responsible for portraying racial, gender, and disability groups that they themselves do not belong to because they have different lived experiences and they will not be able to authentically represent those identities.

The stereotypes could be further reinforced by the mathematical engagement of the enacted avatars. Both Samantha and Rahul had the most opportunities to meaningfully participate in math, whereas the negatively stereotyped students of color, Mia, Regina, and Will, mostly provided disruptions and offered little of mathematical substance. The engagement with the PTs mirrored these stereotypes, whereby the most meaningful questions were asked to Samantha and Rahul, the White and Asian students. The data revealed that Samantha offered about 43% more "Why" contributions than she was solicited (with "Why" questions) and Rahul offered 173% more "Why" contributions than he was solicited. These findings suggest that regardless of the questions the PTs asked, the interactor strongly overacted to reinforce stereotypes. These inequities in participation opportunities mirror the participatory inequities found in studies of real classrooms (e.g., McAfee, 2014; Shah, Christensen, et al., 2020). We wonder how participating in highly stereotyped simulation scenarios might have affected PTs' beliefs, knowledge, and skills.

Our overall goal is to raise critical questions for the field around the use of simulations, not single out a specific software platform. We see early field experiences, such as simulations, as an important initial step in the lifelong journey of becoming an antioppressive educator. We feel that it is critical that these experiences advance racial equity and address systemic racism because PTs have the potential to influence the identities of thousands of students throughout their careers. As such, we consider it essential that as a field we use simulations to disrupt negative racialized and gendered stereotypes, rather than reinforce them. We point the reader to Self and Stengel's (2020) SHIFT project and Buttimer et al.'s (2022) MIT Teaching Systems Lab as two examples of equity-focused simulations projects.

Limitations

Our article has several important limitations. First, our study was conducted during the COVID-19 pandemic, and we cannot predict the state of PT education postpandemic. Second, we recognize that the stereotypes we analyzed were affected by how particular interactors enacted the profiles provided by the simulations software provider to simulate the sample work given by the teacher educator. Although the results we found in this particular study were eminent, it is difficult for us to ascertain whether they were idiosyncratic, or emblematic, of other implementations through the platform. Third, this work was conducted during Academic Years 20–21 and 21–22, so the software or avatars' profiles may have been updated since this study took place. In sum, we caution that the results may not generalize to other implementations of the software or other mixed-reality simulations; nevertheless, we feel that the results are noteworthy enough that they bring up important questions for the implementation of *any* mixed-reality software implementation.

Our findings were a complex interaction of multiple factors. Contributing to this context were the character profiles, the specific interactors involved, the interactor training program, the local context of the university, the tasks chosen by the teacher educator, and so forth. We cannot and do not aim to disentangle the role played by each of these factors. We recognize the inherent risks in deploying any new technology, and in this case study, we suspect that the development of technology may have outpaced the development and deployment of precautions and guardrails to ensure that the simulation experiences positively contributed to the PTs' learning process. We believe our analysis of these data provides a cautionary tale for others to consider as they grapple with how to productively use virtual simulations in our field.

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Appendix: Sample Transcript from Having Kittens Task

T: So did everybody remember the assignment we did about the cats being able to have two thousand descendants in just 18 months?

Regina: Yeah, the cute little kitties.

T: OK, so let's go over our answers for that problem. Let's see who worked in groups and who all worked together.

Samantha: Well, I was by myself. And Rahul and Mia were together and Regina and Will were together.

T: OK, cool, and Samantha, why did you want to work by yourself?

Samantha: No, I did not want to do that. I wasn't really comfortable by myself.

T: OK, well, maybe next time we can get you in a group with someone.

Will: Yeah. Wait, why did she work all by herself?

T: Well, I think they just can only have groups of two if it is assignments and there's only five people in class, didn't really have anybody to help her with it. But I'll make sure that she's with somebody next time. OK, Maci and Rahul you guys work together pretty well or was there?

Mia: My name is Mia.

T: Mia, I'm so sorry.

Mia: Oh, my gosh, I'm texting my mom right now that you're bullying me.

T: Oh, no, you don't need to do that, I'm sorry, I have I am very dyslexic and I just read your name wrong. I'm sorry.

Mia: That's OK, but she's not going to be happy when she hears about that.

T: OK, I'll make sure to talk to her. Did you guys work together well or was there any problems? Did you guys agree with each other or have separate opinions?

Mia: I mean, Rahul, let me draw the cute little kitties. So, I was happy, but he did like all of the math because, you know, he likes that stuff.

T: Oh, OK, well, Rahul, how did you think it went?

Rahul: Well, I really did enjoy doing all of the math. I wanted to do it.

Mia: It was great working with, you know, a nerd.

T: All right, well, that's not very nice. We don't need to call people nerds. But next time, we do need to make sure we're working together and both doing the math together so that everybody gets a chance to do it.

Rahul: Yes, I think that's a really good idea, because I probably could have used some collaboration, otherwise I would have liked to work with Samantha better.

T: OK, well, it's good for us all to work with different people, so maybe next time you and Samantha can be together. OK, let's see. OK. Will and Regina, you guys created a little cat tree like a family tree with the cats to solve your problem.

Will: Yeah, I think we did a really good job, you know.

T: Yeah, you guys did very well at explaining the different parts of how you were getting your numbers, but the answer you got was a lot.

Regina: I don't really know how we got nine thousand. I don't really know where we got that from. But I wrote it down.

T: Yeah, I'm not really sure either you guys were doing very well at showing where the. Like numbers were coming from and then all of a sudden came up with this nine thousand.

Will: I think we just got a little crazy with it. I mean, could you imagine if someone had nine thousand cats in a room? That's too many cats. That was way too many cats. I would not get my dog to eat those cats for dinner.

Mia: Oh my God, well, that is seriously repulsive. You need to, like, get some help.

T: OK, well, it is not very good to have cats eaten by dogs, but let's get back on track and talk about the assignment. So what do you guys think you could have done better to make sure you did not get a crazy number that you don't know where it came from?

Regina: Well, I think we probably should have done more like math work instead of drawing, because maybe that's where we got confused and we stopped showing all of our math work.

T: That's a good idea.

Will: Yeah, she makes a good point. I was kind of worried about drawing all those branches that I forgot about the numbers part.

T: That's very smart. This is a math class, so we do want to make sure that we can keep our math organized and not get crazy with our drawings. Sometimes drawings do help, though, when we're trying to figure out a problem. Yeah, but we also want to write our computational work. Yes. OK, so, Samantha?

Samantha: Oh, sorry!

T: we got to stay awake.

Samantha: Yeah, yeah, I'm so sorry, I'm sorry.

T: It's OK. I know you're tired. It's OK. OK, so why did you choose to do a timeline?

Samantha: Well, like, number lines just kind of makes sense to me when I'm trying to do, like, work with numbers, I guess. So that's kind of my go to.

T: OK, I really liked that you drew this time line. Actually, the only problem with it is that it did not include the amount of kittens that the litter can have as well. You only included the original cat like the mom kittens that she could have.

Samantha: So I should have drawn like so many more lines to represent all of the new kittens?

T: That's one way you can do it. Have a bunch of number lines or you can make it easier and do what Maci and Rahul did, that kind of making a flowchart of the . . . I'm so sorry, Mia, not Maci.

Mia: My name is Mia, not Maci, I am kind of really mad at you.

T: I apologize Mia, I feel very bad. I don't know why I keep saying Maci.

Will. She can just be a drama queen. You got to ignore her.

T: Oh, OK, well, let's not call each other, drama queens.

Will. All right, I'm sorry, I'm just trying to stick up for you because I like you.

T: No problem. I like you, too. I appreciate that Rahul.

Will: I'm Will.

T: Oh, Will, I'm sorry, I saw their lips moving. I'm so sorry. I am a mess today.

Regina: No you're doing OK.

T: Oh, thank you so much. That means a lot to me. OK, so Samantha, how did you get the numbers that you put on your number line?

Samantha: Well, similar to, Rahul and Mia, I said that it takes six months to make a new litter. And so that's where I got that. And I got six cats for each litter, which they also said, even though it's four to six cats, I just went with six, because that's the most they could potentially I possibly have.

T: That's very good. I like that you said that, and next time when we do this, make sure you write down how you're getting those numbers, because when I looked at it, it just looked like you're making it up a little bit in numbers. But I do like that. Let's check back with Mia and Rahul.

Mia. I am not in the mood to participate. Maci is signing off.

T: OK, well, good thing you're not Maci, your Mia, so Mia is going to work with us and try and talk about why we got these answers, OK? OK, Mia? On your guys this chart, and you guys also did not include the litters, having more litters.

Rahul: So I think we just stop adding like, two like three litters, because if we kept doing it, it would just go on and on and on.

T: You did, but you also could consider that the mother could have had more litters as well.

Regina: That helps Will and my work, too. I think we kind of forgot about that.

T: Definitely. So that's one thing that you could think about next time, is that the mom can also keep having litters as well as the next generation having more litters. OK, so what did you guys think like which process did you guys think it's easiest to do? Like Will, did you think that if you did Rahul's would it be easier, like doing the flowchart?

Will: Yeah, I think that flowchart looks really organized and I kind of like the way they even drew those kittens. But I think that it's kind of similar to, like our tree structure, but it looks more messy.

T: Right, it is, there work is a little bit more organized. Rahul, did you raise your hand?

Rahul: Yes, I was just going to say that I kind of liked the way that we did it, but I also like the way Samantha did it. And I think it would be very cool to incorporate the two.

T: That's exactly what I was going to say next, I think if you did a flowchart as well as a number line, there would be a lot easier to keep track of everything. Will, are you in a good mood, you keep dancing over there?

Will: Yeah, I'm just moving and grooving. You know me.

T: Good, Regina, if you got to do this assignment again, what would you do differently?

Regina: Well, I probably would use like a more organized system, but I still like our tree.

T: It is a very cute tree, those are very good artists. Oh, OK. Mia and Rahul how did you guys come up with the six months? And Samantha and you had this your work as well? How do you guys come up with the six months?

Samantha: Because it says that cats need four, well, the pregnancy is about two months, but a cat can get pregnant at four months, so that's six months.

T: That is very good. It's good for us to use all that information that we can in a prompt and try to figure out exactly how many kittens we can have and if it is reasonable that the cat had two thousand kittens. Let's see. If you guys were to do this again, who would you guys want to all work together as a group or do it individually?

Regina: I think it would be nice to just change partners, but I think Samantha should have a partner this time. Maybe we can work in a group of three and she can join our group next time.

T: That's very nice of you, Regina. Maybe we can mix it up and have, like, the girls on one side, on one group and then the boys together, or we could mix it up another way. But I think it's very good for us to work with somebody new. Mia, do you understand how you and Rahul came up with these numbers?

Mia: Yes.

T: OK, do you think that you should have included the mom having more kittens as well?

Mia: No, you don't know.

T: Why not?

Mia: I don't know.

T: OK, well, if we look at our prompt, it says that a female can have three letters in one year, so we have 18 months, that means the cat can have four or five litters.

Mia: Do you know?

T: Yes, I know, I'm just trying to remember. Well, that is a very big part of our thing, because if we make a giant tree kind of incorporating your guys' work and the family tree, that would extend greatly because the mom and the mom would have multiple sets of litters that would be included. Are you guys trying to do the math again.

Rahul: Yes, I was just reorganizing our work and I think it would make a lot more sense if we just had drawn like several more of our branches with different litters, if that makes any sense.

T: It does make sense. I think that's a very good idea. Maybe we can do that for when we talk about this next time.

Will: Can we go to recess now? I got to go. I want to go on the slide.

T: I think you do need to get some energy out. You can go in just a minute.

Will: Yeah, I want to play some soccer too.

T: Does anybody have any questions remain about the assignment?

Samantha: No, but can I just work with someone next time?

T: Yes, definitely, we will get to you in a group next time for sure.

Samantha: OK, thank you.

T: More than ever. Mia, are you still texting your mom?

Mia: Yeah. She says that she is going to schedule a parent teacher meeting to discuss the pronunciation of my name.

T: OK, I would love to have a parent teacher meeting or maybe also we can talk about how you're on your phone during class.