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Virtual Pedagogy, Real Impact: Exploring Zoom-Based Repeated Microteaching Rehearsals in Elementary Science Teacher Preparation

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This study explored the implementation of online repeated microteaching rehearsals (RMTRs) within an elementary science methods course, examining its potential to enhance elementary teacher candidates' (ETCs) instructional development. The study employed a mixed-methods approach, collecting both qualitative and quantitative data to assess ETCs' experiences with online RMTRs. Findings indicate that ETCs (n = 283) generally perceived RMTRs as beneficial for refining their teaching skills, increasing confidence, and enhancing engagement. While the iterative nature of RMTRs provided opportunities for progressive improvement, reflection, and adaptation, some challenges were noted, including technical difficulties and cognitive overload. This study contributes to the literature on teacher education by exploring how structured, iterative microteaching experiences can be integrated into online learning environments to support ETCs. Implications for teacher preparation programs and suggestions for future research are discussed.

Elementary teacher candidates (ETCs) often enter teacher preparation programs with limited experience in teaching science, contributing to lower confidence and self-efficacy in science instruction (Allaire et al., 2023; Brígido et al., 2013; Gunning & Mensah, 2011; Pecore et al., 2023). This issue is exacerbated by the limited time allocated for science instruction in elementary classrooms and the emphasis on high-stakes testing in other subject areas. Teaching rehearsals, particularly microteaching and repeated teaching cycles, have been widely recognized as effective strategies for helping teacher candidates develop confidence, refine instructional strategies, and build pedagogical content knowledge (Hanuscin & Zangori, 2016; Lampert et al., 2013; Marble, 2007). Although it is expanding (e.g., Dieker et al., 2019; Sezaki et al., 2023; Zalavra & Makri, 2022), research on the integration of these strategies in online learning environments remains limited as compared to in-person rehearsals.

To build and support their science teaching self-efficacy and support science content knowledge acquisition, ETCs need as many opportunities as possible to rehearse teaching science and reflect upon their experience. ETCs also need to be able to teach and reflect under the guidance of a mentor teacher or teacher educator with expertise in science. In the wake of the COVID-19 pandemic, the educational landscape has undergone a seismic transformation (Stroupe & Christensen, 2023). With traditional classrooms coexisting with virtual learning environments, teacher educators must equip candidates with the skills and knowledge to navigate in-person and online teaching (Allaire, 2024; Sezaki et al., 2023; Sweeney et al., 2018), particularly in science content teaching.

Enter Zoom, a widely used video conferencing platform. Zoom became one of the most widely adopted platforms for synchronous online instruction during the COVID-19 pandemic, offering a versatile set of tools for teaching, collaboration, and virtual classroom management. The breakout room, in particular, is a dynamic Zoom feature that allows instructors to divide participants into smaller groups for more focused discussions, collaborative work, or for this study, teaching rehearsals. These virtual rooms simulate the small-group dynamics of an in-person classroom and enable more focused collaboration and can be managed by the host, who can assign participants manually or automatically.

Drawing inspiration from Chval (2004), Hanuscin (2004), and Hanuscin and Zangori (2016), repeated microteaching rehearsals (RMTRs) were adapted and integrated into online (during the pandemic) and hybrid (postpandemic) elementary science methods courses from fall 2020 to spring 2024. Through online RMTRs, instructors and ETCs engaged in an iterative cycle of practice, planning, and teaching, all within the virtual spaces of Zoom breakout rooms. This approach allowed for repeated refinements, skill enhancement, and confidence building.

The research questions guiding this study were as follows:

1. How can ETCs in a science methods course engage in a low-risk/high-impact, iterative teaching experiences that maximize limited instructional time?

2. How can RMTRs be tailored for online science teaching and learning environments?

By addressing these questions, this study contributes to the growing body of research on the role of digital tools in teacher education with a focus on elementary science teaching and offers insights into the potential benefits and challenges of online RMTRs.

Guiding Literature and Theoretical Framework

Teaching rehearsals (practice teaching) are widely recognized as essential for developing elementary ETCs' confidence and instructional expertise (Imasiku & Bacchiocchi, 2022; Javeed, 2019; Masters, 2020). Whether in the classroom, the field, or a virtual setting, teaching rehearsals provide ETCs with opportunities to refine teaching strategies, deepen content knowledge, and enhance their confidence under the guidance of experienced educators (Ghousseini, 2017; Kazemi et al., 2016; Sezaki et al., 2023).

RMTRs, particularly in online environments, allow candidates to engage in cycles of teaching, feedback, and refinement, improving pedagogical skills through iterative practice. For elementary science, in particular, repeated teaching opportunities are essential, because many ETCs lack both prior experience and confidence in delivering science instruction. Unlike other subjects, science often involves hands-on materials, inquiry-based questioning, and the explanation of complex concepts in age-appropriate ways, all of which benefit from iterative rehearsal, feedback, and refinement.

Research supports that well-structured online microteaching provides ETCs with a controlled yet immersive experience that fosters reflection and growth (Dieker et al., 2019; Imasiku & Bacchiocchi, 2022; Zalavra & Makri, 2022). Furthermore, teaching rehearsals influence ETCs' self-efficacy, which has implications for retention in the profession and student achievement (Morris et al., 2017; Naidoo & Naidoo, 2021).

Compared to other content areas, elementary teachers frequently express uncertainty and discomfort when it comes to teaching science, often citing limited preparation, content knowledge gaps, and a lack of confidence in delivering science instruction (Banilower et al., 2018; Brígido et al., 2013). These challenges are compounded by the broad curricular responsibilities of elementary teachers, who must teach multiple disciplines, and the overemphasis on standardized testing, which often prioritizes reading and mathematics over science instruction — an imbalance well documented in the 2018 National Survey of Science and Mathematics Education (NSSME+ report; Plumley, 2019). Additionally, the transition to online/hybrid learning can further limit ETCs' access to authentic science teaching experiences (Kokkinos, 2022; Zalavra & Makri, 2022).

To strengthen their science teaching self-efficacy and improve content knowledge, ETCs require repeated opportunities to practice and reflect on their teaching. The role of mentor teachers and teacher educators in guiding these rehearsals is critical, particularly in online and hybrid learning environments. Zoom breakout rooms have emerged as a valuable tool for facilitating virtual teaching rehearsals, allowing teacher educators to structure peer interactions and provide immediate feedback within a controlled, small-group setting (Sezaki et al., 2023). This study leverages RMTR within Zoom breakout rooms to provide ETCs with structured, iterative teaching experiences that support instructional development in an online format. For elementary science teaching in particular, Zoom breakout rooms offer a structured environment where ETCs can rehearse explaining scientific concepts clearly, practice facilitating inquiry-based discussions, and receive targeted feedback. These essential skills are often underdeveloped due to limited field-based opportunities (Hanuscin, 2004; Marble, 2007).

Despite increased attention to teacher preparation programs and science-related professional development, elementary teachers continue to report feeling underprepared to teach science. The 2018 NSSME+ found that only 31% of self-contained elementary teachers felt “very well prepared” to teach science, compared to 77% for reading/language arts and 73% for mathematics (Banilower et al., 2018; Plumley, 2019). This disparity extends to specific science disciplines, with only 13% feeling “very well prepared” to teach physical science, compared to 24% for life science and 20% for earth/space science. Similarly, fewer elementary teachers felt confident in key science-related tasks, such as developing students’ conceptual understanding (23%), differentiating instruction for diverse learners (19%), and engaging students in scientific inquiry (17%; Banilower et al., 2018; Plumley, 2019).

Teaching rehearsals help bridge these gaps by approximating real classroom environments in structured, low-risk settings (Allaire, 2024; Cavanaugh, 2022; Long et al., 2019). While the structure of rehearsals varies, they generally involve ETCs planning, teaching, and receiving feedback, either by modeling mentor-instructor lessons or independently designing and delivering lessons in a methods course (Hanuscin, 2004; Javeed, 2019; Masters, 2020). Regardless of the format, rehearsals provide a structured environment where ETCs refine their instructional approaches and develop reflective teaching practices (Kazemi et al., 2016; Lampert et al., 2013).

Research suggests that when teaching rehearsals are designed around cycles of reflection and feedback, they can be especially powerful for supporting inquiry-based science instruction. For example, Lampert et al. (2013) found that structured rehearsal opportunities helped ETCs deepen their pedagogical content knowledge by focusing on specific teaching moves, such as facilitating student discourse and probing scientific thinking. These findings are echoed in more recent work on virtual rehearsals in science methods courses (Imasiku & Bacchiocchi, 2022) and in studies linking rehearsal to increased confidence and emotional readiness to teach science (Brígido et al., 2013).

Hanuscin (2004) found that teacher candidates perceived instructional improvements after engaging in structured teaching rehearsals. Similarly, findings by Heider (2020) suggest that rehearsal, when integrated with actionable feedback and scaffolded coaching, supports the transfer of theory into practice and enhances novice teachers’ ability to adapt instructional strategies effectively.

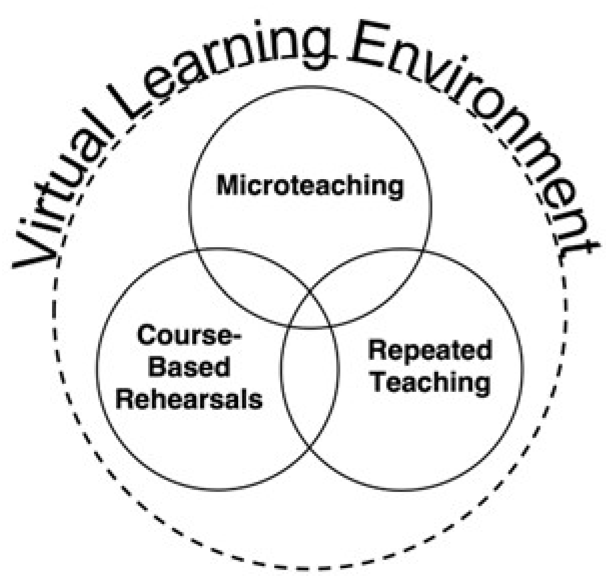
Long et al. (2019) demonstrated that science teaching rehearsals improved passing rates on science certification exams, particularly among ETCs who had previously struggled with the content. Reich (2022) went further and called for teacher preparation to integrate and prioritize structured, low-stakes practice sessions that focus on specific teaching skills.

There are multiple ways to implement science teaching rehearsals, including field-based, course-based, and virtual/simulated approaches (Lee et al., 2021; Lee et al., 2024; Pecore et al., 2023). While field-based experiences remain common, the potential for online RMTR to address logistical challenges and expand access to structured teaching opportunities is increasingly recognized (Dieker et al., 2019; Kokkinos, 2022; Lee et al., 2021).

Theoretical Framework

This study employed a theoretical framework that integrates concepts from course-based rehearsals, microteaching, and repeated teaching (see Figure 1). *Course-based rehearsals* extend this concept by integrating microteaching into structured coursework, ensuring consistent opportunities for practice (Imasiku & Bacchiocchi, 2022; Masters, 2020). *Microteaching*, introduced in the 1960s, breaks down teaching into manageable components, allowing candidates to focus on specific instructional skills in a controlled setting (Cavanaugh, 2022; Hama & Osam, 2021). *Repeated teaching cycles*, as described by Hanuscin (2004), Imasiku and Bacchiocchi (2022), Marble (2007), and Xie et al. (2021) further built on this framework by incorporating iterative lesson delivery, providing ETCs with multiple opportunities to refine their instruction through repeated practice and reflection.

Figure 1
Theoretical Framework Merging Concepts Related to Course-Based Rehearsals, Microteaching, and Repeated Teaching Within a Virtual Learning Environment



Course-Based Rehearsals

Course-based rehearsals provide ETCs with structured opportunities to practice lesson delivery within a controlled setting, often among peers and instructors rather than in K-12 classrooms (Heider, 2020; Imasiku & Bacchiocchi, 2022; Kazemi et al., 2016; Lampert et al., 2013). Although these rehearsals do not fully replicate classroom teaching, they offer consistent, accessible practice that helps address the lack of instructional opportunities in elementary science (Allaire, 2024; Banilower et al., 2018; Plumley, 2019).

Course-based rehearsals also afford teacher educators greater flexibility in designing scaffolded learning experiences, whether online, in-person, or hybrid (Long et al., 2019; Reich, 2022; Xie et al., 2021). Additionally, research suggests that rehearsals within methods courses allow for increased instructor guidance and immediate feedback, helping candidates refine their instructional approaches before entering field-based placements (Kazemi et al., 2016; Lampert et al., 2013; Reich, 2022).

Microteaching

Microteaching enables ETCs to refine instructional skills in a structured, low-risk environment, focusing on lesson pacing, questioning strategies, and pedagogical techniques (Cavanaugh, 2022; Hama & Osam, 2021). This approach allows candidates to practice discrete teaching skills in short, focused sessions, receive targeted feedback, and make immediate adjustments. Research has demonstrated that microteaching contributes to increased teaching self-efficacy, instructional adaptability, and confidence in lesson delivery (Hama & Osam, 2021; Kokkinos, 2022). For example, a study by Kusmawan (2017) demonstrated that an online microteaching program significantly enhanced teachers' confidence, with over 80% reporting improvements in their professional teaching. In the context of this study, micro referred to the duration of the lesson (15-20 minutes) and the focus on a specific teaching skill, such as science, to address the limited experience many ETCs have in teaching this subject (Long et al., 2019).

Repeated Teaching

Repeated teaching extends the microteaching model by incorporating iterative cycles of reflection, revision, and reteaching, which enhances both content mastery and pedagogical adaptability (Imasiku & Bacchiocchi, 2022; Xie et al., 2021). In many teacher preparation programs, teaching rehearsals are structured as **one-shot lessons,** in which candidates plan, teach, and reflect on a single lesson, often receiving feedback only after the full lesson has been delivered (see Figure 2). Due to time constraints in field placements and methods course schedules, this one-time approach has become the norm for instructional rehearsals in teacher education.

By contrast, RMTRs represent a full teaching cycle, involving not only the initial rehearsal but also opportunities for immediate feedback, revision, and reteaching (see Figure 3). These iterative cycles allow candidates to test instructional strategies, receive peer and instructor input, and adapt their lessons in real time, creating a more dynamic and responsive learning experience.

For example, a teaching team leading a lesson on balanced and unbalanced forces initially presented key concepts before engaging students with examples, leading to confused learners and limited interaction. Between iterations, the team revised the order of their lesson to begin with relatable, real-world scenarios (e.g., pushing a stalled car or playing tug-of-war) and then introduced the scientific concepts. They also refined their questioning strategies to prompt more interaction and deeper thinking, shifting from yes/no checks to open-ended prompts like, "What do you think would happen if...?" These changes led to more accurate student explanations and clearer distinctions between balanced and unbalanced forces in the final teaching round. This approach provides ETCs with multiple opportunities to refine their instructional methods, improving their ability to respond to diverse classroom scenarios. Research highlights that repeated teaching promotes deeper engagement with pedagogical content knowledge and supports the development of more effective, student-centered teaching practices (Long et al., 2019; Masters, 2020).

This study integrated these frameworks within an online RMTR model, leveraging Zoom breakout rooms and other digital tools to facilitate deliberate practice in a virtual environment. This distinction between traditional rehearsals and repeated teaching cycles is central to understanding the pedagogical value of RMTR as implemented in this research.

Figure 2
Traditional One-Shot Teaching Rehearsal: Etcs Plan, Teach, and Reflect on a Single Lesson Without Iterative Refinement

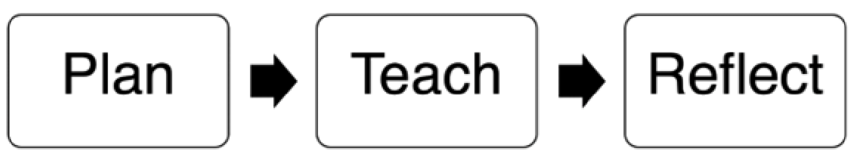
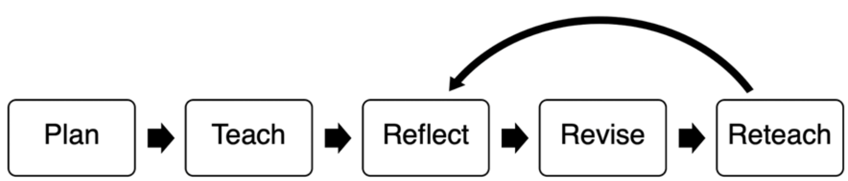


Figure 3
RMTR Cycle: ETCs Plan, Teach, Receive Feedback, Revise, and Reteach Their Lesson Across Multiple Iterations



Online Repeated Microteaching Rehearsals for Science Teaching

The shift to online learning has created new opportunities for integrating RMTR cycles into digital environments. Online RMTR builds upon the principles of course-based rehearsals, microteaching, and iterative teaching cycles, while also leveraging technological affordances that enhance flexibility and accessibility. Virtual platforms, such as Zoom, provide structured spaces for ETCs to engage in iterative practice and receive immediate feedback from peers and instructors (Imasiku & Bacchiocchi, 2022; Sezaki et al., 2023). Research has shown that online teaching rehearsals yield similar benefits to in-person experiences, fostering self-efficacy, instructional clarity, and content mastery (Dieker et al., 2019; Imasiku & Bacchiocchi, 2022; Lee et al., 2024; Pecore et al., 2023).

One advantage of online RMTR is its ability to remove logistical constraints often associated with in-person rehearsals. For example, when RMTR was conducted face-to-face in a science methods course, multiple teaching teams often delivered their lessons simultaneously in the same classroom, which led to high noise levels, distractions, and difficulty hearing student-teacher interactions. Additionally, coordinating movement of students between teaching groups was cumbersome, and the instructor was unable to observe each group equally due to being physically limited to one space at a time (Allaire, 2024).

Online platforms eliminate these barriers, allowing ETCs to engage in multiple cycles of rehearsal within structured virtual breakout rooms. Additionally, online RMTR provides opportunities for recorded teaching sessions, enabling ETCs to revisit their performances, analyze their instructional strategies, and refine their approaches based on structured self-reflection and instructor feedback.

Despite these advantages, online RMTR also presents unique challenges. The absence of physical classroom dynamics, such as direct student engagement and hands-on learning experiences, may limit some aspects of instructional preparation (Imasiku & Bacchiocchi, 2022; Kusmawan, 2017; Lee et al., 2024). However, research indicates that integrating digital tools (e.g., Kahoot!, Padlet, and Pear Deck), interactive simulations (e.g., PhET and Gizmo), and multimedia resources can help mitigate these limitations by creating engaging, inquiry-based online teaching environments (Hama & Osam, 2021; Pecore et al., 2023; Sezaki et al., 2023). This study situated online RMTR as a promising approach for addressing the challenges of elementary science teacher preparation while expanding access to high-quality teaching rehearsals in virtual settings.

Methods

Multiple factors limit ETCs' opportunities to practice teaching science in a public research university's teacher preparation program, including a lack of control over field experience lesson scheduling, variations in mentor teachers' science expertise, and an institutional emphasis on reading, writing, and mathematics due to standardized testing. RMTR was initially integrated into pre-COVID-19 science methods courses with limited success (Allaire, 2024). However, during the rapid transition from in-person to fully online courses in early 2020, RMTR, like many instructional components, was adapted for digital environments. Even as university courses returned to hybrid and in-person formats, online RMTR remained a valuable instructional tool.

Setting and Participants

This study was conducted at a federally designated Minority-Serving and Hispanic-Serving Institution (HSI) in an urban metropolitan area of the southern United States. The university serves a predominantly Hispanic student population, with many undergraduates identifying as first-generation college students, balancing full-time employment, family commitments, and academic responsibilities. University data indicate that approximately 54% of undergraduates identify as Hispanic, with Hispanic females having the highest graduation rate (23%). Within the department, 92% of undergraduates are female, 73% identify as Hispanic/Latinx, and the average age is 28.51 years (Data USA, 2022; University, 2022). The demographics of RMTR participants closely mirror these institutional trends (see Table 1).

Participants and Course Context

Participants in this study were undergraduate ETCs enrolled in science methods courses, which I taught, between spring 2020 and spring 2024. All participants were pursuing early childhood through sixth grade (EC-6) certification. At the beginning of each semester, a voluntary survey (93% response rate) was administered to gauge ETCs' comfort levels in teaching science relative to other disciplines (see Table 2). Findings aligned with prior national data, such as the NSSME+ survey (Banilower et al., 2018; Plumley, 2019), indicating that many ETCs felt less comfortable teaching science than other subjects.

Table 1
Demographics of Participating ETCs (n = 320)

Item	*N* (%)
Gender	
Female	94.6%
Male	5.4%
First/Home Language	
Spanish	60.2%
English	38.0%
Other	1.8%
Ethnicity	
Hispanic/Latinx	78.7%
White (Non-Hispanic)	11.3%
Black/African American	5.9%
Asian	1.4%
Pacific Islander	0.9%
Multiracial	0.5%
Certification Area	
Bilingual	55.7%
ESL	44.3%

In the teacher preparation program ETCs are expected to teach multiple subjects to the same group of students during field experiences. However, due to curricular constraints and an institutional focus on literacy and mathematics due to standardized testing, opportunities to teach science in the field are limited. As a result, elementary science methods courses integrate science teaching rehearsals into coursework, ensuring ETCs gain instructional practice in this subject area.

Table 2
ETC Self-Report on Disciplinary Comfort (n = 303)

Item	*N* (%)
How would you describe your comfort level with teaching science?	
4 = *Very comfortable*	29.6%
3 = *Somewhat comfortable*	32.4%
2 = *Somewhat uncomfortable*	35.2%
1 = *Very uncomfortable*	2.8%
How would you describe your comfort level for teaching Reading/English Language Arts?	
4 = *Very comfortable*	43.7%
3 = *Somewhat comfortable*	36.6%
2 = *Somewhat uncomfortable*	15.5%
1 = *Very uncomfortable*	4.2%
Which of the following science content areas are you MOST comfortable?	
Physical science (chemistry)	7.0%
Physical science (physics)	1.4%
Life science	66.2%
Earth and space science	25.4%

Elementary Science Methods Course

Elementary Science Methods is a required one-semester course taken the semester before student teaching. The course engages ETCs in age-appropriate, inquiry-based science activities and instructional strategies. ETCs learn to integrate science with other disciplines, develop lesson plans, and reflect on their teaching experiences. The course also includes four field-based teaching rehearsals, two per semester. However, due to field placement constraints, these rehearsals rarely include science instruction. Thus, for many ETCs, the science methods course provides the only structured opportunity to plan and teach science lessons before entering the field.

Lesson Structure and Facilitation

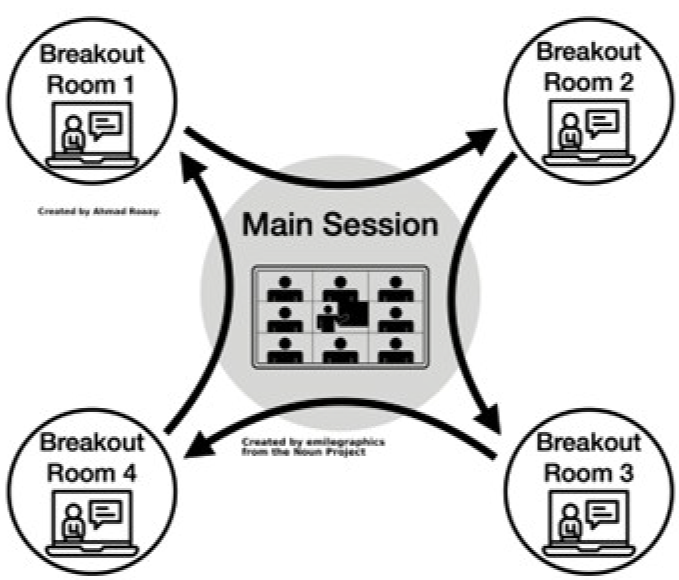
As described in Allaire (2024), the online RMTR was first integrated into science methods courses in spring 2020, in response to the COVID-19 pandemic, and continued through spring 2024, spanning eight semesters.

Zoom was selected as the primary platform for its accessibility, reliability, and the utility of features such as breakout rooms, screen sharing, andrecording. Small groups of randomly selected ETCs (no more than three per group) planned and delivered science minilessons based on assigned science teaching competencies. Topics and teaching competencies were assigned approximately 3 to 4 weeks prior to the RMTR session, allowing candidates ample time for planning, instructor consultation, and individual or group meetings to preview lesson drafts. Each lesson lasted approximately 15 minutes and incorporated content instruction, a reinforcing activity or demonstration, and a brief assessment.

ETCs completed the RMTR cycle by delivering their lesson multiple times within a single class session, teaching to different groups of rotating “students” in a round-robin breakout room format (see Figure 4). While “teachers” remained in a fixed breakout room, “students” rotated between rooms every 15 minutes. This format allowed candidates to engage in repeated, low-risk practice while observing peer instruction. Between rounds, teachers had short debriefing periods (~5 minutes) to revise their lesson based on informal peer feedback. Peer feedback was collected through the Google Forms web-based application, and collaborative planning and revision often occurred via the Google Docs web-based application. Final lesson iterations were recorded through Zoom for subsequent review and instructor assessment.

This online structure allowed for a flexible and scalable implementationof RMTR, removing common logistical barriers, such as space constraints and scheduling conflicts. It also offered ETCs the opportunity to hone their instructional techniques and receive feedback in real time creating a dynamic and iterative cycle of planning, teaching, revision, and reflection.

Figure 4
Example of Online RMTR Facilitated Through Four Breakout Rooms on Zoom



Debriefing and Reflection

Following the RMTR sessions, participants reconvened in the main Zoom session for a structured debriefing discussion. Questions during the debriefing discussion focused on teaching online (e.g., What were the biggest challenges you faced when teaching in an online format? How did the digital environment shape your instructional choices or classroom presence?), RMTR structure and reflection (e.g., How did your lesson change between the first and final iteration? What drove those changes, and how did they impact your confidence or clarity in teaching science content?) and connecting to science pedagogy (e.g., In what ways did RMTR help you think more deeply about how to teach scientific concepts to young learners?).

These types of guided questions prompted ETCs to identify lesson strengths and areas for improvement. "Students" shared peer feedback, while "teachers" reflected on their iterative teaching experiences. These discussions served as a foundation for the written lesson reflections, a key data source for this study.

Data Collection and Analysis

The study included ETCs enrolled in an elementary science methods course that incorporated RMTR. Participation in the research component was voluntary, and all ETCs engaged in the RMTR process as part of their coursework. However, only responses from ETCs who consented to research use were included in the final analysis. No other exclusion criteria were applied.

Qualitative Data

Two primary qualitative data sources were used: (a) lesson reflections, which were required course assignments, and (b) optional anonymous surveys, which gathered additional participant insights. The lesson reflection prompts mirrored those in the class wide debriefing discussion and asked ETCs to individually evaluate their lesson's strengths, describe changes they made between iterations, and assess their overall teaching experience. These responses underwent inductive thematic analysis (Creswell & Plano Clark, 2018; Creswell & Poth, 2025). Themes were identified through open coding, clustered into categories, and refined through constant comparative method (Clandinin & Rosiek, 2007). To support trustworthiness, a second researcher independently coded a subset of responses to assess intercoder reliability and discrepancies were resolved through consensus.

Quantitative Data

ETCs were also invited to complete an optional online survey that differentiated between "teacher" and "student" experiences. Each section contained a combination of Likert-scale items and open-ended questions. Participants rated statements such as, "My lesson improved with increasing teaching experience" (teacher), and, "All 'teachers' demonstrated preparedness, and their lessons were comprehensive and beneficial" (student). Open-ended items asked participants to share feedback about what they liked most and least about RMTR. The survey response rate was 94%.

To evaluate the perceived effectiveness of RMTR quantitatively, one-sample *t*-tests were conducted comparing participant ratings to neutral values (e.g., 2.0 for engagement, 2.5 for improvement). Tests examined whether ratings significantly exceeded neutral benchmarks. Standard deviations and confidence intervals were reported to interpret variability, and Cronbach's alpha was calculated to assess internal consistency. Shapiro-Wilk tests were used to evaluate normality assumptions, confirming that parametric testing was appropriate.

Mixed-Methods Integration

While qualitative and quantitative data were analyzed separately using appropriate analytic techniques, the interpretation phase employed a convergent mixed-methods approach (Creswell & Plano Clark, 2018). Themes from reflection responses were compared with patterns in survey results to triangulate findings and provide additional evidence regarding the ways ETCs experienced instructional growth through RMTR. This integration allowed the study to provide a more comprehensive account of both the measurable outcomes and nuanced reflections associated with repeated teaching in an online setting.

Results

Both qualitative and quantitative data were collected to assess the impact of online RMTR on ETCs' instructional development. The findings indicate that the iterative nature of RMTR was well received, with participants reporting increased lesson effectiveness, engagement, and confidence in their teaching abilities. The qualitative analysis revealed key themes related to progressive improvement, reflection and adaptation, increased comfort and confidence, and technical and logistical refinement, providing deeper insight into the ways ETCs experienced the iterative teaching process. The quantitative results summarize participant responses, highlighting the benefits of repeated microteaching rehearsals in an online format.

Quantitative Results

"Teacher" Perceptions of Online RMTR

Survey data from 283 ETCs revealed strong support for RMTR's iterative teaching structure (see Table 3). More than 97% of participants reported that they liked the repeated microteaching format, and 94% appreciated the opportunity to reteach lessons. Notably, 100% of ETCs agreed that revising and reteaching improved their instructional skills. Confidence in teaching also improved, with 76.5% of participants feeling more confident in teaching science following RMTR.

Table 3
"Teacher" Survey Results

Item	*N* (%)
Compared to course and/or field lessons, was the experience of teaching your lesson multiple times better or worse?	
Better	76.5%
Same	20.6%
Worse	2.9%
Compared with other course- and/or field-based lessons, was RMTR more or less engaging?	
More engaging	35.3%
About the same	52.9%
Less engaging	11.8%
Did you like the structure of the repeated microteaching rehearsal?	
Yes	97.1%
No	2.9%
Did you like being able to teach your lesson multiple times to different groups of students?	
Yes	94.1%
No	5.9%
Did you like being able to revise and reteach your lesson?	
Yes	100.0%
No	0.0%
Did participating in RMTR, as compared to other course- and/or field-based lessons, make you more or less confident in your teaching abilities?	
More confident	70.6%
About the same	29.4%
Less confident	0.0%
Did participating in RMTR, as compared to teaching other course- and/or field-based lessons, make you more or less confident in your ability to teach science?	
More confident	76.5%
About the same	20.6%

Item	*N* (%)
Less confident	2.9%
My lesson improved as I gained more experience teaching it	
Strongly disagree	2.9%
Disagree	2.9%
Agree	35.3%
Strongly agree	58.8%

A one-sample *t*-test showed that the mean rating for perceived lesson improvement ($M = 3.81$, $SD = 0.45$) was significantly higher than neutral, (2.5), $t(282) = 49.15$, $p < 0.001$. These results indicate that ETCs strongly valued RMTR's iterative teaching structure and found it beneficial for their instructional development. Additionally, Cronbach's alpha for lesson improvement and confidence measures was $\alpha = 0.87$, indicating strong internal reliability among survey items.

"Student" Perceptions of Online RMTR

Participants in the role of students also responded favorably to online RMTR (see Table 4). When comparing RMTR to traditional teaching rehearsals, 50% of students found it more engaging, while 46.9% found it equally engaging. Additionally, 72% of students strongly agreed that their assigned teachers were well-prepared and that the lessons were helpful.

ETCs' engagement with RMTR was significantly higher than neutral (2.0). A one-sample *t*-test showed that RMTR engagement ratings ($M = 2.47$, $SD = 0.57$) were significantly higher than neutral, $t(31) = 4.68$, $p < 0.001$. This result demonstrates that RMTR was perceived as a more engaging alternative to traditional course- and field-based teaching rehearsals. Similarly, Cronbach's alpha for the student engagement responses was $\alpha = 0.84$ – a reliable measure of student perceptions. Students were asked whether multiple microlessons were more engaging than a single, longer lesson. The mean rating ($M = 2.47$, $SD = 0.72$) was significantly higher than neutral, (2.0), $t(31) = 3.69$, $p < 0.001$. This result suggests that students preferred the iterative microteaching structure over a traditional, extended lesson format.

Table 4
"Student" Survey Results

Item	*N* (%)
Compared with other course- and/or field-based lessons, was RMTR more or less engaging?	
More engaging	50.0%
About the same	46.9%
Less engaging	3.1%
Did you like the structure of the repeated microteaching rehearsal?	
Yes	90.6%
No	9.4%
All of the "teachers" were prepared, and the lessons were thorough and helpful	
Strongly disagree	0.0%
Disagree	1.3%
Agree	26.8%
Strongly agree	72.0%
Compared to other practice lessons you have seen, do you feel that the multiple micro lessons were more or less engaging than a single, longer lesson?	
More engaging	59.4%
About the same	28.1%
Less engaging	12.5%
How much would you say you learned from the different lessons you participated in today?	
I've learned a lot of things	50.0%
I've learned some things	34.4%
I've learned a few things	15.6%
I hardly learned anything	0.0%
Because teachers were able to revise and reteach, you may have seen a slightly different version of the lesson than other students. Do you feel you "missed out" on some lessons because you did not participate in the final version?	
Yes	30.0%
No	70.0%

Qualitative Results

A thematic analysis of ETCs' lesson reflections identified four key themes that captured their experiences with online RMTR: progressive improvement, reflection and adaptation, increased comfort and confidence, and technical and logistical refinement. These themes illustrate how participants engaged with and benefited from the iterative teaching process.

Progressive Improvement

ETCs overwhelmingly reported that their teaching skills improved as they progressed through multiple iterations of their lessons. Reflection data indicated that participants recognized the value of repetition in strengthening their instructional strategies, pacing, and delivery. One ETC said, *"My lesson got way better as I gained experience. I almost feel like it was perfect by the fourth try."* A separate ETC reflected that "repeating the lesson helped me improve my pacing and how I explained the science concepts. I was able to see where students got confused and clarify it better the next time." Similarly, another noted, *"The second time around, we had a better grasp on our time limits."* These insights highlight the transformational nature of repeated teaching experiences, reinforcing the idea that structured practice enhances instructional competence.

Additionally, ETCs expressed a sense of accomplishment and ownership over their teaching as they refined their lessons. Many reported that each iteration provided an opportunity for targeted improvement, ultimately leading to more effective and confident teaching performances. As one participant noted, *"The more we taught it, the easier it became."*

Reflection and Adaptation

The theme of reflection and adaptation emerged as a central aspect of RMTR's effectiveness. ETCs emphasized how the iterative nature of the experience allowed them to evaluate, adjust, and refine their lessons in real time. One participant reflected, *"The repeated lessons gave us time to grow and use our experience and student feedback to get better."* Another stated in their reflection, *"We found our mistakes at the end of the lesson while having our 5-minute break and talked about what we needed to fix." Further, another student noted that* "as each lesson was progressing, we were able to better explain the science and make connections to real-life examples. We changed the way we introduced the concept."

The rapid nature of reflection between lesson iterations prompted ETCs to make strategic modifications, such as adjusting explanations ("We started using more specific science terms."), reorganizing activities ("The fact that it was on Zoom…we had to change how we taught science because not all of the tools worked the same way as in person."), or enhancing student engagement strategies ("I got to try strategies like using Zoom reactions and direct questioning."). While some ETCs wished for longer reflection breaks, others felt that the fast-paced feedback cycle forced them to focus on essential lesson refinements, making their revisions more deliberate and effective.

Increased Comfort and Confidence

A notable theme in participant reflections was the increase in teaching confidence as they became more familiar with the material and the online teaching format. One participant described their growth, stating, *"At first, I was very nervous, but it got better as I repeated the lesson. My body language got less awkward, and I felt more confident."* Another noted*, "I was nervous at first, but once we completed the first rotation, we loosened up and felt much more confident." Similarly, another student reflected that* what they "liked the most about teaching the science lesson online was that it gave [them] the chance to explain a topic multiple times, to the point where [they] understood well and felt confident teaching it."

This pattern of progressive comfort and self-assurance was echoed by many participants. As they repeated their lessons, they became more comfortable with classroom management, timing, and instructional delivery. One ETC explained, *"Since I already knew what to do and say, my lesson went better."* This finding aligns with previous research suggesting that iterative teaching experiences can significantly enhance preservice teachers' self-efficacy and instructional confidence.

Technical and Logistical Refinement

Navigating the technical aspects of online teaching was an additional challenge that participants actively worked to refine throughout the RMTR process. Many ETCs initially struggled with time management, pacing, and integrating interactive elements but noted improvements with practice. One participant reflected, *"Time management was perfect after the second group. We finished right on time, with time for questions."*

ETCs also recognized the importance of overcoming technical challenges, such as managing Zoom breakout rooms and adjusting lesson materials for online delivery. One participant stated, *"We figured out the technical difficulties, which allowed us to share our activity with the students so they could participate."*Another noted, *"I was able to pace myself and not read everything from the slides."* These reflections underscore how ETCs developed adaptability and problem-solving skills that are critical for online and hybrid teaching environments.

Discussion and Implications

The findings of this study contribute to ongoing conversations about the role of technology in science teacher preparation and offer insights into how repeated microteaching can be used in online teacher preparation. The following discussion highlights key outcomes, challenges, and ideas for improvement. It also shares implications for other teacher educators who may want to use RMTR in their own courses.

Supporting Teaching Effectiveness Through Online RMTR

A key obstacle to developing ETCs' science teaching competence is the lack of opportunities for structured practice and feedback in science methods courses. This study contributes to teacher preparation research by examining how online RMTR might support elementary science teaching effectiveness, engagement, and instructional confidence. The findings highlight the importance of repeated teaching, structured reflection, and iterative feedback in developing pedagogical skills especially within an online environment. These findings align with previous calls to provide scaffolded, inquiry-oriented teaching experiences for preservice teachers (Hanuscin, 2004; Hanuscin & Zangori, 2016; Zalavra & Makri, 2022).

The results provide statistically significant evidence that online RMTR contributes positively to ETCs' lesson improvement and engagement. The strong *t*-test results ($p < 0.001$) reinforce the assertion that repeated microteaching and reflection enhance science teaching effectiveness in ways that traditional single-instance rehearsals may not achieve. This finding echoes past work demonstrating that opportunities for iterative, guided rehearsal can build both confidence and pedagogical content knowledge in elementary science (Banilower et al., 2018; Masters, 2020; Naidoo & Naidoo, 2021). Both the quantitative and qualitative results demonstrate that online RMTR shows promise as a strategy for supporting and improving ETCs' science teaching ability.

Although prior studies have highlighted the benefits of rehearsal-based learning in face-to-face environments (e.g., Ghousseini, 2017; Lee et al., 2024), the findings from this study suggest that online platforms, when structured thoughtfully through RMTR, can offer comparable, if not enhanced, opportunities for repeated practice, reflection, and growth. This counters assumptions that in-person formats are inherently superior for fostering pedagogical development.

Unlike traditional models of single-instance teaching that emphasize preparation and initial performance, this study shows that opportunities for reteaching in an online RMTR model led to deeper instructional reflection and adaptation. This finding supports a shift from performance-based evaluation to process-oriented development in teacher preparation (Lampert et al., 2013).

However, it is important to acknowledge the limitations of these findings, as the study lacks a control group for direct comparison, and self-reported data may be subject to participant bias. Future research should consider controlled experimental designs to validate these initial observations. Additionally, self-reported data from ETCs' surveys and reflections, while valuable, are inherently subjective and may be influenced by social desirability bias or retrospective reflections. Future studies could complement these insights with classroom observations, video analyses of teaching sessions, or external assessments of teaching quality to provide a more comprehensive evaluation of online RMTR's impact on instructional development.

Finally, anecdotal evidence suggests that RMTR may have influenced ETCs' ability to pass science certification exams. While this was not formally measured in this study, future research should investigate the relationship between RMTR participation and teacher certification outcomes (Marble, 2007; Xie et al., 2021).

Alignment With Existing Literature

Despite these limitations, the results presented mirror previous studies on using rehearsals to support both general teacher preparation (Imasiku & Bacchiocchi, 2022; Kazemi et al., 2016; Lee et al., 2024) and discipline-specific teacher preparation (Ghousseini, 2017; Long et al., 2019; Masters, 2020). In general teacher preparation, studies have shown that approximations of practice, such as rehearsals, allow teacher candidates to engage in professional learning that bridges coursework and field experience. For example, Kazemi et al. (2016) emphasized the importance of rehearsals as a means of developing responsive teaching and decision-making. Similarly, Lee et al. (2024) demonstrated that structured cycles of practice promote deeper understanding of teaching routines and reflective thinking.

Within discipline-specific contexts, rehearsal-based models have been used to support subject-matter pedagogy, particularly in math and science. Masters (2020) found that repeated science rehearsals helped teacher candidates better integrate content knowledge with effective pedagogy, while Ghousseini (2017) explored how repeated practice in mathematics instruction improved candidates' responsiveness to student thinking. These connections align with the present study's focus on how repeated online science teaching can enhance both confidence and instructional skill. This study provides evidence that RMTR can accomplish both in online environments.

ETCs participating in RMTR initially expressed nervousness and skepticism, yet they reported that the opportunity to teach, reflect, and reteach enhanced their instructional skills and confidence. Additionally, the statistically significant engagement ratings suggest that the iterative format of RMTR is preferable to single, extended lessons. This has practical implications for structuring teaching rehearsals in teacher education programs, where time constraints often limit opportunities for practice and refinement.

The RMTR model provides a structured way to maximize engagement while ensuring continued improvement through multiple iterations. The data also support the idea that students thrive in dynamic learning environments that offer real-time feedback and adaptation. The ability to reteach a lesson with modifications fosters confidence and allows participants to experiment with different instructional strategies, ultimately strengthening their pedagogical adaptability.

The qualitative results further illustrate the perceived benefits of RMTR. ETCs reported that multiple iterations of lesson delivery helped them refine their pacing, explanations, and engagement strategies. Participants also described gaining confidence with each iteration, transitioning from nervousness to self-assurance. This progression echoes Hanuscin's (2004) findings that inquiry-oriented teacher preparation models allow candidates to build and revise pedagogical strategies over time, with scaffolded support. Similarly, Naidoo and Naidoo (2021) emphasized that self-efficacy in science teaching develops through opportunities to test and refine instructional practices, which is something this study reinforces through the RMTR structure.

The critical role of repetition in pedagogical growth is also supported by Xie et al. (2021), who documented how multiple cycles of practice improved preservice teachers' ability to make responsive instructional decisions. In the context of science education, this repeated rehearsal becomes particularly important due to the cognitive demands of guiding student inquiry, addressing misconceptions, and promoting conceptual understanding (Hanuscin & Zangori, 2016). Online RMTR creates a context in which these complex tasks can be practiced, refined, and reflected upon. This process enhances not just procedural fluency but also pedagogical reasoning.

Taken together, these findings extend previous literature by showing how the core tenets of RMTR — repetition, real-time feedback, and structured reflection — can support the growth of novice science educators in online environments.

Challenges and Critiques of Online RMTR

Despite its benefits, online RMTR posed technical, logistical, and pedagogical challenges. Some ETCs struggled with unreliable internet access, leading to disruptions in their teaching. Additionally, the iterative structure required intentional planning and structured debriefing, which not all participants found equally beneficial.

"Teacher" Challenges

While most ETCs appreciated the repeated teaching and revision process, some noted fatigue and diminishing engagement by the final iteration. Several participants stated they felt "exhausted" or "drained" after teaching their lesson multiple times in a row, leading to lower energy and reduced student engagement. Others noted that student participation varied across iterations, sometimes affecting the overall lesson experience.

Despite encouraging active engagement in the lessons, a few ETCs commented on the challenge of teaching to "blank screens" in Zoom, where students opted not to turn on their cameras or actively participate. This variability in student involvement led some teaching teams to modify their strategies, incorporating structured engagement expectations, such as calling on students by name, using interactive tools like polls and chat prompts, and establishing behavioral norms, to increase participation and accountability. These adaptations not only supported more consistent student engagement but also offered opportunities for ETCs to refine their classroom management and questioning techniques in an online context.

"Student" Challenges

For "students" participating in RMTR, one of the primary critiques was cognitive overload. Some felt that moving through multiple short lessons in a single session made it difficult to retain information. Others noted that processing and reflection time between lessons was too brief, limiting their ability to synthesize what they had learned. Additionally, some ETCs critiqued their peers' engagement, stating that student participation levels varied, and some students remained quiet or disengaged during lessons.

Addressing Critiques and Strategies for Improvement

While online RMTR was well received, participant critiques highlight areas for refinement. ETCs reported lesson fatigue, cognitive overload, technical difficulties, and inconsistent student engagement. Addressing these concerns through intentional instructional design can enhance RMTR's effectiveness in teacher preparation. To reduce lesson fatigue, RMTR sessions could be spread across more instructional classes, allowing for cognitive rest and reflection. Implementing peer observation cycles, where ETCs alternate between teaching and observing, may also provide valuable metacognitive learning opportunities while minimizing burnout.

To address cognitive overload, future RMTR sessions could incorporate longer reflection periods between iterations, structured with guided prompts or coaching sessions to help ETCs process feedback more effectively. Technical difficulties highlight the need for explicit training in digital teaching strategies. Providing ETCs with best practices for online engagement, such as interactive tools (polls, chat discussions, and structured breakout rooms), could help combat the disengagement some faced when teaching to blank screens.

Finally, structured engagement expectations for students, such as calling on participants by name, establishing clear behavioral norms, and using interactive tools, could improve participation. These strategies were implemented by several teaching teams in response to observed inconsistencies in student involvement during the first round of RMTR lessons. However, assigning peer coaching roles and using active participation rubrics may increase participation, foster collaborative accountability, ensuring all ETCs contribute meaningfully. By refining RMTR with these strategic adjustments, teacher preparation programs can maximize its benefits, making iterative microteaching a more sustainable and impactful tool for developing future educators.

Online vs. In-Person RMTR: Lessons Learned

Before the COVID-19 pandemic, RMTR was implemented in-person during the spring and fall 2019 semesters with mixed results. While the pedagogical intent was well-received, logistical challenges such as limited classroom space, overlapping noise from simultaneous lessons, and the instructor's inability to observe all groups equitably hindered the effectiveness of the in-person model (Allaire, 2024). The transition to an online environment during spring 2020 unexpectedly resolved many of these issues. Zoom breakout rooms provided clearer sound separation and flexibility in assigning groups, and the built-in recording function enabled equitable assessment of each group's final lesson. Furthermore, the online format allowed for easier transitions, centralized timekeeping, and immediate distribution of feedback forms, enhancing the consistency and flow of the RMTR process.

Despite these improvements, online RMTR is not without limitations. Candidates noted difficulties with student engagement, especially when peers did not turn on cameras and the lack of classroom realism inherent in a virtual environment. Nevertheless, the ability to rehearse, revise, and reteach in a controlled, low-stakes space was repeatedly cited as a valuable learning experience. Moving forward, teacher educators may benefit from hybrid models that combine the best elements of both formats, allowing candidates to develop instructional confidence online and then apply refined lessons in in-person settings.

Scalability and Practical Applications in Teacher Preparation

These findings have potential implications for structuring teaching rehearsals in teacher preparation programs. Time constraints often limit ETCs' opportunities for structured practice and refinement. The RMTR model offers a structured and replicable approach, allowing preservice teachers to receive real-time feedback and engage in reflective practice. Furthermore, students benefited from the dynamic structure of RMTR, with many finding the short, iterative lessons more engaging than traditional, extended teaching rehearsals. This suggests that iterative microteaching structures could be adapted to enhance K-12 instruction, particularly in science education, where hands-on learning and engagement are crucial. By integrating structured iteration, reflection, and feedback, RMTR has the potential to become an integral part of teacher preparation and professional development, addressing both the need for increased science teaching confidence and the challenges of limited field-based experiences.

Conclusion

This study explored the implementation of online RMTR within an elementary science methods course, examining its potential to support ETCs' instructional development. Despite initial apprehensions, participants expressed positive perceptions of the structured nature of RMTR, which diverged from the conventional one-shot rehearsal model. The iterative process of planning, teaching, reflecting, revising, and reteaching provided ETCs with tangible opportunities to refine their instructional methods and build confidence.

While online RMTR cannot fully replicate the complexities of teaching in K-12 classrooms, its adaptability and structured nature offer a promising approach to preparing ETCs for the evolving landscape of education. By integrating repeated practice, reflection, and feedback, online RMTR may serve as a valuable component of teacher education, providing an efficient and meaningful way to engage ETCs in science teaching rehearsals. As teacher preparation programs continue to explore innovative instructional strategies, the integration of online RMTR represents a step forward in addressing the challenges of limited instructional time and practice opportunities.

This is particularly relevant in methods courses, which often compress complex pedagogical content into a single semester and may only offer one or two opportunities for practice teaching. By embedding repeated microteaching opportunities into these courses, instructors can create more sustained, reflective spaces for pedagogical development.

Moreover, although this study focused on science methods, the core features of RMTR — structured rehearsal, iterative feedback, and lesson adaptation — can benefit content preparation in other subject areas such as mathematics, social studies, and language arts, where scaffolding instructional skill is equally critical. Further research will be essential to fully understand its long-term impact, but the findings from this study suggest that RMTR holds promise in enhancing the quality and adaptability of future educators as they prepare for the dynamic demands of modern classrooms.

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