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# Pre-service teachers' perceptions on eliciting learners' knowledge in a mixed-reality simulation environment

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**Background:** Concerns have been raised about the inconsistency and quality of pre-service teacher preparation, especially in reading literacy. Mixed-reality simulations can potentially revolutionise initial teacher education by offering realistic, risk-free practice opportunities to master reading practices.

**Objectives:** This study explores pre-service teachers' perceptions of: (1) interacting with avatars, (2) teaching core reading skills, particularly eliciting background information on informational text, and (3) using an action review cycle within a mixed-reality simulation environment.

**Method:** A qualitative exploratory case study design was used in this study in order to document pre-service teachers' perceptions of engaging within a mixed-reality simulation environment. A purposive sampling strategy was used to select participants for this study. Data were analysed using thematic analysis.

**Results:** Findings reveal that pre-service teachers valued interacting with the avatars and appreciated the unique focus on eliciting learners' background knowledge, a core reading practice. They typically teach full lessons with limited genuine engagement during microteaching opportunities, making this an interesting experience. They highlighted the mixed-reality simulation's features, such as pausing, redoing, and receiving immediate feedback. The simulator allowed them to concentrate on skill mastery rather than staging lessons for grades.

**Conclusion:** This study concludes that pre-service teachers' skill development benefits from deliberate practice opportunities designed to enhance complex skills. Mixed-reality simulations could reshape how student teachers are prepared for reading instruction.

**Contributions:** This research contributes to the understanding of pre-service teachers' perspectives on teaching core reading practices in a mixed-reality simulation environment.

**Keywords:** pre-service teachers; mixed-reality simulation; TeachLivE™; core reading practices; teaching practice.

## Introduction

As stated by a teacher:

> 'I thought I would know how to teach my learners to read, but great was my disillusionment. I know the approaches, what activities to give and how to assess, but putting it all together, trying to think on my feet in order to identify problem areas, and helping learners who struggle is far more complex than I thought and was prepared for. I am totally stressed out and way out of my comfort zone'. I want to quit! (Grade 3 Beginner Teacher, South African)

This statement supports the research which indicates that preparing pre-service teachers for the teaching profession is a complex task (Grossman, Hammerness & McDonald 2009:273; Nel, Marais & Dieker 2020:44). Every moment within initial teacher education programmes matters, as four years is a very short period to prepare pre-service teachers for the complex task of teaching, specifically for preparing them to teach children to read (Barends & Nel 2017:2). Preparing pre-service teachers to teach effectively has often been cited as being insufficient and weak, specifically the theory-practice divide (Korthagen 2016:388; Taylor 2021:1). The gap between the theoretical knowledge gained at university and the reality of teaching results in new teachers finding themselves unprepared for the challenges they face each day. Subsequently, new teachers soon find themselves in a 'sink-or-swim' situation (Gaikhorst et al. 2017:46). It is possible that some universities may have underestimated the complexity of preparing pre-service teachers to teach reading (Nel 2022).

Reading literacy is a complex and multifaceted skill that requires a deep understanding of both the cognitive processes involved in reading and the various strategies and techniques that can be used to support learners in developing their reading abilities (Brown 2014:40). Preparing pre-service teachers to teach reading literacy effectively requires a comprehensive and intensive programme of study that goes beyond a narrow focus on methods and techniques, and instead provides a deeper understanding of the underlying theory and research related to reading literacy (Moats 2020:25). Additionally, universities may have underestimated the complexity of teaching reading literacy in a diverse classroom context, where learners come from different cultural and linguistic backgrounds, and have unique learning needs (Nel 2022). Many pre-service teachers and beginner teachers experience disillusionment when faced with their own classrooms (Gan 2018:2), and many exit the profession within the first 3–5 years, totally overwhelmed by the many challenges that they face (Kraft & Papay 2014). However, initial teacher education programmes have the potential to impact the trajectory of pre-service teachers who become beginner teachers and the effectiveness of their instruction and the longevity of their careers (Zhang & Zeller 2016). Benedict et al. (2016:2) state that pre-service teachers are more likely to be successful when their teaching is 'cultivated through high-quality opportunities to practice, coupled with support and feedback'. Research suggests that relying on school-based placement as the sole avenue to explore teaching might not be enough (Carrington, Kervin & Ferry 2011:353). Frequent and deliberate practice opportunities can enhance pre-service teachers' readiness to teach (Grossman et al. 2009).

During military and medical training, novices often participate in simulated practice opportunities in order to perform a specific surgical procedure or land a plane where they can make mistakes, try new techniques and grow and develop in a safe and risk-free setting (Hughes et al. 2005; Kaufman & Ireland 2016). Pre-service teachers need to engage in extensive, dynamic and rigorous deliberate practice-based opportunities in which they will have exposure to a classroom of learners and can try out the techniques (Ball & Forzani 2009; Ball et al. 2009:462). Research indicates that pre-service teachers' perceptions affect how they react, perform and grow (Brock et al. 2008:133). To ensure that there is buy-in with new practice-based training initiatives it is important to take cognisance of pre-service teachers' perceptions of their experiences within mixed-reality simulation environments during initial teacher education programmes. The purpose of this article is to detail pre-service teachers' perceptions of: (1) engaging with avatars, (2) teaching a core reading practice, eliciting background information on an informational text, and (3) utilising an action review cycle (ARC) within a mixed-reality simulation environment.

## Literature review
### Teacher preparation and core reading practices
Taylor and Mawoyo (2021:165) state that 'concern has long been expressed regarding the highly variable and generally poor quality of Bachelor of Education (BEd) programmes responsible for educating the country's primary school teachers'. The quality of a teacher plays a pivotal role in shaping learner success (Darling-Hammond 2003; Hanushek, Kain & Rivkin 2001). Consequently, it is essential that learners are instructed by teachers who are well equipped and competent. A significant element that contributes to a teacher's competence is the robustness of their training (Carver-Thomas & Darling-Hammond 2017).

However, there is a significant disparity in both the quantity and quality of practical training given to aspiring teachers during their preparatory phase (Deacon 2016:18). Gravett, Petersen and Ramsaroop (2019:2) support this by stating that 'the work-integrated learning (WIL) component of initial teacher education qualifications is however riddled with difficulties'. With reference to the Initial Teacher Education Research Project (ITERP) study, Taylor and Mawoyo (2021) state that:

> [A]t all except one institution, teaching practice takes place mostly in suburban schools, most supervisors are not subject specialists; and in at least two institutions it is possible for students to pass teaching practice despite performing poorly in a classroom, or even without being assessed on their classroom expertise at all. (p. 168)

As a result, initial teacher education programmes frequently lack sufficient oversight over the quality and reliability of the opportunities provided to pre-service teachers during their teaching practicum placement in schools (Shaughnessy & Boerst 2017).

Hence, it is challenging to guarantee that all pre-service teachers get equal chances to practise certain fundamental reading skills during their school-based placements. Mixed-reality simulations, which act as proxies for actual practice, can help overcome these difficulties (Dieker et al. 2015; Shaughnessy & Boerst 2018).

Pre-service teachers should have practical experiences in critical reading instruction methods, often referred to as core or high-leverage practices (Ball & Forzani 2009), well in advance of their school-based assignments as part of their work-integrated learning journey. High-leverage practices (HLPs) are characterised as crucial teaching practices that pre-service teachers can acquire and implement, which play a fundamental role in supporting the learning of learners in the classroom (Ball et al. 2009). In this study we focused on eliciting background knowledge on an informational text. Willingham (2016:6) argues that background knowledge is a key cognitive resource that learners use when they read, and that teachers should elicit and build on learners' background knowledge in order to support their reading comprehension. Background or prior knowledge is a critical factor in understanding new information, as it provides a framework for organising and making sense of new information (Dong, Siu-Jong & King 2020:1). Willingham (2016:1–2) states that learners who lack background knowledge about a topic will have difficulty understanding

the text and will not be able to retain the information for the long term. Additionally, eliciting background knowledge can be used to support diverse learners by considering their different backgrounds and experiences, which can help to make the material more relatable and relevant for them. Furthermore, eliciting background knowledge is a powerful teaching practice because it can be used to engage learners in the learning process and to empower them to take ownership of their learning. By asking learners questions, teachers can help them to reflect on their own understanding and to identify areas where they need further support (Shanmugavelu et al. 2020:45).

Grossman et al. (2009:2056) propose the concept of 'approximations of practice' as a strategy to offer pre-service teachers genuine opportunities to experiment with the essential skills required for successful teaching. Grossman et al. define approximations of practice as opportunities pre-service teachers have 'to engage in practices that are more or less proximal to the practices of a profession' (p. 2056). Mixed-reality simulations, incorporated early into teacher education programmes, serve as practical examples of approximations of practice. They offer pre-service teachers a chance to exercise key teaching strategies, like eliciting learners' prior knowledge for reading informational text or illustrating and explaining content, in a regulated setting that closely resembles real classroom scenarios. While these simulations do not aim to replace actual school-based teaching experience, studies suggest that they can offer a genuine hands-on learning experience for future teachers before they step into their on-site school placements as part of their professional learning experience (Bautista & Boone 2015; Cil & Dotger 2017).

## Mixed-reality simulation environments

Ade-Ojo et al. (2022) define simulation as:

[*A*]n approach to teaching that utilizes the process of creating a replica of real-life situations in order to develop students' response to such a situation if and when confronted with it in their actual practice. (p. 862)

Simulation has been used in various domains (Jackson, Tolujevs & Kegenbekov 2020:194), but within initial teacher education, specifically in South Africa, it is still in its infancy.

Mixed-reality simulations represent a cutting-edge technology that combines the physical and digital realms, enabling users to interact with both real and virtual elements within a unified environment (Lindgren et al. 2016). TeachLive™ is a mixed-reality simulation platform designed to provide teachers with realistic, immersive training experiences. In mixed-reality simulations, the use of 'digital puppetry' is employed through avatar learners in a virtual classroom. These avatars are controlled by a live interactor who operates the technology behind the scenes, dictating the behaviours and actions of the avatar learners (Bautista & Boone 2015). The TeachLivE™ simulator is a platform where student teachers can practise their skills in a virtual classroom,

displayed either on a white board or television screen, or via Zoom conferencing software. This simulation is made realistic through avatars controlled by an operator, referred to as the interactor, who makes the characters look, sound, and interact like real people within the setting's cultural context (Dieker et al. 2015). The term 'human in the loop' in this context refers to the interactor who synchronises the voice and body movements of the avatars.

The TeachLivE™ environment comprises four elements: the interactor, avatars, student teacher, and observers like a teacher educator. The interactors, who are usually trained improvisation actors and puppeteers, are tasked with managing the human in the loop feature, which allows for real-time conversation (Nagendran et al. 2014).

Every avatar is unique in terms of its form, voice, and personality. The interactor can portray varying responses, ranging from compliant to disruptive interactions. Using an interactive gaming controller and preprogrammed movements, the interactor can move the five avatars (e.g. Kevin, CJ, Maria, Sean, and Ed) to simulate real classroom interactions. While most responses are real time, the interactor can trigger some pre-recorded behaviours, like laughter, pen clicking, or cell phone ringing (Straub et al. 2014). Interactors ready themselves for the simulation in a similar way to how teachers prepare for their classes, by thoroughly familiarising themselves with the unique characteristics and backgrounds of the avatars, as well as understanding the planned scenario for the simulation (Dieker et al. 2015:12, 2014a). According to Dieker et al. (2015:12), TeachLivE™ is referred to as 'sandbox technology', providing pre-service teachers with a precise set of tools necessary for focused skills practice. It utilises virtual reality technology to create a simulated classroom environment, where teachers can practise their skills and receive feedback on their performance. One of the major benefits of using TeachLivE™ for teacher training is the ability to practise in a safe and controlled setting. In the context of initial teacher preparation programmes, pre-service teachers may be limited to observing experienced educators or practising their skills solely in real classrooms with actual learners. This can be intimidating for new teachers, who may be nervous about making mistakes in front of a live audience. Within mixed-reality simulation environments, such as TeachLivE™ and Mursion, (Mursion and TeachLive™ are similar platforms, but TeachLive™ originated at the University of Central Florida), pre-service teachers can practise their teaching skills as many times as they need to, without the pressure of a real classroom setting. They can also receive immediate feedback on their performance from avatar learners and teacher educators, which can help them identify areas for improvement and develop their skills more effectively. Another advantage of using TeachLivE™ is the ability to customise the training experience to meet the specific needs of the pre-service teachers. The platform allows teacher educators to create customised lesson plans and scenarios, so pre-service teachers can practise teaching core teaching practice within specific subjects and

for specific grade levels or work on specific skills such as classroom management. Specific features intrinsic to mixed-reality simulations are beneficial for focused skills training for aspiring teachers. Dieker et al. (2014a) especially highlight the importance of TeachLivE's™ pause and restart options. Unlike a real classroom setting, a mixed-reality classroom allows an educator to stop a scenario at any given moment to provide guidance to a pre-service teacher, or even reset the scenario if the pre-service teacher is encountering significant challenges. These features provide an opportunity for the pre-service teacher to repeatedly practise skills until they are proficiently mastered.

The mixed-reality environment within TeachLivE™ allows pre-service teachers to learn without placing 'real' learners at risk through engaging in virtual rehearsals of a targeted core teaching practice (e.g. eliciting background knowledge, teacher–parent meeting or learner behaviour management). In the simulation literature, specifically in teacher education, learning is done via an ARC (Nel et al. 2020:53). The ARC starts with the teacher educator determining what core teaching practice or task they want the pre-service teacher to perform. Next, the teacher educator creates a plan and presents the core teaching practice (e.g. eliciting learner background knowledge on an informational text making use of questions) to the pre-service teachers. Pre-service teachers can also be given the opportunity to watch video recordings of expert teachers or peers to assist with their preparation. The teacher educators and pre-service teacher sets a goal they are trying to achieve (setting the Before Action Review – BAR) which is aligned with the core teaching practice focus, for the simulated teaching experience. For example, the goal could be to elicit the learners' background knowledge by asking a number of questions and eliciting discussion on the selected informational text so as to be able to determine where to focus the explanation of content that may follow. Next, the pre-service teacher enacts the lesson segment in the mixed-reality simulator. Following the simulated experience, the pre-service teachers participate in a reflection process with the teacher educator and peers. In 'the world of simulation, [this] is called After-Action-Reviews (AAR)' (Nel et al. 2020:53). Research conducted by Straub et al. (2014) showed that the AAR process is crucial for core teaching practice transfer to the 'real' classroom environment. Typically, this ARC should not extend beyond 10 min. However, if a pre-service teacher's performance doesn't align with the BAR, it could be accelerated and only last a few minutes.

# Research Methods
## Research design

In this article, we have opted for a qualitative approach as it aligns with our objective of comprehending the perceptions of final year pre-service teachers engaging with the avatar learners, and how they perceived teaching within a mixed-reality simulated environment with an explicit focus on eliciting background knowledge. The qualitative research

design chosen for this study was a single exploratory case study. The case study allowed for the 'exploration of a "bounded system" or case through a detailed in-depth data collection involving multiple sources of information rich in context' (Creswell 1998:61). The case study 'allows investigators to retain the holistic and meaningful characteristics of real life events' (Yin 2009:4).

According to Yin (2009), the case study method is frequently employed when the research aims to address 'how' or 'why' questions. In the context of the BEd programme at the university, our investigation focused on a specific bounded system comprising 12 pre-service teachers who were assigned to the same partnership school for their teaching practicum. Zeichner (1999:9) notes that case studies in teacher education programmes have 'provided a close-up and detailed look at particular teacher education activities and show what a teacher education program looks like from the inside, from the perspectives of students and faculty'. Studying the individual perceptions of pre-service teachers as they engage with avatars and emphasise eliciting background information during the teaching practicum component of an initial teacher education programme offers a more comprehensive and insightful 'inside' perspective. Essentially, this approach allows for an examination of the lived experiences in greater depth (Glesne 2006). Prior to exploring with mixed-reality simulations, the teacher educators mostly made use of micro-teaching as practice-based opportunity for contact students only. As initiators of the use of mixed-reality simulation on the African continent we acknowledge that the use of an exploratory case study with a limited number of participants may have affected the results. In future designs, proactive action research may be considered to showcase the changes in pre-service teachers' reading practices. In a previous case study, the potential transferability of a students' teaching of group guided reading from the simulator to a school-based classroom was shown (cf. Nel 2022).

## Participants and participant selection

Sampling entails choosing a subset of the finite population under investigation. Non-probability sampling, on the other hand, does not aim to select a random sample from the population of interest. Instead, subjective methods are employed to determine which elements are included in the sample (Battaglia 2008:525). Generalisations derived from non-probability sampling should be approached with caution and scrutinised carefully. A purposive sampling strategy was used to select participants for this study. According to Creswell (2012:156), when purposive sampling is used in qualitative research it means that 'the inquirer selects individuals … because they can purposefully inform an understanding of the research problem and central phenomenon in the study'. The study was conducted in a teacher education programme that was an early adopter of simulation technologies and where teacher educators often design and use simulations in their research and in their courses. All participants were specialising in an English language module, within the BEd programme, either as

home language or as first additional language. Students were enrolled as either contact or distance students. Teaching within the mixed-reality simulator on campus requires students to teach the avatars as they are projected on a screen whereas the distance students taught the avatars by accessing the Zoom conferencing platform. Students do not require extensive computer literacy; they only need to be able to access the classroom via Zoom and have a stable internet connection. During the COVID-19 pandemic all students received training in the use of the Zoom platform.

## Data collection methods and procedure

The following data collection methods were used in this study: semi-structured individual interviews via WhatsApp as well as video recordings of the 'lessons' in the mixed-reality simulator and audio recordings of the After-Action-Reviews (AAR) reflections. The teacher educators developed the 'eliciting background knowledge using questioning' scenario and systematically guided the pre-service teachers through the ARC. The pre-service teachers enacted their lessons in a classroom set up for mixed-reality simulation teaching purposes.

## Data analysis

We used thematic analysis to analyse the data. According to Kiger and Varpio (2020:2), thematic analysis 'is a method for analysing qualitative data that entails searching across a data set to identify, analyse, and report repeated patterns'. When attempting to comprehend a collection of experiences, thoughts or behaviours within a data set, thematic analysis proves to be a suitable method to employ (Braun & Clark 2006). We utilised Braun and Clarke's (2006:16) six step method of analysis, namely familiarising yourself with the data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and lastly producing the findings in a report.

## Ethical considerations

Ethical clearance to conduct this study was obtained from the North-West University from the university gatekeeper (No. NWU-00003-21-A2).

All participants were informed about the purpose of the research, that their participation was voluntary and that they could withdraw at any time without providing reasons. Before participating in the mixed-reality simulations, the teacher educators and the pre-service teachers signed consent forms that are kept on the principal investigator's password-protected computer.

# Results and discussion

The results are presented according to the research questions with the major themes emanating from the data highlighted and discussed. The first research question that was addressed was: *How did pre-service teachers perceive their engagement with the avatars?* Investigation revealed the following main themes.

## Positive features during engagement with the avatars

Once the pre-service teachers entered the mixed-reality simulated classroom and started to interact with the avatars, they had to take control of the classroom. Each student teacher had a unique and individual interaction with the avatars. Student teacher 2 (Female, Foundation Phase, October 2022) commented that interacting and engaging with the avatars was fun and that she couldn't believe they acted like real learners. She stated that 'this experience was amazing, the avatars were fun to work with and I couldn't believe the way they interacted with me'. She continued to state that 'this is far more realistic than working in our microteaching groups with our peers. They just act stupid, and their interactions and responses are seldom realistic'. Student teacher 3 made a similar comment, saying:

'[T]he avatars were very interesting. I did not expect them to be so interactive in the way that they were. They made me aware of the fact that I must really think when I prepare my content. I did not realise the effect that their responses could have on my preparation. One of the avatars really knew a lot about robots and my whole lesson would have been a disaster because his one response included most of the content that I wanted to focus on.' (Female, Intermediate Phase, October 2022)

Student teacher 9 stated that:

'I was amazed by the feedback I got, as the avatars responded well to my questions. It was a very good learning experience for me, and I learnt how to think on my feet. Everything does not always go as planned in a classroom, and as a teacher, one needs to be able to adapt. Engaging with the avatars gave me the opportunity to experience that and reflect on it.' (Female, Intermediate Phase, October 2022)

Student teacher 7 mentioned that:

'I really enjoyed interacting with the learners because most of the time, when on practical, the mentor teachers give us work to do, and we end up not interacting with the learners.' (Female, Foundation Phase, October 2022)

## Challenges during engagement with the avatars

The following theme emphasises some of the challenges that the pre-service teachers mentioned. Student teacher 1 commented that:

'The avatars were realistic in that they could raise their hands, and I could notice when they were quiet or not engaging, but the lack of facial expressions was a bit of a challenge to me as I tend to rely on that a lot. However, one thing I did notice was the diversity among the avatars and this made me aware of the fact that I need to pay attention to their different needs. During microteaching, things like that are not foremost in your mind and you don't notice it.' (Female, Foundation Phase, October 2022)

Student teacher 4 found the engagement with the avatars challenging, stating that:

'[T]heir responses are so realistic and challenging that I was definitely out of my comfort zone. Some of them even challenged my questions and this made me aware of the fact that I really need

to be so well prepared and be able to think on my feet, because all learners are different.' (Female, Intermediate Phase, October 2022)

The second research question was: *How did the pre-service teachers experience teaching within a mixed-reality simulated environment explicitly focused on eliciting learners' background knowledge on an informational text?* This elicited the following themes and responses from the pre-service teachers.

## Unfamiliarity with focusing on a specific core teaching practice

The responses from the student teachers indicated that focusing on a core practice, such as eliciting learners' background knowledge was 'strange' to them. Student teacher 10 stated that:

'This is the first time in our four years of teaching practice that we get the opportunity to focus on only one particular aspect. We usually have to present complete lessons and then the feedback we get is seldom on the content of our lesson, but more on how we handled the discipline, how we started the lesson – did we "hook" them!' (Female, Intermediate Phase, October 2022)

Student teacher 6 stated:

'I did not realise the importance of checking their background knowledge and how this would impact the rest of my lesson. This experience was an eye opener. During the AAR sessions when the student teachers had the opportunity to watch their recorded lessons with the teacher educators and critically engage on how they were eliciting the avatar learners.' (Female, Foundation Phase, October 2022)

Background knowledge, many of the student teachers commented:

'Oh no, I now see that I tend to ask questions straight from the text and mostly lower order questions. I really battle to engage more than one learner at a time. I tend to ask questions to one student at a time instead of getting them to feed off each other's ideas.' (Student teacher 6, Female, Foundation Phase, October 2022)

'Wow, I didn't realise the importance of my questions. During my preparation, I just randomly wrote down a number of questions and then during the lesson I fired them off. I guess I really need to think about this.' (Student teacher 4, Female, Foundation Phase, October 2022)

Student teachers 7 (Female, Foundation Phase, October 2022) and 11 (Female, Foundation Phase, October 2022) had very different experiences. Student teacher 7 stated that:

'I don't know how to engage the learners if they can't answer my questions. During last semester's teaching practice, if the learners can't answer I would generally just give them the answer and go on with my lesson. Here I couldn't do that because the purpose was to elicit their background knowledge. We have never gotten any practice like this before. My teaching is really not up to par.' (Female, Foundation Phase, October 2022)

## Thinking versus putting on a show

Some of the student teachers' responses indicated that they prepared their content, but seldom put any serious thought into how what they were doing affected learning. Student teacher 12 stated that:

'I underestimated how well the learners would answer my questions. I enjoyed this experience a lot because during my practical I had to focus on other things that felt more important than the quality of my questions. I think it's great that we got different types of learners because I've never had a learner like Sean that would go off topic. I now know that's something I need to work on because I didn't know how to get him back to the topic without discouraging him from answering other questions.' (Female, Foundation Phase, October 2022)

Student teacher 10 stated that:

'During our teaching practice it feels as if I have to put on a show for the lecturers who come to assess me. I have to follow all the components of presenting a good lesson – hook them with an entertaining introduction, present the content, give them activities and assess. I don't want to say this, but I have been copying and pasting the same lessons from my first year; I just adapt to the grade level. For the reading comprehension, we mostly focused on comprehension strategies and the questions come from the text.' (Female, Intermediate Phase, October 2022)

Student teacher 3 mentioned that:

'This experience has taught me that I will have to think on my feet and be well prepared to make adjustments to my lesson, based on the responses that the learners give me.' (Female, Intermediate Phase, October 2022)

Student teacher 2 mentioned that:

'I did not realise the importance of trying to engage the learners in a discussion on the text; this should actually shape what I want to teach. In class we learnt about background knowledge, but not how to actually get learners to engage with us on it.' (Female, Foundation Phase, October 2022)

The third research question: *How did the pre-service teachers perceive the utilisation of the after-action-review cycle?* Pre-service teachers' responses highlighted the following themes. During the AAR session the teacher educators guided the pre-service teachers through the process to ensure that they understood the cycle that was followed. The themes are also centred around the main steps in the AAR cycle.

## Identifying task and core practice

The teacher educators formulated the following task and core practice for the mixed-reality simulation:

'A student teacher will be teaching a reading text, *Robot Explorers*, to a Grade 4 class. The main focus is on the types of questions that the teachers ask to elicit background knowledge on the text – explaining, activating background knowledge, asking a variety of questions, and engaging children.'

When asked about focusing only on a specific core teaching skill the pre-service teachers responded by stating:

'This is very new to us, we are usually required to do a complete lesson of about 25–30 minutes.' (Student teacher 3, Female, Intermediate Phase, October 2022)

'I liked this very much, because I only had to focus on this one thing and try to get it right.' (Student teacher 1, Female, Foundation Phase, October 2022)

'I never knew what eliciting learners background knowledge meant and how to do it properly. I thought it was just ask a number of random questions to get the class going.' (Student teacher 7, Female, Foundation Phase, October 2022)

## Plan and create scenario

The teacher educators designed the scenario and then introduced the pre-service teachers to the mixed-reality simulation classroom as well as the avatars. We did not give any information on the working of the mixed-reality simulator. The students were only given background information on each of the five avatars, namely Sean, Kevin, CJ, Maria and Ed. This included their personalities and home background. The students were also given the opportunity to see recordings of previous sessions so that they could familiarise themselves with what the avatars looked like, how they spoke, how they react and also how a previous group of student teachers engaged in the mixed-reality simulator. The students commented in the following way:

'This co-planning and preparation have given me a lot of confidence going into the classroom.' (Student teacher 8, Female, Intermediate Phase, October 2022)

'For our microteaching lessons we usually work on our own and seldom get to engage with our lecturers beforehand to ask questions or just test ideas.' (Student teacher 10, Female, Intermediate Phase, October 2022)

'I really liked having the opportunity to see what the classroom and the avatars look like – it put me at ease.' (Student teacher 12, Female, Intermediate Phase, October 2022)

For the BAR section, the following objectives were formulated:

Learning Objective 1: The teacher will practise introducing a text (i.e. discussion) by focusing on the elicitation of background knowledge.

Learning Objective 2: The teacher will practise asking a variety of questions at different levels.

Learning Objective 3: The teacher will practise engaging children in a rich discussion of the meaning of the text.

The pre-service teachers made the following comments:

'I really appreciate the fact that very clear objectives were set for us. I know what I needed to focus on and what the aim of the engagement with the learners was.' (Student teacher 13, Female, Intermediate Phase, October 2022)

'It feels as if I can now focus on one thing and try to really do it well instead of just going through the motions – usually it is a hit or miss thing anyway.' (Student teacher 9, Female, Intermediate Phase, October 2022)

'This is the only time that I really know what is expected of me and why I am doing it.' (Student teacher 13, Female, Intermediate Phase, October 2022)

'I really got to see how I could link what I learnt about background knowledge and its importance for reading comprehension in practice. It becomes real and not something I have to memorise for a test or exam. If I don't do this well, the rest of my planned lesson may not be effective for all learners.' (Student teacher 5, Female, Intermediate Phase, October 2022)

## Enacting the lesson

The pre-service teachers made the following comments:

'This has been an amazing experience. This is what I think teaching should be about.' (Student teacher 2, Female, Intermediate Phase, October 2022)

'This is the most realistic experience, apart from being in an actual classroom, that I have ever had at university. Our microteaching lessons are a waste of time as we are seldom put on the spot and rarely get any constructive feedback.' (Student teacher 13, Female, Intermediate Phase, October 2022)

'I have never been put through my paces like this before – wow [,] what an opportunity. I hope this becomes part of our curriculum.' (Student teacher 13, Female, Intermediate Phase, October 2022)

## After-action-review

After teaching in the simulator, the pre-service teachers participated in an after-action-review session with the teacher educators and where they also got the opportunity to review a recording of their lesson. The following were some of the most important comments made by the pre-service teachers:

'It is clear that I did not achieve the objectives as set out for us. I have been so used to just teaching a whole lesson that this small teaching focus really threw me.' (Student teacher 3, Female, Intermediate Phase, October 2022)

'We have never been given the opportunity to practise in this way. At first I was nervous, but I could actually pause the classroom, not possible in an actual classroom, get help and input from my lecturers, and then go back into the classroom and redo.' (Student teacher 13, Female, Intermediate Phase, October 2022)

'We hardly ever get feedback on our practice at university anyway; at school the mentor teacher says a few things, but I never get the opportunity to practice it or try and do it over or better. This was so helpful and it has increased my confidence.' (Student teacher 2, Female, Intermediate Phase, October 2022)

'For the first time I am not focussed on getting a mark, but only on improving my practice and practising my teaching skills. I thought I was not too bad, but oh dear, I am starting to doubt whether I am really prepared for this.' (Student teacher 2, Female, Intermediate Phase, October 2022)

'I just loved the fact that we could get help from our lecturers while we were teaching. We paused the classroom and I go redo something. And what was extra cool and really helpful was the fact that even though I asked the same question again, the avatars responded in a different way, so I had to keep thinking and making adjustments.' (Student teacher 3, Female, Intermediate Phase, October 2022)

The results seem to indicate that mixed-reality simulations have the potential to transform the way we prepare our pre-service teachers, specifically with regard to core reading

practices. Research indicates that there is a major problem with our preparation of teachers to teach reading (Taylor & Mawoyo 2022:165). Learning to be a teacher involves not only 'knowing that' but also 'knowing how' (ed. Grossman 2018:9). The results indicate that the pre-service teachers participating in this study were only prepared with the 'knowing that'.

This study focused on understanding what pre-service teachers' perceptions were of participation in a mixed-reality simulation. By paying attention to what our pre-service teachers are saying, we gained new insights into how to support our students to become well-prepared teachers of reading. Overall, the pre-service teachers experienced the mixed-reality simulation as being 'awesome' and that it provides a risk-free environment where they can get actionable and targeted feedback as well as the opportunity to practise until they have mastered the skill. This is supported by similar research focused on mixed-reality simulations, conducted within an international setting (Bautista & Boone 2015). In terms of content, the pre-service teachers, as in other studies (Theelen, Ven den Beemt & Den Brok 2018), described being able to practise their reading skills as one of the most important advantages of the mixed-reality simulation, and also that the scenarios were aligned with what they would be required to do in real classrooms (Badiee & Kaufman 2015). Additional aspects that the results highlighted include the unique features of the mixed-reality simulations, namely being able to pause and redo and receive immediate feedback and coaching from the lecturers or peers (Dieker et al. 2014b). Repeated deliberate practice opportunities enable the pre-service teachers, and teacher educators, to notice their improvement and growth and to see how effected changes can have immediate results. According to Kraft and Papay (2014), it takes years for teachers to build their expertise. Sebastian and Cohen (2021:31) state that '[b]y repeatedly having candidates practice targeted skills, we have the opportunity to compress that time frame and to help candidates rapidly build skills'.

## Conclusion

While school-based teaching practice remains as the conventional approach for pre-service teachers to learn and hone their subject-specific core teaching practices, it may not always provide students with sufficient opportunities for risk-free practice, dedicated time, repetition, or extensive and focused feedback necessary to acquire comprehensive knowledge, skills, and confidence. In addition, the recent COVID-19 pandemic has made it evident to us that there is an urgent need to assess the viability of mixed-reality simulations such as TeachLivE™ and Mursion in initial teacher education programmes. The mixed-reality environments would still allow pre-service teachers to practise their teaching if school-based placements are either suspended or disrupted due to unforeseen events or natural disasters. It is also clear that developing pre-service teachers' expertise in 'knowing how' benefits from deliberate practice opportunities that are specifically designed to improve complex skills. The results indicated that teaching within the mixed-reality environment provided them with a unique opportunity to practise a core instructional practice such as eliciting learners' background knowledge by asking questions. They needed to make decisions and changes on the fly which did not occur during traditional micro-teaching lessons where their peers merely 'play the role of a learner' and which is seldom realistic. Therefore, being able to deliberately enact core reading practices in realistic mixed-reality simulations is crucial for pre-service teachers' development. Mixed-reality simulations, supported by pre-service teachers' perceptions, have the potential to transform the way we prepare our students to teach reading.

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