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Teacher educators' coaching experiences in a mixed-reality simulation intervention

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Abstract

Purpose – This study aimed to explore teacher educators' experiences and learnings as coaches in a mixed-reality simulation intervention aimed at teaching adaptive practices in preservice teacher education.

Design/methodology/approach – This interpretive study utilised elements of self-study research in combination with education action research. Data were collected through semi-structured peer interviews, group reflection and video-recorded coaching sessions with student teachers. The constant comparative method and thematic analysis were employed to analyse the data.

Findings – The study's findings indicate that coaching within a mixed-reality simulation intervention is crucial in developing student teachers' adaptive practices. Additionally, it was found that coaching experiences within this intervention inform teacher educators' assumptions and knowledge of student teachers' learning processes.

Originality/value – This study contributes to the emerging field of mixed-reality simulation interventions in teacher education by providing insights into the role of coaching in enhancing specific teaching skills. It addresses a gap in the existing literature by exploring coaching experiences within the context of mixed-reality simulations, offering valuable implications for teacher educators and curriculum development in preservice teacher education programmes.

Keywords Coaching, Teacher education, Mixed-reality simulation, Deliberate practice, Questioning

Paper type Research paper

Introduction and background to the research

Teacher education programmes face the challenge of providing student teachers with sufficient practice opportunities to master core teaching skills (Gravett *et al.*, 2023). One of these skills is effective questioning, which is crucial for fostering learner engagement and learning (Stokhof, 2018). However, research indicates student teachers often find questioning difficult to implement effectively (van der Merwe, 2021). This highlights the need for innovative approaches in preservice teacher education to bridge the gap between theory and practice. One promising solution is combining mixed-reality simulation (MRS) with coaching.

MRS consists of immersive virtual environments where student teachers practise teaching skills in scenarios mimicking real classroom interactions. Avatars within these environments resemble children, and their responses mirror real learners in a classroom (Dieker *et al.*, 2023; Pas *et al.*, 2016). These simulations approximate real classroom situations (Grossman *et al.*, 2009), allowing students to experiment with teaching practices safely, repeat specific skills through trial and error, and practise until objectives are achieved (Dieker *et al.*, 2023).

Despite the potential of MRS, research on integrating coaching alongside these simulations to enhance preservice teacher development is limited. Little is known about the experiences of teacher educators who provide coaching alongside MRS practice. This study addresses this gap by

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exploring how teacher educators experience and implement coaching within an MRS intervention, offering insights for improving the practice component of teacher education programmes.

Our study builds on deliberate practice, which involves structured activities to improve performance through focused practice and high-quality feedback (Bronkhorst *et al.*, 2014). In the context of our intervention, final-year student teachers engaged in MRS to practise questioning techniques under the guidance of experienced teacher educators who acted as coaches. This approach aligns with the principles of deliberate practice by targeting specific teaching skills, providing measurable goals, and moving individuals beyond their comfort zones. This research was framed by these principles combined with the existing body of literature on coaching, particularly emphasising coaching as deliberate practice (discussed in the next section). Using this conceptual framework, the authors aimed to explore the role of teacher educators as coaches, facilitating deliberate practice within the MRS intervention. This framework allowed for an in-depth exploration of the experiences of teacher educators as coaches and the relationship between deliberate practice and coaching in the context of teacher education.

Given the importance of high-quality feedback in deliberate practice, this study investigated the role of coaching combined with MRS sessions. Previous research indicates this combination can significantly improve teaching practices by offering immediate feedback and promoting reflection (Cohen *et al.*, 2020; Pas *et al.*, 2016). However, the dynamics of coaching coupled with MRS interventions remain underexplored. This study seeks to fill this gap by addressing the research question: "How do teacher educators experience coaching in a mixed-reality simulation intervention, and what do they learn from these experiences?" Exploring these experiences and learnings offers implications for integrating MRS and coaching in teacher education programmes.

Coaching in teacher education

A growing body of literature highlights the role that coaching can play in enhancing pre-service and in-service teachers' teaching (Cohen *et al.*, 2020; Pas *et al.*, 2016; Shannon *et al.*, 2020; Strieker *et al.*, 2020). This body of research collectively argues that coaching is a critical component in the professional development of teachers, significantly contributing to their ability to implement evidence-based practices and improve instructional effectiveness.

For instance, Denton and Hasbrouck (2009) argued that teachers are more likely to incorporate newly learned strategies into their teaching if they are provided with coaching from peers or experts. Similarly, Shannon *et al.* (2020) found that coaching can positively impact in-service teachers' use of evidence-based practices, reinforcing the practical benefits of coaching in real classroom settings. A review of 13 research studies by Kretlow and Bartholomew (2010) also found that coaching improved teachers' implementation of evidence-based practices. In addition, Stahl *et al.* (2018), who reviewed 25 studies from 1996 to 2016, concluded that coaching significantly contributes to the professional development of pre-service teachers.

Although scholars acknowledge the importance of coaching in pre-service and in-service teacher training, what effective coaching entails remains unclear (Denton and Hasbrouck, 2009; Pas and Bradshaw, 2016). Stahl *et al.* (2018) define coaching as personalised learning activities engaging students in authentic tasks with feedback for improvement. Pas *et al.* (2016) describe it as targeting specific skill development with ongoing, performance-based feedback.

Key characteristics of effective coaching include small-group training on specific techniques, followed by observation and feedback on teaching practices (Kretlow and Bartholomew, 2010). Coaches provide descriptive, non-evaluative feedback on strengths and areas for improvement, crucial for teacher development. Nugent *et al.* (2023) emphasise the role of reflective discussions initiated by the coach to build rapport and trust, which is essential for a positive coaching relationship. These discussions often involve clarification and prompting to address teacher and learner behaviours. The questions asked during coaching are key for uncovering knowledge gaps, fostering discussions, promoting self-reflection and guiding improvement decisions. Open questions, in particular, prompt reflection on teaching practices (Averill *et al.*, 2016).

Strieker *et al.* (2020) highlight that effective coaching depends on the coach's skill in asking insightful questions rather than merely providing solutions, allowing student teachers to reflect and collaboratively generate ideas for improvement. Targeted feedback should be immediate, specific and informative, focusing on the performance of the practised skill (Cohen *et al.*, 2020; Denton and Hasbrouck, 2009; Pas *et al.*, 2016; Stahl *et al.*, 2018). Bronkhorst *et al.* (2014) argue that without such feedback, teachers may not recognise incorrect implementation of strategies, underscoring its importance in effective coaching.

In summary, the literature highlights that coaching is essential in teacher education, enhancing the adoption of evidence-based practices. Effective coaching involves personalised feedback, reflective discussions and insightful questioning, all crucial for the professional development of in-service and pre-service teachers.

Coaching in a mixed-reality setting

There is limited research on coaching in a mixed-reality setting. However, a few studies have explored this topic. Pas *et al.* (2016) explored a coaching approach using a mixed-reality simulator to improve teachers' competence in addressing the needs of students with autism spectrum disorder (ASD). Teachers engaged in guided practice within the TeachLivE™ simulator, focusing on ASD learners' needs. The coaching model involved observing teaching in the simulator, providing immediate feedback, and encouraging self-reflection. The findings indicated that this intervention "shows promise as an effective and acceptable intervention" (Pas *et al.*, 2016, p. 3648).

Cohen *et al.* (2020) used an MRS platform in a teacher education course to help student teachers develop skills in managing learner behavioural issues. Coaching sessions included observing teaching in the simulator, evaluating strengths and weaknesses, identifying areas for improvement, and providing feedback. Results showed that student teachers who received coaching significantly improved their skills. The authors concluded that while MRS can create powerful learning opportunities, "coaching between sessions will enhance the utility of these practice opportunities" (p. 212).

These studies underscore the importance of combining MRS with effective coaching to enhance teaching practices. Integrating immediate feedback and reflective practices with MRS appears to be a promising approach for in-service and pre-service teacher development.

The MRS intervention

The MRS intervention, conducted from April to October 2022, was led by experienced teacher educators who served as coaches. They individually coached five student teachers specialising in literacy, mathematics, or social sciences in the foundation phase (Grades R–3) or the intermediate phase (Grades 4–7). Author 1, a foundation phase specialist, coached the literacy group; Author 2, a social sciences specialist, coached the social science group; and Author 3, a mathematics specialist, coached the mathematics group in the intermediate phase. Each coach has over eight years of experience lecturing in their respective fields.

Drawing on Kretlow and Bartholomew (2010), the MRS intervention emphasised initial small-group training, multiple observations, feedback, and modelling. The goal was to enhance student teachers' use of questioning in lessons. They taught planned lessons to five computer-based avatars acting as learners using the TeachLivE™ platform, simulating diverse classroom environments.

The intervention comprised five cycles, with each student teacher teaching the avatars in two sessions per cycle, focusing on specific questioning skills. Cycle 1 emphasised eliciting and expanding prior knowledge, Cycle 2 focused on guiding learners' thinking, Cycle 3 on promoting metacognition, and Cycles 4 and 5 on checking for understanding and eliciting creativity and critical thinking. During the teaching sessions, the student teachers taught the avatars projected on a large screen at the front of the venue. These avatars, controlled by a digital puppeteer/simulation specialist who could see the student teachers, responded in real

time, mimicking the behaviour of real learners in a classroom setting. The digital puppeteer/simulation specialist uses an Xbox controller and simulation software (https://www.mursion.com) to manage the avatars' movements, voices, and actions.

Before each session, coaches briefed student teachers on the focus, after which they designed their lessons. Literacy group members created Grade 3 reading comprehension lessons, the social science group designed Grade 6 lessons on weather and climate, and the mathematics group designed Grade 5 lessons on equivalent fractions. During sessions, each student teacher presented a 5-min lesson segment, receiving feedback from coaches and peers using an observation tool (refer to Annexure 1). Post-session, a 30-min reflection involved feedback on strengths and areas for improvement, followed by 30-min coaching sessions for further guidance.

In subsequent sessions, student teachers revised their lesson designs based on feedback and presented again, following the same structure as the initial session. Figure 1 illustrates the intervention's progression, detailing the lesson focuses and specific questioning skills practised in each cycle.

Methods

We adopted an interpretive research approach, which involves how knowledge is constructed, interpreted, and experienced from multiple perspectives (Merriam and Tisdell, 2016). In this case, the authors served as coaches to student teachers in this study. This approach, as explained by Schwartz-Shea and Yanow (2012), acknowledges that sense-making is influenced by context. Thus, research is conducted within natural settings where the researcher is deeply embedded. Specifically, our study occurred within the teacher education

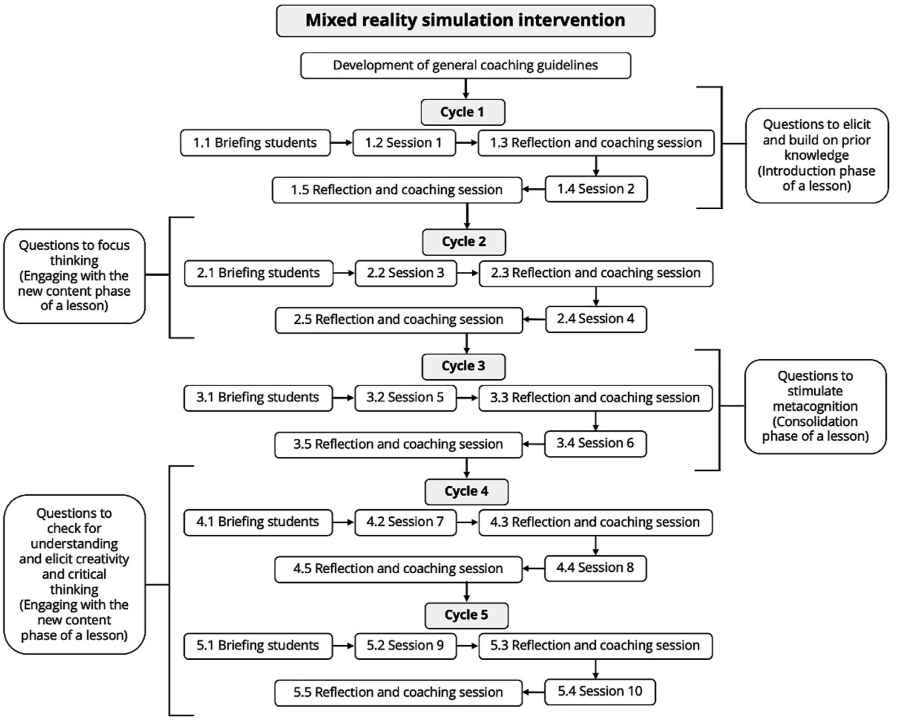

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Figure 1. Unfolding of the MRS intervention

programme where we, as teacher educators, worked and implemented the MRS intervention. We, as authors, played dual roles as researchers and active participants in the coaching process. This concept aligns with Gans (1976), as cited in Schwartz-Shea and Yanow (2012), highlighting the researcher's simultaneous engagement and observation within a specific role.

With a focus on meaning-making, the authors of this paper explored how they, as teacher educators, experience coaching in an MRS intervention and what they learned from these experiences. We utilised elements of self-study research as we set out to intentionally and systematically inquire into our practices as teacher educators and coaches (Dinkelman, 2003) pertaining to how we experienced coaching within our disciplinary fields, both through individual interviews and in the group reflection session. In combination with education action research from the cyclical design of the MRS intervention, self-study research offers us an opportunity to critically examine our roles as researchers, teacher educators, and coaches, with the goal of preparing teachers who are reflective about their pedagogic choices and practices (Feldman *et al.*, 2004). We were aware of the limitations of self-study research, such as the potential influence of personal biases and perspectives. To address this, we co-constructed the narratives through interactive interviews (Chang *et al.*, 2013). This approach involves participants sharing their experiences and engaging in group discussions (Toyosaki and Pensoneau, 2005), which helps counteract the critiques associated with relying on a single narrative. We used theoretical tools, methodological approaches, and existing coaching literature to describe and analyse our experiences (Ellis *et al.*, 2011). Thus, we maintain validity by offering concrete examples of practices, fully elaborated so that the research community can assess their trustworthiness and the validity of observations (Lyons and LaBoskey, 2002, p. 20).

Self-study manifests in two distinct forms: individual and collaborative. In the individual approach, practitioners seek to enhance their own practice by engaging with others. Conversely, collaborative self-study involves two or more participants who jointly focus on learning and act as critical friends to one another. These critical friends may also include external individuals not directly involved in the practice (Fletcher *et al.*, 2016). In the context of our research, co-authors and researchers from the broader research team assumed the role of critical friend. The trustworthiness of self-study was established through transparent procedures and a commitment to sharing findings with others (LaBoskey, 2004).

Data was generated through individual interviews, a group reflection session, and video recordings of the authors' coaching sessions. Semi-structured peer interviews were conducted on MS Teams after the intervention concluded: Author 1 interviewed Author 2, Author 2 interviewed Author 3, and Author 3 interviewed Author 1, using the same questions. Each interview lasted approximately 60 min. A group reflection session followed, discussing our coaching approaches (see Annexure 2 for guiding questions). The group reflection session lasted 1.5 h. We aimed to identify similarities and differences across the three disciplinary areas. To address potential bias from peer interviewing, we cross-checked data from the peer interviews and the group reflection session using real-time video recordings of the coaching sessions. Each session, lasting 30–60 min, was recorded as the intervention occurred. The video recordings of the coaching sessions were not transcribed. However, we randomly selected three out of the 10 recorded sessions per author to verify the accuracy of our interview and reflection statements.

In analysing the data, we combined the constant comparative method with thematic analysis to compare the data as a collective to identify similar and divergent trends (Merriam and Tisdell, 2016). Figure 2 delineates the steps of the data analysis process.

We transcribed interviews verbatim and then read transcripts thoroughly to create provisional categories. Next, we collaborated to identify "units of meaning" in each transcript (Maykut and Morehouse, 1994, p. 128), assigning inductive codes to encapsulate them. Similar codes were grouped into provisional categories using the "look/feel-alike" criteria (Maykut and Morehouse, 1994, p. 137). Figure 3 illustrates how codes (listed as bulleted points) were organised into provisionally identified categories, such as "Tailored coaching to students' needs".

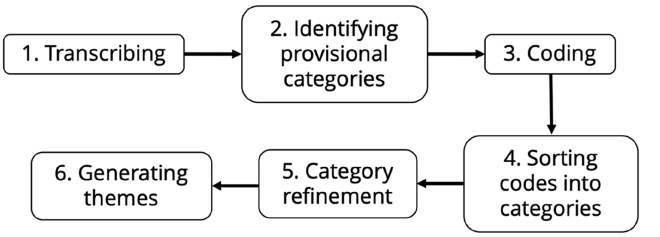

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Figure 2. Data analysis process

CA–APPROACHES TO COACHING

CA_ Went into coaching not knowing students' strengths and weaknesses

- Initially didn't know STs strengths and weaknesses
- Assumed STs were all on the same level

CA_ Identifying students' strengths and weaknesses made it possible to tailor coaching to their specific needs

- Identifying STs strengths and weaknesses guided coach ITO what to focus on
- Realised STs had gaps in their understanding of the content

CA_ Tailored coaching to students' needs

- Tailored coaching to address STs needs
- Initially did not have pre-coaching

CA_ Coaching = student reflections on what went well; commenting on each other's practice; highlighting and providing feedback on what needs to be improved

- Initially gave STs a brief of what to focus on
- Shared with STs before each session what they had to focus on
- Started with STs understanding
- STs had the opportunity to reflect on their own teaching
- Coached STs according to their needs
- Had another coaching session after lesson
- STs highlighted want went well | Commented on each other's practice | TE gave feedback
- Summarised areas for improvement

CA_ Adapting coaching approach according to students' needs

- Realised the need for pre-coaching
- Optimised coaching based on needs of STs
- Realised the need for pre-coaching
- Had online pre-coaching sessions to make sure STs understood what was expected
- STs had to understand the content before they could focus on questioning

Source(s): Authors' own creation

Figure 3. Examples of codes and provisionally identified categories

Drawing on our experience in qualitative data analysis, we developed codes and categories using comparison, contrast, and inter-coder reliability – key elements of the constant comparative method. This process led to the identification of three themes, which will be presented in the next section. Figure 4 provides an example of categories, codes, and excerpts from raw data that helped generate the theme "Teacher educators adapted their approach to coaching according to the student's needs and the subject matter, fostering reflection, discussion, and problem-solving".

Ethical approval (ethics clearance number: 1-2022-041) was granted by the Faculty of Education Ethics Committee in accordance with the Declaration of Helsinki. Student teachers were briefed on the ethics protocol and gave written informed consent before data collection, ensuring ethical compliance. We were mindful of power dynamics between us (as lecturers)

Theme 1: Teacher educators adapted their approach to coaching according to the student's needs and the subject matter, fostering reflection, discussion, and problem-solving

Categories related to the theme	Examples of codes	Examples from the raw data
• Identifying students' strengths and weaknesses made it possible to adapt coaching to their specific needs • Coaching entailed student reflections on what went well; commenting on each other's practice; highlighting and providing feedback on what needs to be improved • Students had gaps in their content knowledge, which resulted in having to first teach them to ensure they understood the content	• Identifying STs strengths and weaknesses guided coach ITO what to focus on • Tailored coaching to address STs needs • STs highlighted want went well | Commented on each other's practice | TE gave feedback • TE provided feedback via digital platforms (pre-coaching)	Once I became aware, or I could identify what their strengths and weaknesses were. Then I could... no, not streamline, but have specific foci area that I had to focus on. So like, if one was like very weak in the content knowledge then that guided my coaching that this is the area that I need to focus on. We had group coaching, but then there was also like the one-on-one specific tailoring to their needs and to the questions they had. Initially, I did not have, like I said, pre-lesson coaching. Initially it was just to give them the brief with the template that we used to guide them, but then I realised that there was a need for pre-coaching. So then we would start off with their understanding and their questions and then I would coach them according to the needs that were raised in the coaching session. And then also after the lesson we had another coaching session where they would... similar to the reflection session, they would highlight what went well for them and they could also comment on each other's practice and then I would highlight and give feedback of what still needs to be improved.

Source(s): Authors' own creation

Figure 4. Example of theme generation

and student teachers, emphasising voluntary participation and the freedom to withdraw without consequences.

Findings

The data analysis process generated three themes that encapsulate how the teacher educators in this study experienced coaching in an MRS intervention. The themes are presented in the sections that follow.

Theme 1. Teacher educators adapted their approach to coaching according to the student's needs and the subject matter, fostering reflection, discussion, and problem-solving

Before starting the MRS intervention, the research team, including teacher educators, jointly developed coaching guidelines and an observation tool. These guidelines aimed to prompt student reflection on their learnings for, in, and from practice. This self-study enabled coaches to reflect on how specific coaching techniques promoted reflection. We recognised that the timing of the reflection sessions allowed us to give prompt feedback and allowed students to provide concrete examples from their lessons. Coaches' questions before, during, and after teaching episodes encouraged students to delve deeper into their practice and question their decisions, facilitating the uptake of feedback and closing feedback loops. An example is found in a conversation between TE3 and a student:

> TE3: Student 1, do you think you asked probing questions?
>
> Student 1: I don't think I did. My questions were more focused on the procedure instead of the conceptual understanding of it.
>
> TE3: What questions can you ask that would require thinking from the students? I get that your lesson focused on the procedures, but what questions can you ask to find out their understanding?
>
> Student 1: I think with the step where I said they need to find the lowest common denominators when the denominators are not the same, maybe I could have asked them why are we doing this. And how does it help us to compare fractions?

Another example from TE2 of how the coach focuses on students' self-monitoring of their actions, combined with how well tasks are performed and how to perform tasks, is captured in the coaching conversation below:

> TE2: I've noticed that when you ask questions, you tend to expect an immediate response from the learners without giving them much time. Do you think there's sufficient wait time?

Student 4: Learners need time to connect prior knowledge with new information.

TE2: Too long can make them restless, but give them enough time to think before responding.

Student 4: I don't think I've mastered prompting yet, but I used to prompt by asking learners "why". Last week, it didn't happen.

TE2: Asking "why" prompts deeper thinking and understanding of the reasoning behind responses. You used visuals which helped prompt reasoning. The interconnectedness of teaching elements is important for effective questioning and prompting.

The coaching approach promoted individual and peer reflection, emphasising questioning techniques like wait time and engaging all learners in answering questions. Data confirms coaches used reflective questioning to challenge student teachers' assumptions. Teacher educators facilitated peer feedback on teaching strengths and areas for improvement during sessions, followed by individual feedback. Excerpts from the data illustrate this approach:

> We started one at a time with the first person, for example, would say how she did in the lesson and how she felt she did in the lesson, and what aspects she thought needed improving. Then we got the groups' inputs, and then I came in. (TE2, Group Reflection Session)

> I would then share with the students specific feedback where I think they can improve. (TE1, Group Reflection Session)

> I would highlight and give feedback of what still needs to be improved" (TE3, Peer Interview)

We were mindful of the power relations that we, as teacher educators who are also coaches, posed to students. Here, TE1, TE2, and TE3 explained their thinking of creating a space for student teachers to feel safe and confident to nurture conversations in the coaching sessions. Examples from peer interviews conducted that support this view are:

> I tried to [pause] in my coaching, create almost like a relaxed environment where the students felt free to, you know, to express the things that they were struggling with, they felt free to express things where they think that they might have improved on during that week. (TE1)

> I think that for me was key that they could feel comfortable. They could feel confident. They were able to express themselves "I'm having a challenge with this" or "I don't know why I did that" and it was in a good, safe space to be able to do that. (TE2)

> For students to feel free to approach me if they are not certain about what is expected of them. And then also to be more mindful of the different strengths and weaknesses of the students. And I think highlighting their strengths to build their confidence is key. (TE3)

Each teacher educator adhered to broad guidelines, yet data indicates they tailored their coaching approaches to suit students' needs and subject areas. TE1 focused on Literacy (Grades 1–3), TE2 on Geography (Grades 4–6), and TE3 on Mathematics (Grades 4–6). While aligned with research team guidelines, coaching experiences varied subtly due to the different disciplines. The questions posed during coaching sessions prompted diverse conversations across subjects and phases. Analysis revealed that TE2 and TE3 adjusted their coaching methods based on student teachers' needs. For instance, TE3 implemented pre-coaching sessions to address gaps in student teachers' understanding of the content. Excerpts from peer interviews illustrate these observations:

> Once I became aware or could identify their strengths and weaknesses, I could [pause] not streamline, but have specific foci area that I had to focus on. So, if one was very weak in the content knowledge, then that guided my coaching that this is the area that I need to focus on. (TE3)

> Initially, I did not have [pause] pre-lesson coaching [pause] it was just to give them the brief with the template that we used to guide them, but then I realised that there was a need for pre-coaching. So then we would start off with their understanding and their questions, and then I would coach them according to the needs that were raised in the coaching session. (TE3, Peer Interview)

Similarly, TE2 also adapted her coaching approach in response to the identified gaps in student teachers' understanding of the content they were required to teach, as highlighted in the following excerpt from the group reflection session:

> I did find that the content knowledge was lacking in certain areas. And that you have to take them back to the curriculum and do a little bit of teaching for them to make sure that they first understand the content well before they can actually teach it to the children. (TE2, Group Reflection Session)

In both cases, the primary goal was questioning, but it became clear that students lacked content knowledge, necessitating adjustments in coaching priorities. Mastery of questioning as a teaching skill hinges on addressing these gaps or misconceptions first. Coaching sessions occasionally expanded beyond their initial scope to ensure students were confident in understanding the content they intended to teach. For instance, TE3 noted additional one-on-one tailored sessions apart from group coaching, stating, "There was also the one-on-one specific tailoring to their needs and to the questions they had." TE3 also employed digital platforms for student teachers to clarify doubts during pre-lesson coaching: "We would use WhatsApp or e-mail where they just needed clarity, or, you know, more information or guidance, or they would send an activity and ask if this was appropriate" (TE3, Peer Interview).

The findings indicated that TE1 demonstrated minor variations in his coaching approach during the MRS intervention by getting student teachers to set goals for themselves for subsequent sessions. The following excerpts are indicative of this finding: "I would then ask each student to identify one or two goals for the next session that they want to improve on" (TE1, Group Reflection Session) and "Towards the end of those sessions, I would ask them to come up with one or two goals for the next session" (TE1, Peer Interview). Evidence for this can also be seen in the following exchange between TE1 and a student teacher during a coaching session:

> TE1: What do you think is one thing that you can take away from last week's session that you want to try for this week? It can be something that you want to try again, or it can be something that you try and strengthen, or it can be something new. But what is something that you want to specifically focus on with regard to questioning?
>
> Student 1: I think I want to try and broaden my questions in a sense that I accommodate all [the learners]. I think I did do that, but I was just too nervous at that time to actually see if it was implemented correctly. So, I think it is something I need to work on [pause] looking at how I structure my questions to allow all the learners to be actively engaged in the session.

Theme 2. Teacher educators observed that while deliberate practice led to improvements, there were also some regressions

The notion of deliberate practice was enacted with the understanding that through intense coaching sessions and repeated practice using MRS, student teachers will improve and refine their questioning skills from one lesson to the next. Through our individual and collaborative research, we realised that coaching and teaching are complex. In the context of Argyris's (1991) double-loop learning, the coaches assumed that students, by engaging in an iterative feedback process during coaching sessions, would reap medium to long-term benefits. This process involves closing the feedback loops, re-evaluating their actions, and implementing the feedback in subsequent cycles. However, evidence from the findings highlighted that some student teachers would regress in using a specific questioning skill when they were introduced to new skills. This implies that students were functioning at the level of single-loop learning, as the feedback remained confined to immediate problem-solving or troubleshooting scenarios. The following quotes provide evidence for this finding:

> By the fourth, the fifth session, there were one or two students that would revert back to "OK, I'm no longer adhering to wait time", so the other aspects are coming right, but I forgot about the wait time again. So you needed to keep going to and fro to be able to keep reminding them. (TE2, Peer Interview)

TE1 shared a similar observation linked to the skill of asking questions at different cognitive levels.

> There were a few instances where a student would start using more open-ended questions by the second or third or the fourth session, and then I would see maybe by like the fifth or the sixth session that they've started asking more closed-ended questions again. (TE1, Peer Interview)

The coaches realised the closure of the feedback loop necessitated students' active involvement in making sense of their teaching choices in action and engaging with them for the purposes of ongoing improvement. In the reflection session with students, the coaching sessions prompted students to make their thinking and assumptions visible:

> TE2: Why do you think you are still struggling with this after so many sessions? For example, some questions you posed started with imagine, predict, compare. [Pause] Did you give sufficient time for students to think?
>
> Student 4: I think I did okay as I gave them time to think and then I would cold call students to answer as they all had enough time to think about it.
>
> Student 1: I don't think I did that well. The moment one or two learners raised their hand immediately after I asked the question, I assumed that all knew the answer.
>
> Student 2: I was using too many lower-order questions and was asking too many questions one after the other.
>
> Student 3: Some learners shouted out the answer.

In a reflection session with TE3 and the student teachers, one student showed improvement in asking probing questions to elicit understanding when teaching the second iteration of the mathematics lesson. However, when she had to teach a new topic, she reverted to only asking procedural questions, as shown in the following quotes:

> TE3: Student 1, did you ask any open-ended questions?
>
> Student 1: [Laughing] Well, I am actually still struggling asking the open-ended questions because I feel like I actually focus more on the procedures than the conceptual knowledge, but I think I am kind of getting there.

The coaches identified the need to foster agency among students to bolster their abilities to engage constructively with feedback. As the sessions progressed, all teacher educators/coaches noticed an improvement in the student teachers' uptake of feedback. This included asking questions at various cognitive levels, using wait time effectively, using questions to prompt learners to explain their reasoning, and using questions to cognitively engage learners. The mastery of one skill seemed to support the development of others.

> I could see the development towards the latter stages whereby, I want to use an example of the wait time, and this one student, she gave them a picture and she didn't just ask questions. She asked specific questions and she said "I'm going to give you 10 seconds. And when you look at this picture, I want you to complete the following sentences with I see [pause] I think [pause] I wonder [pause]". And she asked them to write it down. Now that for me was, "Wow, that is such a unique way of eliciting prior knowledge", and you could see as they moved along, they didn't have this long list of questions. They had one or two key questions and they got the idea that I need to ask fewer questions, but I need to ask deep questions so that I could be able to get to the core objective of that particular lesson, and that took them time. I have to admit they really struggled with that, but they actually got it right. (TE2, Group Reflection Session)

TE1 observed similar notable improvements: "Through this intervention and them getting the opportunity to constantly go in and reteach and then receive coaching in between, I gradually saw them improving in all of the different aspects of questioning" (TE1, Group Reflection Session).

Evidence for this can also be seen in the coaching videos, wherein TE1 commented on the student's progress:

> TE1: I've seen so much improvement. [pause] wait time, I think you all waited for a response. [pause] I think some of you gave a bit more wait time than others, but generally, wait time was a big improvement. Also, something that all of you did was that you told them that you were randomly going to select learners. So instead of saying "Lionel, what do you think about this?", rather asking the question first [pause] or saying to them upfront "I am going to ask specific learners". Something that I also picked up when you would ask a closed question, for instance, you would immediately change it to an open question by asking them, "Why do you say this?" So very good job done with that. I also like that you all used different techniques to get them to think about the content.

TE3, in addition to mastery of specific questioning skills, observed positive improvements in students' enactment of pedagogical content knowledge: "I think it was successful because the students were at a better level or gained more confidence and a little bit more knowledge compared to where they were when they started" (TE3, Peer Interview).

Theme 3. Engaging in coaching within the MRS intervention prompted teacher educators to re-evaluate their assumptions and experiences regarding this aspect of the intervention

The peer and group interview methods helped us, as coaches and researchers, to make our coaching decisions visible and reflect on them. A key approach in self-study research involves questioning preconceived notions about learning and teaching (Garbett *et al.*, 2018). Dialogues with fellow coaches and students allowed us to see problems from various angles and view our coaching differently. For instance, TE2 noted, "In addition to getting the students to reflect on their own practices, you were also reflecting on what you were doing in your methodology modules" (TE2, Group Reflection Session).

Interviewing each other, followed by group reflection, made us aware of our skills and how our assumptions affected our coaching. It's about challenging our assumptions and being open to new ways of thinking. This is the essence of self-study research in teacher education, highlighting the importance of questioning preconceived notions (Hamilton and Pinnegar, 1998). The data showed all three teacher educators assumed that final-year students would have mastered questioning techniques from the curriculum introduced in Year 1. The following excerpts from the group reflection session illustrate this finding:

> There was this expectancy that I expected you to know this because we've done this in the methodology across the three years. [pause] did we cover this properly or well enough for students to know? So, that is part of my experience where I had this internal struggle. I am also the methodology lecturer, looking at the gaps of what students should have learned and did not learn. (TE3, Group Reflection Session)

> I think this is something that we all experienced in that these were fourth-year students, and we took for granted that they would all know how to question, only to realise that there are actually huge gaps. (TE2, Group Reflection Session)

> I take for granted that when I've taught something that the students have grasped it, they will be able to apply this to their teaching. But as we have seen, you can't take for granted that they've learned something. (TE1, Group Reflection Session)

The importance of asking good questions in coaching sessions that facilitate dialogue was also reflected upon. Here, TE2 reflected on the importance of framing questions in a way that promotes dialogues rather than the coach instructing students on how it should be done. For example:

> The way one frames the questions is very important as a coach so that you don't put them in a footing whereby "I need to defend my decisions", but rather it needs to be a conversation to say "I did this" and for them to be able to bring forth "Actually, you know, I should have done it this way", rather than it coming from me. So asking the right questions to elicit those responses is something that I think needs work on. (TE2, Group Reflection Session)

Next, the teacher educators/coaches reflected on the importance of providing actionable feedback to student teachers in the MRS intervention and how one teaches in methodology modules. These are modules in the undergraduate curriculum designed to develop student teachers' pedagogical content knowledge (PCK) and teaching competence in primary school subjects. TE1 and TE3 examined their understanding of the importance of such feedback in the following excerpts from the group reflection session:

> That is something that I became aware of. You know, the importance of deliberate practice in a methodology course. Especially focusing on the feedback which is currently missing for me. (TE3)

> We also need to model to the students the importance of feedback because when they are in the classroom, they themselves have to provide feedback to the learners, and if they've never really learned the importance of feedback, they aren't going to do that. (TE1)

> Important to the feedback is what students do with the feedback. They need to implement it. That's something I need to work on. How we get students to implement it and see evidence that they implemented it. (TE3)

All coaches also expressed the importance of understanding student teachers' strengths and weaknesses before coaching can commence, an area that they recognised needed further development:

> And then also to be more mindful of the different strengths and weaknesses of the students. And I think by highlighting their strengths to build their confidence, that is key. (TE3, Peer Interview)

> I didn't actually look at each person's strengths and weaknesses. I just assumed that because they are in fourth year, they are all on the same level. (TE3, Peer Interview)

> You need to know your students. You need to know what they struggle with [pause]. And that is something that I went in blind with. (TE2, Peer Interview)

In addition to having an understanding of students, a deep understanding of one's own strengths and weaknesses as a coach is also important. In this regard, TE1 was able to identify gaps in his own understanding of the use of questioning: "I realised in this coaching process that I myself didn't know [pause] well, I knew a lot about questioning, but there also were some things I actually didn't know about" (Group Reflection Session).

After the first rounds of teaching and coaching, TE2 and TE3 realised that gaps in content knowledge had to be addressed before the actual brief of the MRS intervention, namely, to strengthen questioning skills, could be addressed. For this reason, TE3 adopted a pre-coaching intervention, as was shared in the first finding. The adaptations made by TE3 prompted TE1 to also consider this approach, as follows:

> I would also include the pre-coaching. I think it's so valuable if there's more information for the students and you provide a bit more scaffolding before they actually go in and teach than them just going in blindly. [pause] So I think if I were to do it again, or how I would adapt my coaching, is that I would also include pre-coaching as part of the overall coaching that the students get. (TE1, Group Reflection Session)

Discussion of findings and implications for teacher education

In this collaborative self-study research, the authors set out to explore how they, in their role as teacher educators, experienced coaching in an MRS intervention. Wearing multiple hats as coaches, educators, and researchers, the authors leveraged their roles to scaffold student

teachers' questioning skills, challenging assumptions and fostering growth within their zone of proximal development (Bronkhorst *et al.*, 2014). They observed that students struggled with the complex, non-linear nature of teaching (Gravett and Kroon, 2021), often forgetting previously mastered questioning skills when new ones were introduced in subsequent cycles. The cyclic nature of the coaching and reflection sessions was important in helping students understand the interrelated nature of teaching and how the different skills support one another. The learnings from this study's cyclical nature of reflection are similar to that of double-loop learning, which prompts a re-examination of how problems are addressed versus single-loop learning, which involves changing actions without understanding why (Argyris, 1991).

Group coaching and reflection sessions stimulated critical thinking through dialogue, a feature of double-loop learning (Argyris and Schon, 1978). Emphasising dialogic talk and learning conversations, these sessions focused on subject-specific pedagogic content knowledge. Coaches observed differences, such as in geography lessons, where questioning promoted geographical thinking and inquiry (Smith, 2022), and in mathematics, where questioning enhanced students' reasoning (Mahmud and Drus, 2023). The authors recognised that deep content knowledge is essential for mastering questioning skills; thus, coaching was adapted to address these gaps.

Our coaching role was a valuable learning experience, revealing assumptions about student knowledge and skill acquisition. Coaching in the MRS allowed us to explore students' mindsets and understand their practices. The coaches reasoned that repetitive practice, immediate coaching, and reflective sessions would allow for the analysis and contextualisation of teaching practices (Ericsson, 1998). Deliberate practice, structured across five MRS intervention cycles, aimed at enhancing practice and fostering an understanding of the underlying rationale behind teaching choices (Ericsson *et al.*, 1993). Working alongside final-year students, we assumed that the curriculum across the four years supported them sufficiently to develop the appropriate PCK to teach in the primary school. However, research shows students often have weak content knowledge from their schooling backgrounds (Taylor, 2019). Our primary school teacher education programme includes academic support, tutorials, tracking, and follow-up (Ramsaroop and Petersen, 2020). Despite these efforts, transforming pedagogical practices over the past four years has been insufficient. Addressing the apprenticeship of observation (Lortie, 1975) and weaknesses in content knowledge from 12 years of schooling is crucial.

These findings are relevant to countries facing similar challenges regarding the quality of university students. To achieve transformative learning, student teachers must modify their behaviour and fundamentally change how they approach teaching. This level of transformation is particularly challenging and necessitates profound self-reflection and heightened self-awareness (Mezirow, 2009). By consistently evaluating and challenging their own teaching practices, student teachers can work towards meaningful change – a goal that coaching sessions aim to facilitate.

The peer and group discussion methods of data collection used in this study provided access to the different coaching experiences and practices. They enabled the authors to co-construct their interpretations of coaching. As such, making their coaching practices visible for scrutiny when they interviewed one another meant disclosing their "knowledge and experiences in dialogue" with ourselves "and others" (Cushion, 2018, p. 82). It was evident from the data that through the actual coaching experience, the authors began developing skills and knowledge and refined taken-for-granted assumptions about students' PCK. The shared stories of our experiences and assumptions related to our roles as coaches deepened our understanding of what it means to be a coach as a reflective practitioner. The authors acknowledged that coaching is complex and that a "one size fits all" approach cannot be used with all student teachers.

The study's findings emphasise the advantages of integrating MRS alongside coaching in teacher education programmes. By combining these approaches, student teachers benefit from deliberate practice and significant learning gains. Coaching plays a crucial role in maximising

the effectiveness of MRS, guiding student teachers towards intentional growth. Guided self-reflection and collaborative peer reflection during coaching sessions enhance teaching practices. Beyond this research, the insights gained have broader applications for addressing practical challenges related to the theory–practice divide in education.

Based on the study's findings, we recommend that teacher education programmes incorporate opportunities for student teachers to practise core teaching skills deliberately. Combining repeated deliberate practice with coaching in these programmes could enhance student teachers' use of core teaching skills, such as questioning.

Limitations and future research

Acknowledging the study's limitations with only 15 student teachers, we recognise the need for broader exploration. Scaling this approach to larger classrooms requires a dedicated coaching team, with the teacher educator leading. While adaptable guiding questions and observation tools apply across subjects, expert knowledge is crucial for addressing content misconceptions and understanding children's learning. Patience and time are vital in the student teacher's developmental journey. We have begun integrating MRS and coaching in our pre-service teacher education programme, training simulation specialists in partnership with Mursion™, a software company which specialises in immersive learning simulations. Additionally, we trained post-graduate students to coach about 200 second- and third-year student teachers, limiting MRS and coaching sessions. Longitudinal research on student development in a larger cohort is ongoing.

Conclusion

The study shows that coaching in an MRS platform can significantly support student teachers in adopting evidence-based teaching practices, such as deliberate practice, to enhance specific skills like questioning. These skills, honed through coaching and MRS, can be effectively applied in real classroom settings. The combined impact of coaching and deliberate practice in MRS leads to deeper mastery of these skills, facilitating their transferability to actual teaching scenarios.

Iterative cycles of reflection allow students to identify mistakes and learn from peer and coach feedback. Coaching also provides a feedback loop for teacher educators to pinpoint gaps and areas for improvement in their methodology courses. It is not a linear process but involves ongoing reframing, listening, reflecting, and articulating thoughts. Coaches also introspectively apply their observational and analytical skills, questioning underlying principles and assumptions.

In summary, integrating coaching into an MRS platform offers numerous benefits for both student teachers and teacher educators, enhancing teaching practices and advancing teacher education programmes. This study contributes valuable insights to the existing knowledge base on coaching in teacher education.

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Annexure 1

Table A1. Observation tool used during the MRS intervention

How many questions did the ST ask?				
Does not meet expectations (not there yet) - 1	Approaching expectations (progressing) - 2	Meets expectations - 3	Exceeds expectations - 4	Comments
The ST rarely gives wait time between asking questions	The ST sometimes gives wait time between asking questions	The ST very often gives wait time between asking questions	The ST always gives wait time between asking questions	
The ST rarely asks questions at a variety of cognitive levels	The ST sometimes asks questions at a variety of cognitive levels	The ST very often asks questions at a variety of cognitive levels	The ST always asks questions at a variety of cognitive levels	
The ST rarely asks questions in a way to involve all the learners	The ST sometimes asks questions involving all the learners	The ST very often asks questions involving all the learners	The ST always asks questions involving all the learners	
The ST rarely prompts learners to further their responses	The ST sometimes prompts learners to further their responses	The ST very often prompts learners to further their responses	The ST always prompts learners to further their responses	
The ST rarely asks learners to explain their reasoning	The ST sometimes asks learners to explain their reasoning	The ST very often asks learners to explain their reasoning	The ST always asks learners to explain their reasoning	
Comment on the appropriateness of the questions in terms of the focus of the lesson:				

Annexure 2
Guiding questions during interviews

Semi-structured interview questions:

(1) What is your understanding of the term coaching?

(2) How did your understanding of coaching influence your decisions as a coach?

(3) How did you experience coaching in the MRS intervention?

(4) How did you approach coaching in the MRS intervention? Probe: Why did you choose to approach coaching in this particular way?

(5) In your opinion, how successful was your coaching approach? Why?

(6) How do you evaluate the effectiveness of your coaching?

(7) Can you discuss any challenges that you have encountered in your coaching practice? How do you navigate and address them?

(8) What changes or adjustments would you make in your coaching approach going forward? If any?

Group-reflection session prompts:

(1) How did you experience coaching in the MRS intervention?

(2) How did you approach coaching? Why did you approach it in this way?

(3) How effective was your coaching? Why do you say this?

(4) What challenges did you experience?

(5) How would you adapt your coaching approach going forward?

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