Pre-Service Teacher Acceptance of a Chat-Based Dialogue Simulator for Rehearsing Mathematical Questioning.

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Abstract: This study explored pre-service teachers' perspectives about the usefulness and ease-of-use of a low-cost online chat-based dialogue simulation tool when it is used to provide them with opportunities to practice asking purposeful questions. The study was conducted with 200 participants enrolled in elementary mathematics methods courses at a large mid-Atlantic university. Five different implementations of the simulation tool were studied. Quantitative post-implementation survey data was collected and analyzed for the overall degree of technology acceptance and for differences across implementations. Results indicate that pre-service teachers' perspectives of the chat-based dialogue simulator are that they somewhat to strongly agree that the simulator is both useful and easy to use. These results imply that using accessible online simulation tools like the one examined in this study has the potential to be accepted by pre-service teachers as a valuable part of their teacher preparation coursework.

Keywords: teaching simulations, mathematical questioning, AI-based tools

Introduction

As teacher educators adopt practice-based approaches and provide pre-service teachers with opportunities to practice essential teaching skills (Grossman et al. 2009, Zeichner 2012), there is growing interest in using teaching simulations within teacher preparation programs (Howell & Mikeska 2021). Teaching simulations are scenarios where pre-service teachers interact with a real or virtual student and make decisions that impact the interaction. Teaching simulations have been used to rehearse a variety of essential teaching skills and can have a large impact on the development of these skills (Chernikova et al. 2020). This impact is greater when followed by high-quality feedback or coaching (Cohen et al. 2020, Mikeska et al. 2022).

Despite these reported benefits, there are currently significant barriers to implementing existing teaching simulation tools at scale. Barriers include the cost of simulation tools, the need for most of these tools to be used in a lab, outside of regular classroom instruction, and the time required to provide detailed feedback to each per-service teacher after using a simulation (e.g., Qualls et al. 2024). To mitigate these barriers, a low-cost online chat-based dialogue simulation tool, the AI-based Classroom Teaching Simulator (ACTS, Bywater et al., 2025), has been developed that can be used during classroom instruction by all pre-service teachers at the same time. This tool also automatically provides pre-service teachers with detailed feedback about their dialogue immediately after using the simulation (Datta et al., 2023). This study explored pre-service teachers' perspectives about the usefulness and ease-

of-use of this tool when used to provide them with opportunities to practice the critical skill of asking purposeful questions (NCTM 2014), and asked the research question:

What are pre-service teacher perspectives about the usefulness and ease-of-use of a chat-based dialogue simulator for rehearsing mathematical questioning?

Framework

This study examines pre-service teacher perspectives through the framework of the Technology Acceptance Model (TAM, Davis et al. 1989). This framework highlights two key constructs that impact a user's acceptance of, or intention to use, a technology: the user's perception of the technology's *usefulness* and *ease-of-use*. Usefulness is defined as the degree to which a person believes that using a technology would enhance their job performance, and ease-of-use is defined as the degree to which a person believes that using a technology would be free of effort (Davis et al., 1989). The TAM is used in many fields (King & He 2006), including the field of teacher education where it has been used to measure preservice teachers' perceptions about using a variety of technologies in their future classrooms (e.g., Casey et al. 2023, Yeo et al. 2022).

Literature Review

When mathematics teachers are skilled at asking purposeful questions that probe and explore student thinking they can promote inclusive classroom conversations that help to develop students' mathematical ideas and mathematical identities (NCTM, 2014, Aguirre et al. 2013) as well as make access to mathematics learning more equitable (Oakes et al. 2001). As a result, there is considerable interest in finding ways to support pre-service teachers to practice asking such questions (e.g., Liljedahl 2020, Smith & Stein 2018), and providing them with feedback about the questions they ask (Boston & Candela 2018).

At the same time, given the increasing popularity of teaching simulations, various technologies have been leveraged to provide pre-service teachers with opportunities to practice asking questions to virtual students. These include interactive technologies such as LessonSketch (Herbst et al. 2014) that uses animations and storyboard interactions, and Eliciting Learning Knowledge (Thompson et al. 2022) that provides opportunities for pre-service teachers to consider the questions they might ask in particular situations. In addition, mixed-reality simulations such as Mursion offer pre-service teachers opportunities to engage in an interactive dialogue with student avatars that are controlled by trained actors (Lee et al. 2021). Research with these technologies have provided insight into the questioning strategies pre-service teachers use (Weston, 2018), and how pre-service teachers view the impact of the technology on their questioning skills (Thompson et al. 2022).

However, pre-service teachers' views about the design of teaching simulation technologies have received little attention. This study aims to address this gap by studying pre-service teacher views about the usefulness and ease-of-use of an online chat-based dialogue simulator that provides pre-service teachers with opportunities to practice asking purposeful mathematical questions.

Methods

In this study, we use quantitative methods to examine pre-service elementary teachers' degree of acceptance of a chat-based dialogue simulator for rehearsing their mathematical questioning practice. We do this by examining survey responses about their perspectives about the *usability* and *ease-of-use* of the simulator.

Chat-Based Dialogue Simulator

ACTS, the chat-based dialogue simulator used in this study, is accessible online by pre-service teachers and allows them to practice asking questions with virtual students (Bywater et al., 2025). The simulator scenarios can be customized by researchers or course instructors to include different tasks. For example, Figure 1 shows a scenario

with a pattern growth task, but this could be replaced with other tasks and other interactive visualizations. The simulator scenarios can also be customized to allow the virtual students to be played by AI-chatbots, human actors, or pre-service teacher peers. When the dialogue ends, the chat-based dialogue simulator immediately generates feedback for the pre-service teachers about the questions they asked during the conversation. The type of feedback provided can also be customized.

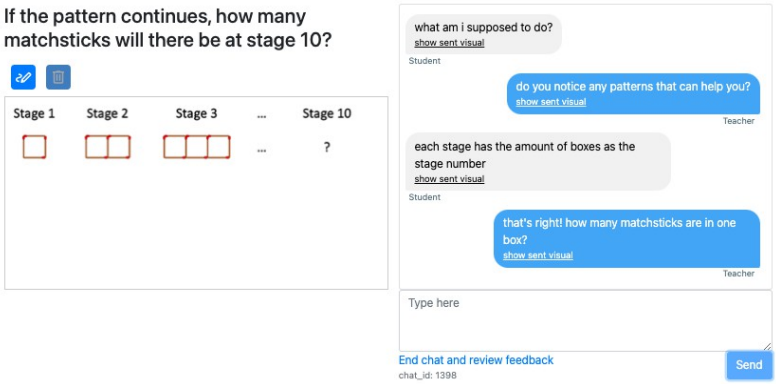

Figure 1. Screenshot of the chat-based teaching simulator.

Participants and Implementations

The participants in this study were pre-service teachers enrolled in undergraduate elementary mathematical methods courses at a large mid-Atlantic university. All participants used the chat-based dialogue simulator to practice asking mathematical questioning within their courses. In total there were five implementations, each conducted under slightly different conditions and contexts. For example, while most implementations occurred within in-person undergraduate teacher preparation courses, implementation C occurred within a fully online alternative teacher preparation course. In addition, different instructors chose to use different tasks. Implementations A and D used growth patterns tasks, B and C used equivalent fractions tasks, and E used rich mathematical tasks (VDoE 2020). Table 1 summarizes the differences between each implementation.

Table 1. Summary of the five chat-based dialogue simulator implementations examined in this study.

Implementation	Context	Modality	Task	Instructor[b]	Semester	n
A[a]	Undergrad	In-person	Growth Patterns	Ali	Fall 2023	58
B[a]	Undergrad	In-person	Equivalent Fractions	Ali	Fall 2023	58
C	Alternative	Online	Equivalent Fractions	Beth	Fall 2023	15
D	Undergrad	In-person	Growth Patterns	Ali	Spring 2024	40
E	Undergrad	In-person	Rich Mathematical	Carl	Spring 2024	29

[a] Implementation A and B used different tasks but occurred within the same courses with the same pre-service teachers during the same semester. Implementation A occurred at the beginning of the semester and implementation B occurred toward the end of the semester.
[b] Instructor names are pseudonyms.

Data Sources and Collection

After completing the chat-based dialogue simulator activity, participants were asked to complete a survey that included four Likert-style items related to the usefulness of the simulator activity, and three Likert-style items related to the ease-of-use of the simulator activity. These items are shown in Table 2. For each item, participants could select one of the following responses: *Strongly disagree*, *somewhat disagree*, *neither agree nor disagree*, *somewhat agree*, and *strongly agree*.

Table 2. The survey items provided to participants at the end of the implementation.

Construct	Item code	Item text
Usefulness	U1	The interactive visualization of the task was helpful in communicating with the "student".
	U2	The simulation was helpful for practicing how to teach elementary mathematics.
	U3	The feedback was useful for helping me reflect on what I said to the "student".
	U4	I would like to use this again in methods classes.
Ease-of-use	E1	The instructional objective of the mathematical task was clear.
	E2	It was easy to use the tool's interface to engage with the task.
	E3	The instructional objective of the mathematical task was clear.

Data Analysis

To analyze the responses, we converted the responses to a numeric score. *Strongly disagree* responses were scored as 1, *somewhat disagree* responses as 2, *neither agree nor disagree* responses as 3, *somewhat agree* responses as 4, and *strongly agree* responses as 5. We then calculated the mean and standard deviation of the survey response scores for each survey item, and for all usefulness and ease-of-use items. In addition, we conducted non-parametric Kruskal-Wallis rank sum tests to examine whether participants responded differently to survey items about usefulness and ease-of-use, and whether they responded differently when implementations had different context and modality and used different tasks.

Results

As shown in Table 3 and Figure 2 below, the mean scores for all survey items are about mid-way between *somewhat agree* and *strongly agree*. This indicates that participants somewhat to strongly agree that the simulation is useful and easy to use. While similar, the Kruskal-Wallis rank sum test showed that the mean ease-of-use rating was significantly greater than the mean usefulness rating ($\chi^2 = 16.5$, $df = 1$, $p = 4.79 \times 10^{-5}$), but with only a small effect size (Cohen's $d = 0.241$; Hedges' $g = 0.238$).

Table 3. Summary statistics for each survey item.

Construct	Item code	Mean	Standard Deviation	n
Usefulness	U1	4.50	0.722	200
	U2	4.42	0.828	200
	U3	4.56	0.741	200
	U4	4.30	0.934	200
	All	**4.44**	**0.815**	**800**
Ease-of-use	E1	4.64	0.642	200
	E2	4.62	0.647	200
	E3	4.59	0.724	200
	All	**4.62**	**0.671**	**600**

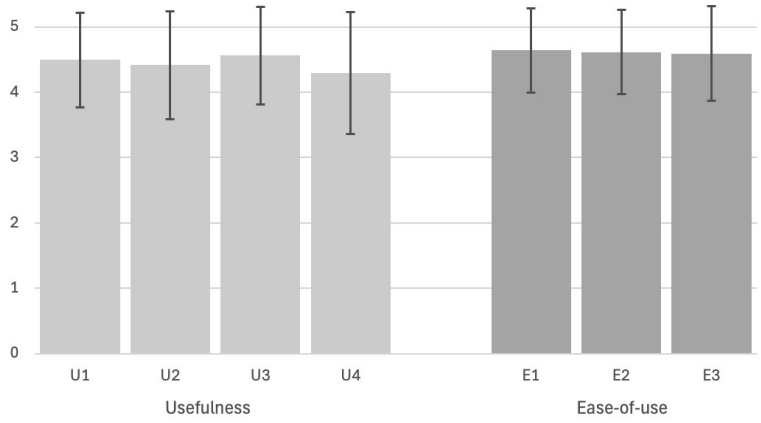

Figure 2. Graph indicating the mean (columns) and standard deviation (error bars) for each survey item.

The result that ease-of-use is scored higher than usefulness was also observed when results were broken down by implementation (see Table 4 and Figure 3). In addition, when comparing these implementations by context and modality, i.e., when comparing the *alternative online* implementation C with the *undergraduate in-person* implementations A, B, D, and E, the Kruskal-Wallis rank sum test found a significant difference, with participants in the alternative online implementation rating the usability and ease-of-use of the simulator lower than the undergraduate in-person participants ($\chi^2 = 14.6$, $df = 1$, $p = 1.33\text{x}10^{-4}$). Comparing these implementations by task used, i.e., comparing implementations A and D that used *growth pattern* tasks with implementations B and C that used *equivalent fractions* tasks and with implementation E that used the *rich mathematical* tasks, the Kruskal-Wallis rank sum test found no significant difference ($\chi^2 = 0.0479$, $df = 2$, $p = 0.976$).

Table 4. Summary statistics for usefulness and ease-of-use survey items for each implementation.

Implementation	Construct	Mean	Standard Deviation	n
A	Usefulness	4.62	0.641	232
	Ease-of-use	4.72	0.585	174
B	Usefulness	4.51	0.811	232
	Ease-of-use	4.68	0.559	174
C	Usefulness	4.15	1.005	60
	Ease-of-use	4.36	0.743	45
D	Usefulness	4.30	0.807	160
	Ease-of-use	4.43	0.741	120
E	Usefulness	4.29	0.942	116
	Ease-of-use	4.68	0.814	87

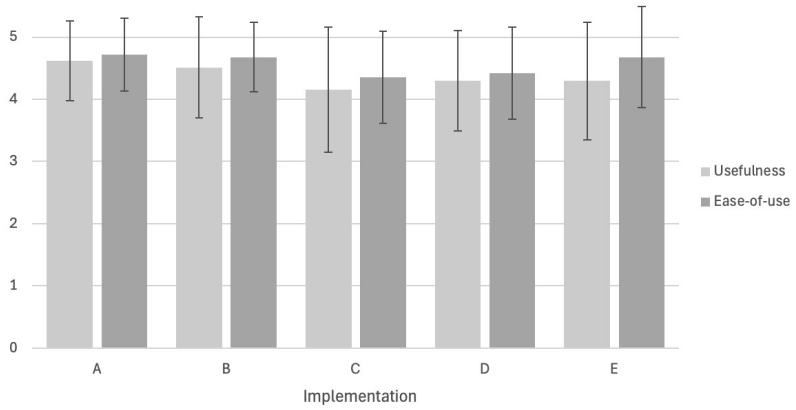

Figure 3. Graph indicating the mean (columns) and standard deviation (error bars) for usefulness and ease-of-use survey items for each implementation.

Implications

These results show that over the five implementations, pre-service teachers' perspectives of the chat-based dialogue simulator were high, and they somewhat to strongly agreed that the simulation is both useful and easy to use. These results imply that chat-based dialogue simulations can be well received by pre-service teachers and usable in coursework. Further, the fact that no significant difference was found when different tasks were used indicates that pre-service teachers' perspectives of the simulator are fairly robust and that different customizations of the simulation scenarios are unlikely to make a significant difference to their views of the simulator. This is particularly important given the potential for the simulator to scale and be used in a variety of teacher preparation contexts.

Results showed a statistically significant difference between the usefulness and ease-of-use scores, with ease-of-use scoring higher than usefulness across all implementations. This might indicate that the usefulness of specific components of the simulator could be improved when refining the simulator design in future, however, the simulation feedback is rated as most useful, followed by the visualization, so other aspects of the simulation implementation might be considered for future implementations.

Results also showed differences between the in-person undergraduate course implementations when compared with the online alternative course implementations. While the online tool was accessed in the same way in all courses, there are many other factors that could have impacted the experience of the tool with pre-service teachers enrolled in the online alternative program, and this result shows that these factors need to be further explored.

Given that this study was conducted at only one institution and uses an exploratory design that prevents causal comparisons, it is unclear how generalizable these results are. Despite such limitations, the positive ratings found during this study indicate that using accessible online simulations tools like the one examined in this study has the potential to be accepted by pre-service teachers as a valuable part of their teacher preparation coursework.

References

Aguirre, J., Mayfield-Ingram, K., & Martin, D. (2013). *The impact of identity in K-8 mathematics: Rethinking equity-based practices.* The National Council of Teachers of Mathematics.

Boston, M. D., & Candela, A. G. (2018). The Instructional Quality Assessment as a tool for reflecting on instructional practice. *ZDM: International Journal of Mathematics Education, 50*(3), 427-444.

Bywater, J. P., Lilly, S., Datta, D., Ansari, A., Mohammad, A., Watson, G. S., Brown, D., & Chiu, J. L. (2025). The Role of Automated Post-Rehearsal Feedback on Pre-Service Mathematics Teacher Questioning. In *Annual Proceedings of Selected Papers Presented at the Convention of the Association for Educational Communications and Technology* (forthcoming). AECT.

Casey, J. E., Kirk, J., Kuklies, K., & Mireles, S. V. (2023). Using the technology acceptance model to assess how preservice teachers' view educational technology in middle and high school classrooms. *Education and Information Technologies, 28*(2), 2361-2382.

Chernikova, O., Heitzmann, N., Stadler, M., Holzberger, D., Seidel, T., & Fischer, F. (2020). Simulation-based learning in higher education: A meta-analysis. *Review of Educational Research, 90*(4), 499-541.

Cohen, J., Wong, V., Krishnamachari, A., & Berlin, R. (2020). Teacher coaching in a simulated environment. *Educational Evaluation and Policy Analysis, 42*(2), 208-231.

Datta, D., Bywater, J. P., Phillips, M., Lilly, S., Chiu, J. L., Watson, G. S., & Brown, D. E. (2023). Classifying mathematics teacher questions to support mathematical discourse. In *International Conference on Artificial Intelligence in Education* (pp. 372-377). Cham: Springer Nature Switzerland.

Davis, F. D. (1989). Technology acceptance model: TAM. *Information Seeking Behavior and Technology Adoption*, 205, 219.

Grossman, P., Hammerness, K., & McDonald, M. (2009). Redefining teaching, re-imagining teacher education. *Teachers and Teaching: Theory and Practice, 15*(2), 273–289.

Herbst, P., Chieu, V. M., & Rougee, A. (2014). Approximating the practice of mathematics teaching: What learning can web-based, multimedia storyboarding software enable? *Contemporary Issues in Technology and Teacher Education, 14*(4), 356-383.

Howell, H., & Mikeska, J. N. (2021). Approximations of practice as a framework for understanding authenticity in simulations of teaching. *Journal of Research on Technology in Education, 53*(1), 8–20.

King, W. R., & He, J. (2006). A meta-analysis of the technology acceptance model. *Information & management, 43*(6), 740-755.

Lee, C., Lee, T., Dickerson, D., Castles, R., & Vos, P. (2021). Comparison of peer-to-peer and virtual simulation rehearsals in eliciting student thinking through number talks. *Contemporary Issues in Technology and Teacher Education, 21*(2), 294-324.

Liljedahl, P. (2020). *Building thinking classrooms in mathematics, grades K-12: 14 teaching practices for enhancing learning.* Corwin Press.

Mikeska, J. N., Howell, H., & Kinsey, D. (2022). Do Simulated Teaching Experiences Impact Elementary Preservice Teachers' Ability to Facilitate Argumentation-Focused Discussions in Mathematics and Science? *Journal of Teacher Education,* 00224871221142842.

National Council of Teachers of Mathematics (2014). *Principles to actions: Ensuring mathematical success for all.* Reston, VA: National Council of Teachers of Mathematics.

Oakes, J., Joseph, R., & Muir, K. (2001). Access and achievement in mathematics and science. In J. A. Banks & C. A. McGee Banks (Eds.), *Handbook of research on multicultural education* (pp. 69-90). San Francisco, CA: Jossey-Bass

Qualls, L. W., Carlson, A., Scott, S. N., Cunningham, J. E. M., & Hirsch, S. E. (2024). Special Education Teachers' Preservice Experiences With Mixed-Reality Simulation: A Systematic Review. *Teacher Education and Special Education, 47*(2), 124-141. https://doi.org/10.1177/08884064231226255

Smith, M. & Stein, M. K. (2018). *5 Practices for orchestrating productive mathematics discussion.* Reston, VA: National Council of Teachers of Mathematics.

Thompson, M., Leonard, G., Mikeska, J. N., Lottero-Perdue, P. S., Maltese, A. V., Pereira, G., ... & Reich, J. (2022). Eliciting Learner Knowledge: Enabling Focused Practice through an Open-Source Online Tool. *Behavioral Sciences, 12*(9), 324.

Virginia Department of Education. (2020). *Rich mathematical tasks.* Virginia Department of Education. https://www.doe.virginia.gov/teaching-learning-assessment/k-12-standards-instruction/mathematics/instructional-resources/rich-mathematical-task

Weston, T., Kosko, K., Amador, J., & Estapa, A. (2018). Preservice teachers' questioning: Comparing platforms for practice-based teacher education. *Journal of Technology and Teacher Education, 26*(1), 149-172.

Yeo, S., Rutherford, T., & Campbell, T. (2022). Understanding elementary mathematics teachers' intention to use a digital game through the technology acceptance model. *Education and Information Technologies, 27*(8), 11515-11536.

Zeichner, K. (2012). The turn once again toward practice-based teacher education. *Journal of Teacher Education, 63*(5), 376-382.

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