

Article

The Integration of Mixed Reality Simulation into Reading Literacy Modules

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Abstract: The reading literacy crisis, among learners, in countries throughout the world and in South Africa seems to be reaching pandemic levels. Hence, the quality of teaching and the preparation that pre-service teachers receive at initial teacher education institutions is under the spotlight. A proactive action research design is used to integrate mixed reality simulation into reading literacy modules. Our data collection methods included professional conversations, WhatsApp voice notes and video calls, reflective journal entries and reflections on observing video recordings of lesson segments in the MRS environment. The data was analyzed using content analysis. The main themes emanating from the data included: lack of focus on high leverage teaching practices, limited use of pedagogies of enactment, add-on to existing content, experimentation, perceptions, planning and preparation, content-method integration, pedagogies of enactment, assessment, resources and feedback. Grounded in a Community of Practice framework, we narrate our experiences of re-imagining mixed reality simulation as a core component of initial teacher education programs. The authors conclude by sharing insights and recommendations for policymakers, faculty leaders, and curriculum designers, contributing to informed decisions regarding integrating and potentially upscaling mixed reality simulation within reading literacy modules in initial teacher education programs.

Keywords: mixed reality simulation; initial teacher education; reading literacy; proactive action research

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1. Introduction

In South Africa, as in most parts of the world, reading literacy stands as a cornerstone of educational development and societal progress. However, the persistent challenge of low reading literacy levels among learners threatens to impede a nation's growth and development [1]. For example, scores on the Program of International Student Assessment (PISA) note a downward trend worldwide of 10% or greater from 2018 to 2022 in literacy scores. In South Africa, the 2021 Progress for International Reading Literacy Study (PIRLS) results indicated that 81% of Grade 4 learners did not reach the lowest benchmark level [2]. According to the United Nations [3], the PIRLS 2021 assessment revealed declines in 21 out of 32 countries with comparable data from 2016–2021. According to national education targets, the percentage of learners attaining basic reading skills by the end of primary school is projected to rise from 51 per cent in 2015 to 67 per cent by 2030 [3]. In South Africa, Van der Berg et al. [4] and Kotzé et al. [5] estimate that learning losses, post-pandemic, at the level of primary school amount to at least one full year of learning, suggesting that ten-year-olds in 2022 now know less than nine-year-olds pre-pandemic. Pretorius and Spaull [6] (p. 2) state that, “This is a catastrophic setback that will take many years to overcome”.

Pre-service teacher preparation plays a pivotal role in shaping the competencies and practices of educators. Hence, the quality of teaching and the preparation that pre-service teachers receive at initial teacher education institutions is under the spotlight.

Spaull [7] (p. 4) states that “It is now clear that, on the whole, faculties of education are not preparing incoming teachers to teach reading in the home language”. Similarly, Taylor and Mawoyo [8] (p. 164) state that, with few exceptions, “South African education faculties only pay lip service to policy set by government regarding the initial education of primary school teachers, that they neglect the poor language and mathematics skills of their students, and give scant attention to research on reading pedagogy”. The issue of low levels of teacher knowledge is one that has been highlighted in the South African context for some time [9,10]. Van der Berg et al. [11] refer to it as a ‘binding constraint’ on raising literacy levels. The question is whether the preparation pre-service teachers receive with regard to reading literacy could be the “smoking gun at the crime scene” of South Africa’s, and other countries, literacy crisis?

Efforts to adequately equip pre-service teachers for effective classroom instruction have frequently been criticized for their lack of effectiveness, particularly in how well they facilitate the transition from theoretical knowledge gained in university modules to the practical demands of teaching in real classrooms [12]. Research discussing the significance of continual practice opportunities in preparing pre-service teachers has emerged as a means to offer more impactful training to these students [13,14]. Researchers argue that simply being present in and around classrooms falls short [15,16]. Instead, scholars emphasize the necessity for pre-service teachers to engage in structured activities that allow for the analysis and implementation of teaching practices.

We are of the opinion that bridging or narrowing the gap between the actual and desired levels of pre-service teacher instruction, specifically reading instruction, will not be achieved by practice as usual; game changers involving the integration of deliberate and equitable practice-based teaching and learning opportunities via the use of mixed reality simulations may be needed. The integration of mixed reality simulation environments, such as TeachLivE™ or Mursion, in teacher education programs offers a transformative approach to preparing preservice teachers. Mixed reality simulations provide a safe, controlled, and realistic platform where preservice teachers, both contact and distance students, can practice pedagogical skills, classroom management, and learner engagement techniques in English and various African languages [17].

The research questions formulated for this study included (1) Why was mixed reality simulation included in reading literacy modules in a B.Ed. program? (2) How did the integration of mixed reality simulation facilitate the “re-building” of the reading literacy modules in a B.Ed. program?

2. Mixed Reality Simulation in Teacher Preparation Programs

Simulations can encompass any experience that immerses participants in a realistic, life-like environment [18]. Their primary aim is to prompt students to actively engage, make informed decisions, and communicate effectively as professionals would in real-world contexts [19]. Simulation-based learning endeavors to “replace or amplify real experience with guided experiences” [20], p.12. The use of teaching simulations emerged from case studies that were traditionally read and role-played within initial teacher education programs [21].

TeachLivE™ and Mursion, two prominent mixed-reality simulation platforms, are clearly present in the teacher education literature. TeachLivE™ a mixed reality classroom environment, was originally created at the University of Central Florida [22] and then supported by the Bill & Melinda Gates Foundation to create partnerships and commercialization. The company Mursion then licensed the technology and both systems allowed pre-service and in-service teachers to engage with virtual learners and practice their instructional skills in a safe and controlled setting [23]. These highly interactive and customizable virtual environments enabled teacher educators to customize their preparation programs and for pre-service teachers to hone their instructional skills, classroom management, communication, and decision-making abilities [23]. Although work with simulation and other virtual reality platforms are occurring in teacher preparation, these two platforms are the only ones that incorporate the integration of a human in the loop to ensure authentic and

somewhat unscripted interactions between the avatar learners and the pre-service teachers. Both platforms mimic real-life scenarios by blending virtual and real environments [24,25]. Research indicates that the term “mixed reality simulation” (MRS) encapsulates this fusion, where real pre-service teachers interact with virtual avatars, allowing them to practice and refine their skills and dispositions repeatedly until mastery is achieved [18,21].

The literature highlights various ways mixed reality simulation can be integrated into teacher preparation to ensure that pre-service teachers practice teaching reading. These brief but focused sessions enable teachers to refine specific core reading literacy skills, such as eliciting background knowledge by using questions, decoding and fluency assessment instruction [26,27]. MRS has been effective in teaching evidence-based strategies for reading comprehension [28]. The study found that participants significantly improved their knowledge and application of these strategies, showcasing how simulations can bridge the gap between theory and practical application. In addition, studies using platforms like TLE TeachLivE™ and Mursion have demonstrated that pre-service teachers improve in areas such as error correction, hierarchical prompting, and comprehension strategies [28–30].

Nel and Marais [27] explored the perceptions of pre-service teachers regarding the use of mixed reality simulation environments to teach reading skills. The pre-service teachers valued the opportunity to engage with avatars in teaching core reading practices, emphasizing how the simulations allowed them to pause, redo, and receive immediate feedback. This structure supported their learning of critical teaching strategies. MRS offers pre-service teachers an alternative to traditional placements, providing them with deliberate practice opportunities to improve their reading literacy teaching skills.

Kamhi-Stein et al. [31] explored the use of Mursion® for pre-service teacher preparation in the field of language education. Pre-service teachers, especially those with limited experience, found the MRS platform beneficial in building their teaching confidence and skills. The study noted that MRS provided a much-needed opportunity for novice teachers to experiment with teaching strategies in a controlled, low-risk setting. The study emphasizes that MRS helps address the gap between theory and practice by offering pre-service teachers a platform to apply their learning in simulated classroom environments.

Research has consistently shown that preservice teachers who engage with MRS perform better in real classroom settings. Studies by McKown et al. [32] and Spencer et al. [33] showed that participants who used simulators reported higher levels of satisfaction and confidence compared to those who practiced with teaching to peers or even their teacher educators. The structured nature of MRS, which often includes cycles of practice, feedback, and reflection, supports deep learning and improved teaching outcomes [30].

Ersozlu et al. [34] provide a comprehensive review of research on TeachLivE™ and its role in initial teacher education. MRS has been found to enhance instructional skills development by offering repeatable, controlled environments for pre-service teachers. The review also indicates that pre-service teachers benefited from engaging with consistent and structured practice sessions, which helped in reducing classroom-related anxiety. The integration of MRS in teacher education addresses the unpredictability of real-world teaching placements by providing a reliable and structured environment for pre-service teachers to practice [27,35]. This allows for more uniform training experiences, which is critical given the variability in traditional teaching practicum quality.

The systematic review conducted by Ledger et al. [36] highlighted the advantages of MRS platforms in supporting pedagogies of practice by offering representations, decompositions, and approximations of teaching scenarios. These platforms allow pre-service teachers to rehearse and refine their teaching skills in a risk-free environment. The study calls for further integration of MRS in teacher education programs, emphasizing the importance of such tools in preparing classroom-ready teachers.

A study conducted by Peterson-Ahmad [37] examined how MRS, combined with instructional coaching, impacts pre-service special education teacher preparation. The study found that the combination of MRS with instructional feedback provided pre-service teachers with critical opportunities to refine their teaching methods, particularly in offering

Opportunities to Respond (OTR). This was done in a simulated, low-risk environment, where pre-service teachers could practice repeatedly. MRS helps special education teachers improve their instructional strategies by providing consistent, individualized feedback and opportunities for practice. The study emphasized the need for more personalized, scaffolded support during teacher preparation, something MRS can effectively provide [21].

Despite the promising potential of mixed reality simulation in teacher education, some potential pitfalls must be considered. Researchers have noted the significant investment in infrastructure, technology, and training to implement these simulations effectively [38]. Some studies noted technical difficulties, such as issues with avatar realism or simulation quality [38–40]. Moreover, it is important that simulations do not oversimplify student behaviors, which could lead to a false sense of security for teachers when transitioning to real-world classrooms [41]. Furthermore, issues of access and equity must be addressed, as implementing these technologies may disproportionately benefit certain institutions or student populations [41]. As the field of teacher education continues to evolve, integrating mixed reality simulation must be approached with careful consideration of these challenges to ensure equitable and effective implementation.

In conclusion, the use of mixed reality simulation in teacher education for reading literacy instruction has shown significant promise in recent years. While ongoing research is needed to fully understand these technologies' overall impact, the current literature suggests that embedding mixed-reality into preparation programs can enhance pre-service teachers' confidence, competence, and preparedness for implementing effective literacy instruction [40].

3. Materials and Methods

3.1. Design

We chose to conduct this study utilizing a proactive action research design [42]. Proactive action research involves implementing actions prior to data collection, followed by studying their effects. According to Schmuck [42], proactive action research entails initiating creative problem-solving and innovative practices before gathering data. This initiative often arises from previous, subconscious data collections. In this study we were inspired to try a new practice, namely the integration of mixed reality simulation into our reading literacy modules within a B.Ed. program with specialization in foundation phase (i.e., Grade R to Grade 3) and intermediate phase (i.e., Grade 4 to Grade 6) teaching.

3.2. South African Initial Teacher Education Context

Students enrolling for initial teacher education can either complete a Bachelor of Education (B.Ed.) degree in foundation phase (Grade 1 to Grade 3), intermediate phase (Grade 4 to Grade 6) or senior (Grade 7 to Grade 9) and FET phase (Grade 10 to Grade 12). As part of these structured programs students complete a compulsory work-integrated learning (teaching practicum or teaching practice) component, as stipulated by the Revised Minimum Requirements for Teacher Education Qualifications (MRTEQ) [43].

In the MRTEQ document it is stated that, "Practical learning involves learning from and in practice. Learning from practice includes the study of practice, using discursive resources to analyze different practices across a variety of contexts, drawing from case studies, video records, lesson observations, etc., in order to theorize practice and form a basis for learning in practice. Learning in practice involves teaching in authentic and simulated classroom environments. Teaching practice takes place in the workplace and can include aspects of learning from practice (e.g., observing and reflecting on lessons taught by others), as well as learning in practice (e.g., preparing, teaching and reflecting on lessons presented by oneself)" [44] (p. 10).

In addition to teaching practice being a requirement, the MRTEQ mandates that all pre-service students training to teach in the foundation and intermediate phases must be qualified to teach both a Home Language and a First Additional Language [43]. This requirement ensures that teachers are prepared to support learners in their primary language

while also fostering proficiency in an additional language, crucial for broadening communication skills and cultural understanding. Furthermore, the MRTEQ encourages teachers to qualify themselves in a third language at a basic communication skill level [43]. This proficiency aims to enhance teachers' versatility and their ability to engage with learners from different linguistic backgrounds, thereby supporting a more inclusive educational environment where language becomes a bridge rather than a barrier.

3.3. Participant-Researcher and Positionality

As teacher educators, we dedicate ourselves to continually enhancing our own learning while also providing clear insights into the how and why behind our actions [44]. To analyze our learning process, we utilize sociocultural learning theories [45–47] to explore the socially mediated aspect of our action research study. Viewing learning through a socio-cultural perspective reveals that it originates within a collective setting, where meaning is negotiated among participants, texts, and tools. As individuals engage in dialogue, they externalize their thoughts, leading to the internalization of learning [48]. We acknowledge the pivotal role of conversations with colleagues and critical friends in thoroughly scrutinizing and enhancing our module content and teaching practices [49,50].

In this study we take the position of insiders in collaboration with an outsider (i.e., a critical friend) [51] (p. 53). Schuck and Russell [52] (p. 107) state that, "A critical friend acts as a sounding board, asks challenging questions, supports reframing of events, and joins in the professional learning experience". As teacher educators we are well positioned to gain an in-depth understanding of the B.Ed. program offered within the Faculty of Education.

3.4. Data Collection Methods and Procedure

Schmuck's [42] proactive action research model consists of three distinct phases, each encompassing several steps. In Phase 1, known as the initiation phase of the proactive action research cycle, the teacher educators engaged in professional conversations, conducted via Zoom or WhatsApp, lasting between 10 and 45 min, completing Step 1 by voicing our hopes, concerns, and perceptions regarding the criticism of the lack of quality pre-service teacher preparation in reading literacy. Among academics, there is a prevailing belief that participating in professional conversations fosters professional development [53]. Timperley [54] (p. 4) states that "professional knowledge is constructed through social interaction", suggesting that academics should actively seek opportunities for professional conversations or dialogue to gain deeper insights into the efficacy of their current practices in higher education. While professional conversations among teacher educators may seem routine, they offer a platform for academics to explore their own thoughts and practices within a supportive and informed community [55]. This perspective aligns with Feldman's [56] assertion that systematic and focused professional conversations involve educators sharing brief practice anecdotes, engaging in questioning, experimenting with new ideas in their classrooms, and then returning to the group to share their experiences.

The primary aim of Step 1 was to address the initial research question: Why was MRS included in reading literacy modules in a B.Ed. program? The professional conversations conducted via Zoom or WhatsApp were focused on the gaps identified and how best we might solve them by using MRS in our reading literacy modules. In Step 1, two teacher educators were involved, one that focused on reading literacy in the Foundation Phase and one that focused on reading literacy in the Intermediate and Senior phase. In addition, one mentor teacher, who is working at a school where some of our pre-service teachers are placed for their teaching practicum, who is currently teaching the foundation phase was included to add valuable insight into current approaches and circumstances in a particular school. Step 2 involved the implementation of mixed reality simulation into our reading literacy modules, on a limited scale. During this step we engaged in piloting mixed reality simulation by using TeachLivE™. During Step 2, second- and third-year students were asked to volunteer to take part. These are students that are studying for a B.Ed degree with a specific focus on reading literacy in the various phases. We also extended the invitation

to colleagues in the foundation phase, a teacher at a partnership school who fulfilled the role of mentor teacher during the students' school-based teaching practicum placement, and also to colleagues and students from a faculty of education at another university in South Africa. This happened between 2018 and 2021.

In Phase 2, termed detection, Step 3 involved data collection, including professional conversations between the two teacher educators recorded via Zoom or WhatsApp voice notes or video calls, the keeping of reflective journals in which we documented our ongoing work and learning about mixed reality, and document analysis [57] of the following documents: language and literacy study guides for the language and literacy and teaching practicum modules, the knowledge and practice standards for primary teacher education graduates: language and literacy [58], and the Revised Policy on the Minimum Requirements for Teacher Education Qualifications [DHET], ref. [43] pre-service teacher documents such as lesson planning, and video recordings of their mixed reality simulation teaching sessions. The pre-service teachers were asked to elicit learners' background knowledge related to an informational text as well as facilitate discussion on the text. The aim was to focus on these core reading practices that we knew the pre-service teachers had difficulty in implementing effectively.

Once data collection was complete, step 4 focused on interpreting the collected data. The detection phase aimed to address research question two: (2) How did the integration of mixed reality simulation facilitate the "re-building" of the reading literacy modules in a B.Ed. program?

In phase 3, judgment, Step 5 involved reflecting on potential alternatives or adjustments, while step 6 focused on refining the practice. During Steps 5 and 6, the teacher educators and our critical friend engaged in further professional conversations via Zoom. During this phase we altered our practice by changing from TeachLivE™ to Mursion, based on feedback we received from the students and our colleagues. The main difference being that we are currently making use of a self-service mode via Mursion. This enabled us to give the avatars a unique South Africa background and allowed them to speak in English, Afrikaans, Setswana and isiXhosa. In addition, the practice-based opportunities were provided within a South African time zone which enabled us to provide more opportunities that suit the students' schedules. To mitigate bias when educators serve as researchers in data collection, adherence to ethical guidelines [59] is paramount, ensuring fairness, confidentiality, and equitable treatment of all participants. Incorporating peer review and feedback [60] is also critical, as it allows external scholars to critically assess the study design, data collection, and analysis, thus helping to identify and reduce potential biases. Furthermore, researchers must engage in reflexive practice [61], critically reflecting on their positionality and acknowledging their own biases. This process should be documented transparently to clarify their relationship with participants and maintain objectivity. Finally, a well-structured research design [62], including clear protocols and pilot testing, is essential to minimize subjectivity and ensure the integrity of the data collection process.

3.5. Data Analysis

We used the guidelines for conducting content analysis, provided by Erlingsson and Brysiewicz [63] (p. 94), to analyze the data. The content analysis was conducted by the two teacher educators involved in the study. We worked collaboratively to ensure a rigorous and credible interpretation of the data. Initially, each educator independently conducted a content analysis, carefully reading and rereading the data and coding the data according to predefined themes and categories. After completing our individual analyses, we came together to compare and discuss our analyses, addressing any discrepancies in coding through discussions and reflection. This process allowed for the refinement of our interpretations, ensuring consistency in the analysis.

The initial step entailed reading and re-reading the transcribed conversations (related to our modules and about our reflections on the recorded mixed reality simulation video lesson segments as well as the conversations with the pre-service teachers), WhatsApp

voice notes and video calls, the reflective journals, and the documents to get an overview of all the datasets. During this step we asked questions to keep us focused, namely What is the text talking about? What stands out? What message did the text leave you with? Secondly, we divided the text into meaning units. An example is given from the conversations with the pre-service teachers—The avatars are realistic, but their accents are strange; I struggled to understand some of the phrases the avatars were using; It would be great if we could have the avatars speaking different South African languages; the responses of the avatars didn't differ for home language and first additional language—I was wondering whether the responses would differ for English, Afrikaans, SeTswana and isiXhosa. The third step entailed labelling the meaning units by formulating codes (e.g., Avatar language), and then grouping these codes into themes such as Perceptions.

3.6. Trustworthiness

In this study credibility was enhanced by our prolonged intense engagement with the B.Ed. program (2018–present) and our persistent observation of our own practices and those of our pre-service teachers specializing in language and literacy teaching. Our insider positionality allowed us to foster rapport with our colleagues and student and this deepened our understanding of contextual factors. Dependability ensures that the “process of research has been logical, traceable, and documented” [64] (p. 294). To enhance the dependability, we acknowledge our position as insiders and an outside “critical friend” We present our data in a detailed descriptive manner to facilitate transferability different contexts [64] (p. 375).

3.7. Ethics

When we started our project in 2018, an independent person, a work-integrated learning coordinator placed an announcement on the learning management system and asked students as well as colleagues who were willing to volunteer and teach within the mixed reality simulation environment. We also extended the invitation to one other Faculty of Education at a university in South Africa as well as a representative of the Department of Higher Education and Training responsible for the Teaching and Learning Development Capacity Improvement Programme which focused on, amongst other aspects, the development of knowledge and practice standards for literacy teaching, as well as for work-integrated learning.

Ethical clearance was obtained from the university ethical committee (EMELTEN-Rec) (NWU-00403-23-A2) as well as gatekeeper permission (NWU-GK-23-147). Participants indicated their consent by either signing a consent form or by consenting to the recording of the videos in the mixed reality simulations via Zoom. Participation was voluntary and any participant could withdraw at any time without providing reasons.

4. Results and Discussion

There are several potential approaches for presenting the results such as grouping them by a particular category, research questions or by theme. To ensure coherence, we chose to organize the results according to the research questions and then emphasize the themes that support the specific research questions.

4.1. Why Was MRS Integrated in Language and Literacy Modules in a B.Ed. Program?

Based on weak learner reading literacy results in South Africa, concern about the gap between pre-service teachers' reading knowledge on the one hand and their classroom practice on the other hand as well as a call for the Council for Higher Education and/or the Department of Higher Education and Training to audit pre-service teacher education programs [7], we decided to take a critical look at what we were doing in our reading literacy modules. Our initial reflective conversations and journal entries highlighted the following themes: lack of focus on high leverage teaching practices and limited use of pedagogies of enactment.

4.1.1. Lack of Focus on High Leverage Teaching Practices

In order to prepare teachers for the diverse South African educational context, the Faculty of Education at the North-West University employs an integrated model for teacher training [65]. This approach aims to combine theoretical knowledge with practical pedagogical strategies within a single module. The program emphasizes the synthesis of content knowledge with teaching methods, ensuring that educational theory is directly linked to classroom practices [65,66]. For example, a language module would not only cover the theoretical subject content knowledge, but also the pedagogical content knowledge. The same teacher educator is responsible for teaching the academic content knowledge as well as the methods component. The integration of theory and practice enhances the learning experience by allowing pre-service teachers to immediately apply theoretical insights in practical, pedagogically sound ways. Some of our comments included:

Based on what I see when observing and assessing the students during the teaching practicum, I think my module is heavily skewed towards the theory and content [A2].

I agree, the students seem to either lack or implement teaching skills such questioning or reading aloud in a haphazard way. [A3]

During their teaching practicum, the student teachers keep asking lower order questions focused on the retrieval of explicitly stated information when they are discussing texts. The learners' responses are usually one word or single sentences. The wait time is also sometimes non-existent. [A2]

The explanations of narrative elements are limited and do not take into consideration that the learners are learning Afrikaans as an additional language. [A3]

Their text selection is often inappropriate in terms of grade level and level of difficulty. [A3]

They can't identify learners' reading problems. They only say, 'they can't read'. They do not know what to do when the learners are struggling, and they seldom, if ever, seem to use assessment data to make instructional changes. [A2]

We realized our student teachers were not mastering “high leverage practices” [14] and we were not placing enough emphasis on this skill during our modules; the inevitable result was that learners were not engaged and learning. High leverage or core practices are strategies, routines or activities that teachers can unpack for learning across subject areas, grade levels or contexts [67]. Matsumoto-Royo and Ramirez-Montoya [68] (p. 1) state that, “Teaching well depends on having a flexible repertoire of high-leverage strategies and techniques that can be deployed quickly with good judgment, depending on the specific context and situation”. We were focusing on the reading literacy instructional methods, but core practices such as questioning, the instructional routine of explicit instruction, providing feedback, explaining content, assessing oral reading fluency, creating meaningful and multiple oral language opportunities, using assessment data to make instructional decisions, giving clear directions, and providing scaffolding were some of the practices we were not addressing. We were assuming that these practices can be caught rather than taught or that they were addressed in the general education modules. Research shows that “the day-to-day practices of teachers exert the most powerful influence on learning” [69] (p. 879). Consequently, teacher educators should focus on preparing pre-service teachers for the work they do in classrooms [70] (p. 10). Grossman and McDonald [71] (p. 189) highlighted that “university-based teacher educators leave the development of pedagogical skill in the interactive aspects of teaching almost entirely to field experiences, the component of professional education over which we have the least control”. As a result, pre-service teachers may pick up practices incidentally during teaching practicum, but core practices are rarely identified and systematically taught through well-coordinated academic and methods modules [16].

4.1.2. Limited Use of Pedagogies of Enactment

The next concern highlighted in our conversations and journals was “how” we were preparing our student teachers to teach reading literacy. Our comments included:

It took me some time to realize that I was “telling or lecturing” them on how to teach a phonic lesson explicitly; how to assess oral reading fluency, etc. There are no opportunities to “see” it in practice, no modelling from side and limited opportunities for them to practice. [A2]

I do give my students the opportunity to plan lessons, but I realized that the feedback they get is on the lesson plan and not on how they teach the lesson. The only time I get to see them teaching lessons is when I assess their lessons summatively during the teaching practicum, and then it is only about five or six students out of a total of 300 students. [A3]

Lesson planning is pretty common, and I used micro-teaching a few times, but I did not find it realistic. The students play at being learners, and I don’t think very successfully. The feedback I give is seldom actionable, because if they repeat the lesson segment, the students give the same answers they did the previous time. [A2]

I agree, the responses from the students, playing learners, are not realistic and they seldom challenge the student teacher. [A3]

The results seem to indicate that learning about and talking about instructional methods is not the same as enacting the methods [72]. Pedagogies of enactment are specific pedagogies that can provide student teachers with the opportunity to enact the practice of teaching [71], and to learn from that enactment. It was clear to us that the pedagogies of enactment we were using were very limited and did not provide our student teachers with the practice-based teaching opportunities they needed.

We realized that we needed to “re-build” the methods component of the integrated modules by providing more practice-based learning opportunities. After reviewing the research on the topic, we decided to explore the integration of mixed reality simulations, specifically TeachLivE™, into our modules because one of the few conclusive implications of large-scale research on pre-service teacher preparation is that there is value in high-quality practice experiences [73,74]. We entered into a research agreement in 2018 with the second author, Lisa Dieker, and started using TeachLivE™ sessions, on a pilot basis, within our modules.

4.2. How Did the Integration of Mixed Reality Simulation Facilitate the “Re-Building” of the Reading Literacy Modules?

In addressing this question, we first focused on the implementation of TeachLivE™, which took place during step 2 of the initiation phase of the study. Secondly, we focused on the integration of Mursion, which took place during phase three, specifically steps 5 and 6, where we reflected on a potential alternative to TeachLivE™ and refined the integration of mixed reality simulation into our modules. The themes that emanated from the data during the pilot implementation of TeachLivE™ included add-on to existing content, exploration, and perceptions.

4.2.1. Add-On to Existing Content

The implementation of TeachLivE™ into our modules was done in an “add-on” manner to gauge both our own and the pre-service teachers’ response to utilizing the mixed reality simulation environment. These sessions occurred in addition to what we were already doing in the reading literacy modules.

Let’s identify a core teaching practice that we know, based on our observation and assessment of students during the school-based teaching practicum in their fourth year, the students struggle with and give them the opportunity to enact this practice in the MRS environment. [A3]

I am going to make the MRS sessions an add-on to my module, because I can't make any major changes now and I don't know if all the students, especially the distance students will be able to log-on successfully when they present their lessons. [A2]

We knew that our decision to “add-on” was not the way to go, but we were determined to expose our students to the environment because we were becoming increasingly frustrated with the high number of “unsuccessful” lessons we were seeing during the teaching practicum period. Research indicates that a “pruning” [75] and possible resign of our module would probably be the way to go [76].

4.2.2. Exploration

We reviewed research studies recommended by our critical friend, where TeachLivE™ had been used as a practice-based learning opportunity for students to practice core teaching skills e.g., [18,21,77,78] to familiarize ourselves with how other educators were using the mixed reality simulation. Over three years, we experimented with various core teaching practices (e.g., eliciting learner background knowledge, questioning, administering and interpreting reading assessment, managing off-task behavior, explaining and/or modeling content), providing practice opportunities individually or using a fish bowl modality, the time allocation for the students' lesson episodes (e.g., 5 min versus 30 min), providing coaching during the sessions, and providing feedback or after action review sessions immediately after a mixed reality simulation session or during a contact face-to-face lecture session at a later stage. Some of our comments included:

The students seem to be responding well when we let them collaborate and when they can provide input on one another's lessons. [A2]

Initially they were skeptical of presenting shorter segments of a lesson, but they immediately commented on the value. [A3]

I just loved being able to pause the lesson and give immediate feedback and see the students go straight back into the simulation classroom and try to implement the changes that I recommended. [A2]

The coaching was really effective when we focused on classroom management aspects. Most of the students were far more aware of what was happening in the classroom, picking up on facial expressions (confusion) and getting learners back on-task. [A3]

A group of educators at another university in South Africa followed a similar exploratory approach to ascertain the benefits of purposefully using TeachlivE™ to enhance the practice learning experiences of pre-service teachers [77].

4.2.3. Perceptions

Reflective conversations held with the students who participated in the MRS environment indicated that they were extremely positive about the practice opportunities in the simulation environment, receiving feedback from teacher educators, mentor teachers and peers, receiving coaching, and being able to pause the classroom when they were “losing it”. As teacher educators we were able to support all our students, both contact and distance, in an equitable manner. This had not been possible before in any of our modules. We also saw the value of providing immediate feedback and coaching. We could see that the students were slowly but surely moving away from having a mark or percentage orientation towards a concern for the effective implementation of their teaching practices and a focus on whether they were facilitating the learners' learning process. For the first time, we could also see improvement in their teaching practices; this was not possible before because when we go out and assess our students, once in the first semester and once in the second semester, we do not assess the same students and can, therefore, not see whether they have acted on our feedback and tried to improve their practice.

The students also highlighted several problematic aspects, namely the American accents of the avatars, the scheduling of the sessions that had to take place in the afternoons to align with the time zone in Florida. Our own issues were twofold, and firstly, related

to the cost of the sessions, namely \$150–175 per hour and that we needed to find our own funding to research and pilot the initiative. Secondly, we realized that to provide the students with deliberate, spaced, focused and coherent teaching practice opportunities we would have to “re-build” our modules as well as the language and literacy curricula for the entire B.Ed. program to ensure developmental progression (the latter is not the focus of the current study).

Following our reflection on the students’ and our own perceptions, the first author had a conversation, via Zoom, with our critical friend to discuss ways of tweaking our implementation of the mixed reality simulated environment into our modules. The major change we made was to switch to a Mursion self-service option which allowed us to address some of the issues we had emphasized, namely ensuring that the avatars spoke with South African accents, that they could speak languages such as Afrikaans, SeTswana and isiXhosa, so that we could accommodate the students who had to learn to teach in these languages, and we could schedule sessions to align with the students’ preferences and within the South African time zone.

After piloting the mixed reality simulated environment with our students, we concluded that the benefits outweigh the challenges. However, we knew we would have to “re-build” our modules to ensure that mixed reality simulated, as an approximation of practice, became a core component of the modules. The following themes emanated from the data we collected and highlighted the components within our modules needing “re-building”: planning and preparation, content-method integration, pedagogies of enactment, assessment, resources, and feedback.

4.2.4. Planning and Preparation

The planning and preparation we did for the module changed completely. We had to address the following aspects:

- Obtain university strategic funding for the MRS initiative.
- Buy the necessary computer equipment (e.g., computers, gaming controllers, headsets) required to run Mursion.
- Undergo Mursion on-boarding training (3 h).
- Undergo extensive Mursion simulation specialist training (approximately 50 h). In addition to being the lecturers responsible for the modules, we chose to fulfil the role of simulation specialists. We implemented a co-teaching approach within our modules. We also spent approximately 50 h observing learners’ interactions and responses in authentic and diverse classroom settings.
- Identify the year-level and modules into which MRS would be integrated.
- Ensure that all students had installed Zoom on either their computers or phones and that they knew how to interact on the platform.
- Design a scheduling form using MS Office 365 so that students can select the time that they would be in the mixed reality simulation environment.
- Place students in groups of four, based on their scheduling, to ensure the implementation of a fishbowl modality, due to our large numbers (150–300 students in one module). According to Driver and Zimmer [78], a fishbowl strategy approach works best for large groups of students.
- Build the scenario that was to be enacted in the mixed reality simulation environment. This included identifying the texts to be used for the ORF assessment, etc. completing the scenario template for the simulation specialists, collaborating with a colleague to co-teach the module, identifying a mentor teacher, at a school where pre-service teachers are usually placed for the teaching practicum, who wanted to be part of the initiative.

Research indicates that planning and building scenarios is a crucial aspect when integrating mixed reality simulations into coursework [79,80]. Driver and Zimmer [78] (p. 49) state that integrating high leverage practices in modules includes “planning for when and how knowledge, skills and understandings will be introduced, practiced, and assessed”.

4.2.5. Content-Method Integration

The content-method integration within our modules had to change to ensure that the method component received the attention that it deserved and that there was greater alignment between the two components. We had to address the followings aspects:

- Reformulate the learning outcomes for the units that would include MRS.
- Identify core teaching practices for use in the methods component (e.g., eliciting learners' background knowledge, questioning, explaining and modeling content, implementing and interpreting assessments, communicating with a parent, reading aloud, etc.).
- Align the subject content with the core teaching practice that will be enacted.

Research supports the need to reformulate learning outcomes for units that include mixed reality simulations. These outcomes should explicitly address the integration of content and method components to ensure effective teaching and learning experiences. For instance, one study highlighted the significance of mixed-reality learning environments in reinforcing a sense of presence and immersive teaching practice, indicating the necessity for well-defined learning outcomes that encompass these new teaching methods [81]. Core teaching practices are crucial for the methods component of mixed reality simulations. Effective practices such as eliciting learners' background knowledge, questioning, explaining, modeling content, and implementing assessments are essential. A study on mixed-reality simulations emphasized their role in providing pre-service teachers with opportunities to practice these core skills in a low-risk environment, thereby enhancing their confidence and proficiency [82]. Aligning subject content with core teaching practices is critical for effective MRS. Research has shown that when subject content is integrated with core teaching practices in MRS, pre-service teachers are better prepared for real classroom challenges. For example, a study found that mixed-reality simulations allowed teachers to effectively practice classroom management and instructional strategies, linking theoretical content with practical application [83]. When emphasizing core practices, we contend that teacher educators must address both the theoretical and practical elements of any given practice. Take instructional scaffolding as an example. When teaching this practice to preservice teachers, educators should focus on the fundamental theoretical principles that explain why scaffolding is important. This helps teachers understand when and under what circumstances to use instructional scaffolding. Additionally, educators should offer preservice teachers' opportunities to learn and implement the specific instructional routines involved in scaffolding.

4.2.6. Pedagogies of Enactment

We planned on mindfully integrating pedagogies of enactment into our modules using an action learning and review cycle (ALRC), adapted from [14,26] utilizing representations of practice, decompositions of practice, and approximations of practice (cf. Figure 1). Pedagogies of enactment involve teaching candidates learning about effective instructional practices through artifacts, decompositions, and approximations of these practices in simulated environments. This approach allows students to practice and refine their skills in a controlled, low-risk setting before applying them in real classrooms [84]. Studies on mixed reality simulation environments highlight its role in providing pre-service teachers with a platform for practicing and refining their teaching skills. The ARC within this environment involves teachers reflecting on their performance, receiving feedback, and then re-teaching to implement improvements. This iterative process has improved teaching strategies and confidence [22]. Research indicates that pedagogies of enactment when integrated within an Action Review Cycle in TeachLivE™ and Mursion, provide a robust framework for teacher education. These methods enhance the development of teaching practices through structured opportunities for practice, reflection, and feedback. This combination is essential for preparing effective and confident educators. A continuum of pedagogies of enactment, ranging from video analysis to virtual simulations, supports pre-service teachers in learning high-leverage practices. These practices are scaffolded

throughout a module or teacher education program to promote deep learning and skill development [85]. Iterative cycles of enactment embedded in diverse contexts provide rich opportunities for pre-service teachers to practice core teaching practices. These cycles involve repeated opportunities to enact, reflect, and improve teaching strategies, which is fundamental to the ARC process [86].

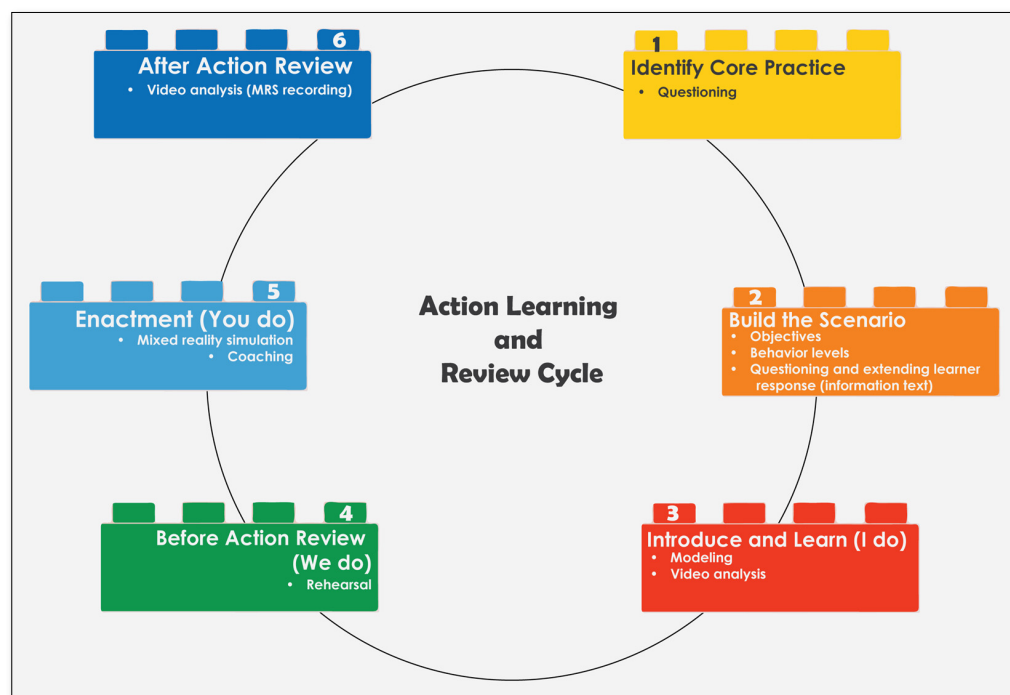


Figure 1. Action Learning and Review Cycle (ALRC).

4.2.7. Assessment

With regard to our assessment, we were invested in focusing on formative assessment to ensure that the students were more focused on improving their practice than on marks, percentages and just passing the module. Some of our comments included:

If I could only get these students to focus on improving their practice and really reflecting on what they were doing, I would have achieved a lot. They are so used to just doing the bare minimum to pass the module. This is really going to take a major mind-shift. [A2]

During the enactment of the high leverage practices in the mixed reality simulation environment, we were able to identify areas in need of improvement in the pre-service teachers' skills; this is supported by research [87,88]. Participation in the mixed reality simulated environment allowed us to standardize the students' experiences, which facilitated reliable assessment of the students' teaching of the high leverage practices [89]. Mixed reality simulations in higher education can offer alternative assessment strategies that are more inclusive and equitable. By using virtual, augmented, and mixed reality technologies, educators can assess students' skills and knowledge in diverse and engaging ways that traditional assessments may not capture [90].

4.2.8. Resources

The two main artifacts that we had to "re-build" were the lesson planning framework and the rubrics we used to guide the assessment as well as feedback process (cf. Figure 2; Table 1). Some of our comments included:

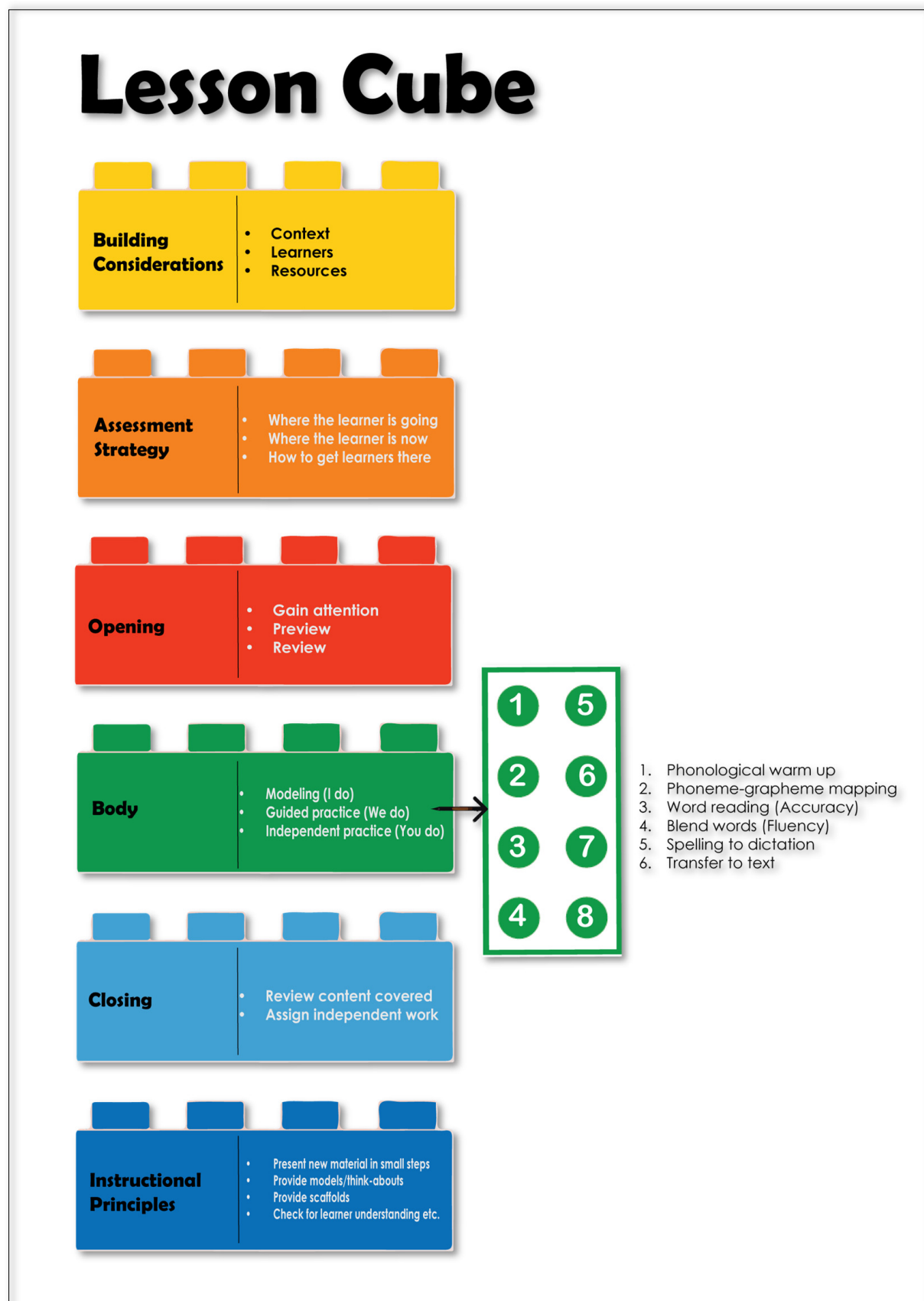


Figure 2. Lesson Planning Framework.

Table 1. Questioning Rubric.

Categories	Criteria			
	1 Beginning	2 Developing	3 Proficient	4 Exemplary
<i>Questioning variety and depth</i>	Uses limited question types, primarily basic recall or yes/no questions, with minimal promotion of learner thinking.	Uses some variety in question types, but often relies on basic recall or yes/no questions.	Uses a range of question types, mostly effective in promoting learner thinking and discussion.	Uses a wide variety of question types (e.g., open-ended, closed, probing, higher-order) that promote critical thinking and in-depth discussion.
<i>Question clarity</i>	Questions are often unclear or confusing, significantly hindering learner understanding.	Some questions are unclear or confusing, requiring frequent clarification.	Questions are generally clear and understandable, with occasional need for clarification.	Questions are consistently clear, concise, and easily understood by all learners.
<i>Wait time</i>	Rarely provides appropriate wait time, frequently rushing learners or leaving excessive gaps.	Inconsistently provides appropriate wait time, often too short or too long.	Generally, provides adequate wait time, with occasional instances of insufficient or excessive wait time.	Consistently provides appropriate wait time, allowing learners to think and respond thoughtfully.
<i>Learner engagement and participation</i>	Engages a few learners, with most of the class not participating or engaged.	Engages some learners, but often the same ones, with many learners not participating.	Engages most learners in the questioning process, with a few learners less involved.	Effectively engages all learners in the questioning process, ensuring active participation from a diverse group of learners.
<i>Feedback and follow-up</i>	Rarely provides effective feedback or follow-up, often missing opportunities for learner growth.	Provides feedback and follow-up inconsistently, missing opportunities to deepen understanding.	Provides generally effective feedback and follows up on most learner responses.	Provides constructive, timely feedback and follows up on learner responses to deepen understanding.
<i>Encouraging higher-order thinking</i>	Rarely uses questions that promote higher-order thinking, primarily focusing on basic recall.	Occasionally uses higher-order questions, but mostly relies on lower-order thinking questions.	Often uses questions that promote higher-order thinking, with occasional reliance on lower-order questions	Regularly uses questions that promote higher-order thinking (analysis, synthesis, evaluation) and problem-solving.

We will have to do-away with the lengthy lesson planning template that the students use when they go out for school-based assessment. It needs to be more focused, and I want them to be engaged in the process of planning. My observation has been that I get a lot of lessons that have been “copied and pasted” from the previous years; they just change the topic. [A2]

I want them to be able to link theory to their planning, and also think about instructional principles. [A2]

All students get LEGO® Six Bricks® as part of our agreement with LEGO® Foundation and Care for Education, so let’s get them to “build” their lessons using a framework. [A3] (cf. Figure 2)

Scoring Guide

- 16–24 (Exemplary): Demonstrates highly effective questioning strategies that significantly enhance student learning and engagement.
- 10–15 (Proficient): Demonstrates generally effective questioning strategies with minor areas for improvement.
- 6–9 (Developing): Demonstrates some effective questioning strategies but needs improvement in several areas.

- 1–5 (Beginning): Demonstrates limited effective questioning strategies, with significant need for improvement.

Rebuilding and utilizing artifacts such as lesson planning frameworks and assessment rubrics significantly contribute to more focused, engaging, and reflective educational practices. They enhance the planning process, align instructional strategies with theoretical principles, and provide meaningful feedback, thus promoting effective teaching and learning. The integration of creative tools like LEGO® Six Bricks® can transform lesson planning into an engaging and interactive process. Such innovative frameworks encourage hands-on learning and help pre-service teachers in building lessons that are dynamic and student-centered [91]. Artifacts like lesson plans and rubrics play a significant role in professional learning models, especially for pre-service teachers. They help in continuously improving instructional practices by providing a tangible reference for what works in the classroom and how it can be replicated or improved [92].

4.2.9. Feedback

Feedback was a theme that was identified as a limitation in our modules. Due to the number of students in the modules (N = 320 in the English module), we hardly ever provided the students remote feedback on the methods component of the module because we never see them. The feedback we gave during the one or two micro-teaching sessions we had was general feedback. Some of our comments included:

Feedback is an extremely challenging issue in my module; there is seldom time to be comprehensive, timely or give actionable feedback. [A2]

The students don't seem to pay attention to it anyway; they just challenge me about their marks. [A3]

I would love to try coaching the students while they are in the MRS environment; you know help them at the point of need. During the school-based teaching practicum, I can't stop the class to tell them that they are going off-track. [A2]

With my Afrikaans module, I scheduled four students per hour within the Mursion environment. Each student presented for 10 min and then I had 40 min to provide feedback to each student and the group. Each student could also provide feedback or ask questions during this time. Although time consuming for me, the students valued the feedback and engaged with Michael, the adult avatar providing the feedback, (me), in a very engaging and respectful manner. I also think that this is the reason that not one student enquired about their marks; we used the rubric and discussed it during the feedback session. [A3]

Feedback following the mixed reality simulated sessions has been identified as a key factor in their effectiveness. Reinking and Martin [93] and Cohen et al. [94] found that real-time feedback and coaching significantly enhanced teaching skills and preservice teachers' perceptions of student behavior, as well as their strategies for addressing such behavior. Bautista and Boone [95] also underscored the importance of feedback, with their study demonstrating a substantial increase in efficacy beliefs among preservice teachers. Peer observations and reflections, as highlighted by Bautista and Boone [95] and Samuelsson et al. [96], were instrumental in the development of new instructional strategies and classroom management techniques. Feedback provided during coaching helps pre-service teachers develop ways of seeing and understanding complex practices [14].

5. Guidelines for Policymakers, Faculty Leaders and Curriculum Designers

The development, integration, and standardization in the use of mixed reality simulation in teacher education is not as simple as deciding to use this type of tool. However, the first step always is to pilot the work and decide the best technology tool for use in a program. To ensure long term integration and sustainability of use the following insights for policymakers, faculty leaders and curriculum designers are offered.

Policymakers play a crucial role in shaping the future of teacher education by ensuring that emerging technologies, such as mixed reality simulation, are effectively integrated into teacher preparation programs. Firstly, policymakers are encouraged to consider allocating specific funds, grants or subsidies to institutions for the development and maintenance of mixed reality simulation and other relevant technologies within teacher preparation programs. This financial support is vital for both the initial setup and the ongoing costs associated with these technologies. Secondly, it is essential to align the knowledge and practice standards for language and literacy, especially relevant within the South African higher education environment, with guidelines for using mixed reality in teacher education programs. This alignment will ensure consistency and quality across various institutions. Moreover, establishing guidelines for the ethical use of these technologies, including data privacy and their integration into curricula, is crucial for maintaining high standards and protecting the interests of all stakeholders. Lastly, policymakers should support research initiatives that evaluate the effectiveness of technology integration in teacher preparation. Evidence-based findings from these studies should be used to refine and enhance the implementation of these technologies, ensuring that they contribute positively to educational outcomes.

For faculty leaders, the integration of mixed reality technology into the curriculum is essential to enhance practice-based learning experiences for pre-service teachers. Faculty leaders should consider embedding mixed reality technology into existing programs and modules, ensuring that the technology is leveraged to develop essential skills in classroom management, instructional strategies, and student engagement. This integration should be done in a way that complements both the content/theory and method components of the curriculum. Creating a collaborative environment where faculty can share best practices, resources, and experiences related to mixed reality simulation or other innovative technologies will help sustain and expand these initiatives. Interdisciplinary collaboration should also be encouraged to integrate diverse perspectives and funding sources, further enhancing the integration of these technologies. Regular feedback mechanisms should be implemented to gather insights from both students and faculty on the effectiveness of the technology tools. This feedback should then be used to iteratively improve the mixed reality simulation experiences and address any challenges that may arise. To provide a seamless and immersive learning experience, robust technical support must be available for both faculty and students. Additionally, the technology infrastructure should be regularly maintained and upgraded to ensure its effectiveness and reliability.

Curriculum designers also play a pivotal role in ensuring that mixed reality technology is effectively integrated into teacher education programs. Mixed reality activities should be aligned with learning objectives and pedagogical frameworks to ensure their relevance and effectiveness. Scenarios designed for these activities should reflect real-world classroom challenges, allowing students to apply theoretical knowledge in practical situations. Curriculum designers should develop mixed reality experiences that cater to diverse learners and their needs, ensuring that all students can benefit from these technologies. The integration of mixed reality simulation environments into modules or coursework should be designed to be scalable and adaptable to different class sizes and institutional contexts. Flexibility in the design will also allow for customization based on specific program needs and goals.

Lastly, several additional insights should be considered when integrating mixed reality into teacher preparation programs. Conducting cost-benefit analyses will help in understanding the long-term value of investing in technologies like mixed reality simulations. Comparing the outcomes of these simulations with traditional preparation methods will provide a justification for the investments made. In addition, partnerships with technology companies and non-governmental organizations will allow institutions stay updated on the latest advancements in mixed reality simulations and other technologies. These partnerships can also provide technical support, resources, and potential funding opportunities, further enhancing the implementation of these technologies in teacher preparation programs.

By considering these guidelines, policymakers, faculty leaders, and curriculum designers can make informed decisions that enhance the integration and scalability of technology tools, like mixed reality simulation, within teacher preparation programs. Ultimately the goal for integration and adoption of using advanced technology tools in teacher preparation is to improve the quality and effectiveness of the preservice educators. In this proactive action research design the goal was to improve teacher preparation in language and literacy to address the crisis in literacy outcomes for students, the truest impact of any tool used in teacher education.

6. Conclusions

The integration of mixed reality simulation into reading literacy modules within this Bachelors of Education program has shown potential for providing practice-based learning opportunities for pre-service teachers and at the same time facilitated the “re-building” of these modules to better prepare pre-service teachers, specializing in reading literacy, for the practical demands of the complex work of teaching. We hope this discussion will provide insight that can be used by others who are striving to implement mixed reality simulation platforms into their teacher education programs.

One of the primary themes identified was the lack of focus on high-leverage teaching practices within the modules. The study revealed that pre-service teachers often struggled with core teaching practices such as eliciting background knowledge using questioning, providing feedback, and using reading assessment data to inform instruction. This gap highlights the need for more deliberate and structured opportunities for pre-service teachers to practice and refine these skills, an opportunity to practice and develop their skills.

The limited use of pedagogies of enactment was another significant finding. Traditional teacher preparation programs often rely heavily on theoretical instruction with minimal opportunities for practical application. This study demonstrated that teaching or discussing instructional methods in the classroom is insufficient for developing teaching competencies. The integration of mixed reality simulation provided a platform for pre-service teachers to engage in realistic teaching scenarios, receiving immediate feedback, and an opportunity to reflect on their practice.

The initial implementation of TeachLivE™ as an add-on to existing modules served as an exploratory phase to gauge its effectiveness. Feedback from both students and educators was positive, indicating that mixed reality simulated sessions can be valuable for practicing core teaching skills in a controlled environment. However, challenges such as the American accents of the avatars, scheduling issues and our different languages prompted a shift to Mursion™, which offered more customization and alignment with the South African context.

The data collected underscored the need for the integration of mixed reality simulation into our curriculum. The practice-based learning opportunities provided by mixed reality simulation allowed for immediate application of theoretical knowledge, fostering a deeper understanding of teaching practices. The ability to pause, reflect, and receive feedback in real-time was particularly beneficial for the students.

The re-building of the reading modules involved several key components: planning and preparation, content-method integration, pedagogies of enactment, assessment, resources, and feedback. Each of these components was re-evaluated and modified to ensure that MRS was integrated into the curriculum. This holistic approach ensured that pre-service teachers received a well-rounded module that combined theoretical knowledge with practical application. Aligning the subject content with core teaching practices was essential for the effective integration of mixed reality simulation. Learning outcomes were reformulated, so that core teaching practices that was identified could be integrated as part of the module and no longer function as an add-on and in doing so aligning the theoretical and pedagogy in these modules.

Within these modules, the emphasis moved from summative to formative assessment. The focus shifted for the pre-service teachers from not only obtaining a grade but

discussing their experiences and adapting their approaches. The introduction of detailed rubrics and real-time feedback during mixed reality simulated sessions allowed for a more comprehensive and reflective assessment process where we as the teacher educators could evaluate and support their teaching skills. This approach encouraged students to focus on the effectiveness of their teaching practices and their impact on learning. Overall, we are of the opinion that the integration of mixed reality simulation platforms such as Mursion can be game changers in the preparation of pre-service teachers.

Limitations of this study include generalizing the findings beyond the specific South African initial teacher education program. Since the study focused on specific modules and teaching phases, the broader applicability might be limited. The researchers acknowledge their “insider” position, which can introduce bias, despite efforts to include an “outsider” critical friend. This dynamic can limit objectivity, especially in reflecting on the effectiveness of the interventions introduced. While professional conversations and reflective journals are valuable, the reliance on subjective self-reports (via Zoom or WhatsApp) could introduce interpretation bias, where participant reflections might not fully capture the effectiveness of the mixed reality environment objectively.

Moving forward, the insights gained from this study not only informed our entire teacher preparation program but the approach and integration of practice-based teaching and learning opportunities possible through current and potentially future technology. While the cost, administrative load and time associated with the integration of mixed reality simulation was problematic at times and took both creativity and partnerships to evolve, the value for the teacher education students demonstrated the value of this investment. The success of this initiative for supporting the development of African languages in South Africa highlights the need for continued innovation to address the practice-based learning opportunities for pre-service teachers to ensure that they are well-equipped to meet the diverse needs of South African learners. The potential future of technology such as artificial intelligence, biometric data, and continued use with mixed reality are all future areas yet to be explored.

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