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Exploring insights from initial teacher educators' reflections on the Mental Starters Assessment Project

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Background: The Mental Starters Assessment Project (MSAP) seeks to address poor performance in Grade 3 mathematics. The programme focusses on eliminating inefficient counting methods and promoting strategic mathematical skills, including numerical sense, mental calculation and rapid recall skills. Additionally, MSAP supports teachers' professional growth by providing them with a toolkit of effective calculation strategies to bridge the performance gap and enhance mathematical education.

Aim: This paper explores the insight gained from reflections of final year Bachelor of Foundation Phase (FP) initial teacher educators (ITE) students in South Africa.

Setting: Grade 3 classrooms.

Methods: The ITE students were given training and materials to implement the MSAP, and this occurred over a 4-week teaching practicum, after which they completed a reflective task on the implementation. A total of 20 students were selected from a cohort of 138 based on their academic performance.

Results: The analysis of the reflections showed that ITE students benefitted from reflecting on their practice and highlighted important elements of their professional learning. The reflections raised issues related to challenges in their pedagogical content knowledge (PCK) as well as their confidence and competence to teach mathematics and manage the classroom context.

Conclusion: With a multi-dimensional model of reflection, ITE students can achieve a deeper understanding of mathematics teaching and learning when building learners' mental strategies, fostering professional growth and elevating the overall quality of mathematics education.

Contribution: Overall, the findings provide insight into the benefits of reflective practices for ITE students' professional development and the improvement of mathematics education.

Keywords: early grades; initial teacher education; mental mathematics; reflection; South Africa.

Introduction and background

This paper explores the insight gained from reflections of final year Bachelor of Foundation Phase (FP) initial teacher educators (ITE) students in the Western Cape, South Africa. The ITE students were required to reflect on their learning and experiences of implementing the Mental Starters Assessment Project (MSAP) in teaching mathematics to Grade 3 learners during their teaching practice in July 2022. The MSAP is a relatively new intervention implemented nationally by the Department of Higher Education and Training (DHET) in schools since the beginning of 2022. The motivation for the MSAP programme stems from the concern that South African learners perform poorly in mathematics, with evidence indicating that by Grade 4, learners are already two grades behind the curricular standards (Spaull & Kotze 2015). Additionally, studies show that this gap is worsened by the absence of adequate support for teachers in addressing learners' challenges and deficiencies in number sense. Consequently, teachers often prioritise obtaining correct answers while paying minimal attention to developing effective calculation strategies (Graven & Venkat 2014).

The MSAP seeks to provide teachers with a programme of strategic and efficient mathematical skills development to assist Grade 3 learners to move beyond inefficient and time-consuming single-unit counting (counting all) on their fingers and similarly, the use of tally marks on paper.

Note: Special Collection: Mental mathematics and number sense in the early grades.

The strategies and skills promoted by the MSAP, on the other hand, aid learners in the development of a strong numerical sense, development of mental mathematical skills, strategic calculation abilities, rapid recall skills, as well as routine practice opportunities for learners. Additionally, the project promotes teachers' professional growth by providing them with a toolkit of 'go-to' calculation strategies that may not have otherwise been familiar to teachers (Graven & Venkat 2021). In total, there are six strategies covered, with eight sessions of 10-min lesson starters for each of the strategies. The strategies include bridging through 10, jump strategies, doubling and halving, rounding and adjusting, re-ordering, linking addition and subtraction (DHET 2022).

Each of the strategies is taught over 3 weeks in a sequential and progressive order and begins and ends with a short test for the learners. Marking these tests provides information for the teacher and the learners about how much they have improved in using that particular set of skills during the 3 weeks.

In anticipation of entering the profession as newly qualified teachers, the ITE students were provided with extensive training and materials on how to teach and administer MSAP. Their training took place in their mathematics education lectures and consisted of interactive online sessions totalling 5 h over a period of a month. The ITE students were required to teach one of the six strategies, namely jump strategies during their 4-week Teaching Practice in Grade 3 classes in July 2022. The ITE students were provided with the background to the study including supporting readings and were taken through the entire process of teaching MSAP. The materials provided included hard copies and e-books of the training manual and master resource book needed for teaching (DBE 2021). As a result of coronavirus disease 2019 (COVID-19) restrictions, this cohort of ITE students had limited exposure to real-life classroom situations and practical experience. Additionally, this marked the ITE students' first experience with conducting testing procedures, and consequently, they required significant guidance on how to administer these processes effectively.

Research question

The research question that guided this study was:

What insights were gained from reflecting on the implementation of the MSAP project during teaching practice, particularly in terms of ITE students' learning and professional development?

Literature review

There are two sections to the literature review: firstly, we explore the role of reflection in professional development and secondly, we cover early-grade mathematics research in South Africa over the past 20 years. The reason for this twofold approach is to provide an overview and link between reflective practice and early-grade mathematics.

In this first section, we explore scholarly works relating to the role of reflection in initial student education to establish how reflection impacts professional development, the importance of pedagogical content knowledge (PCK) and skills and ITE student preparedness to contextualise this research.

The process of reflection is widely recognised as a universally essential component of teacher education. However, as argued by Bognar and Krumes (2017), and Harford and MacRuairc (2008), there are different conceptions of reflection and consequently different instructional strategies assigned to foster the process of reflection. In a study to define reflection more specifically, Bailie and Gebre (2020) classified instructional strategies associated with reflective processes into three different models, namely hierarchical, categorisation, and procedural. Hierarchical models conceptualise reflection as a process that has levels moving from lower levels of reflection on technical aspects to higher levels of reflection on critical thinking and meta-analysis. Categorical models define reflection by delineating aspects of reflection, while procedural models are stage related and follow a more linear trajectory. Importantly, in describing these models, they highlight how each one has its limitations owing to the diverse ways in which the different dimensions of reflection are captured.

Black and Plowright (2010) developed a model of reflective learning for professional development. The model consists of four different dimensions, including the source of reflection (learning and practice experience), the target of reflection (reflection on learning and practice), the levels of reflection, the realisation of reflection (through written and internal dialogue) and the purpose of reflection (learning and practice). Importantly, the study highlighted two purposes for reflection in each of the dimensions, namely reflection for learning and reflection for practice. Outcomes arising from this study indicate increased efficacy through deepened and more structured reflection, and importantly, subsequent studies using this approach report findings that suggest that this model could be applied to mathematics education, allowing for reflection on learning and practice through both internal and written processes (Alsina & Mulà 2019). Of interest, Black and Plowright (2010) recognise their omission of the creative and affective dimensions in their model.

Working towards a hierarchical analysis of reflection, Tavyl (2014) conducted a focussed study on the use of self-reflective e-journals in teacher education to enhance reflectivity and self-efficacy among ITE students in South Africa. The ITE students recorded their lessons and consequently, compiled reflective journals after watching each of the recordings. The students reported on their experiences throughout the duration of this study suggesting that journal writing is an enhancing approach, which can instigate sub-dimensions of improvement in self-efficacy, namely management, instruction and planning skills.

Moodley, Adendorff and Pather (2015) utilised ITE student reflections to highlight the importance of addressing negative perceptions and attitudes towards mathematics in teacher education institutions to produce more competent and confident mathematics teachers. Their study analysed drawings and written reflections depicting the ITE students' perceptions of learning and teaching mathematics. The findings revealed that participants had varying attitudes towards learning mathematics, with many experiencing performance-related anxiety. Their perceptions as future teachers were also diverse, with some expressing positive attitudes, some negative attitudes and some a mix of both. However, overall, the participants expressed a desire to provide meaningful mathematical learning experiences for their future learners. Providing meaningful experiences to make mathematics accessible and understandable for learners requires teachers to have the content knowledge (CK) and PCK needed to create these opportunities. Ball, Thames and Phelps (2008) suggest that teachers need to know mathematics (CK) and know how to use mathematics in the work of teaching (PCK).

This second section of the literature review relates to early-grade mathematics research in South Africa. It explores the changed focus over the past 10 years from broadly looking at *what* teachers taught and *how* to develop their teaching knowledge and skills to a more defined focus on teaching and learning of *fundamental* number concepts (Venkat & Roberts 2022). This arose in the context of a large-scale research study by Schollar (2008, 2015), which revealed that learners continued to use single-unit counting to solve problems at Grade 3 and higher grades. This research highlighted a lack of emphasis on developing number sense and efficient calculation strategies in the early stages of teaching and learning as highlighted by Morrison et al. (2023). Similarly, Taylor (2021) focussed on delays in mathematical understanding in primary school mathematics and concluded that many learners are not acquiring a true understanding of mathematics; instead, they are being taught inefficient counting procedures to carry out arithmetic operations.

To address these shortcomings through educating ITE students, Bowie (2014) emphasised the ongoing need for universities to collaborate more in terms of the design of mathematics and language, primary teacher education content and courses. This later led to the formation of the Primary Teacher Education Project (DHET 2022), which was a project to strengthen literacy and numeracy in primary teacher education. A number of working groups were set up to develop recommendations and resources related to mathematics, one of which was number. The focus was to develop ITE students' ability to teach number sense and lay the foundations for early algebra. Their work helped to inform the Mathematics Standards for ITE students and drew attention to the topic of learning and teaching of number (Askew, Bowie & Venkat 2019; Bowie 2014).

Additionally, with the introduction of the SARChI[1] Numeracy Chairs based at Wits and Rhodes University in 2011, attention was focussed on the work of teachers and the crucial role of number sense development. One of the projects to emerge from this process was the MSAP project to advance learners' number sense through the development of mental mathematics strategies (Askew, Graven & Venkat 2022). This involved the production of teaching and learning materials that were used to train subject advisors and teachers to implement the mental starters. The MSAP work started with the piloting of national diagnostic assessments for strategic calculation with Grade 3 learners in South Africa and subsequently led to the initial small-scale pilots of the Mental Starters, in which students completed a pre-test, followed by structured lesson starters and a post-test and showed promising results (Graven & Venkat 2021). Later, a national trial ensued involving subject advisors and schools within their districts with reported increases from the pre- to post-test scores. This intervention is now a national policy and research findings continue to show that the intervention, across four provinces, has been successful and helped to improve student addition and subtraction of two-digit numbers (Askew et al. 2022).

Following the success of the MSAP in schools, the focus then shifted to the implementation of MSAP training for ITE students. Several researchers from universities across South Africa are currently investigating the comprehension of mental mathematics strategies and the nature of PCK for teaching additive mental mathematics strategies among ITE programmes. Their focus is on exploring the PCK specific to FP ITE for teaching additive mental mathematics strategies. The aim is to determine the most effective methods for supporting ITE in this context.

This was the outcome of promising results from 2021 MSAP for in-service teachers that showed statistical improvements across all provinces (Askew et al. 2022) with consequences for pre-service teacher education.

In this review, we explored the critical role of reflection in ITE students' education and its impact on professional development and pedagogical skills within the complex and unequal context of education in South Africa. We also investigated various models of reflective learning for professional development and discussed the use of self-reflective e-journals to enhance reflectivity and self-efficacy among ITE students. We also drew attention to the shift in early-grade mathematics research towards focussing on fundamental number concepts to address shortcomings in both pre-service and in-service teacher education. Collaborative efforts in designing mathematics education content were highlighted such as initiatives like MSAP, which has shown success in improving ITE student number sense.

1.The South African Research Chairs Initiative (SARChI) was established in 2006 by the Department of Science and Technology (DST) and the National Research Foundation (NRF).

Theoretical framework

A theoretical framework provides a structured lens through which to interpret and analyse data (Hesse-Biber & Leavy 2011). In the context of this study, we draw on Black and Plowright (2010) and their categorical model to guide and understand the ITE student reflective narratives to contextualise our findings within existing knowledge and theory in the field. Black and Plowright (2010) adopted a three-dimensional model for reflection on learning and practice; these dimensions are identified as the source, the target and the purpose of reflection. The *source* refers to the origin of reflection on learning *or* reflection on a professional experience.

As an outcome of reflecting on three dimensions, Black and Plowright (2010) proposed an extension to their existing model: a multi-dimensional model of reflection by adding a fourth dimension: the realisation of reflection (refer to Figure 1). Their findings indicated that participants needing to produce a portfolio of reflection were forced to confront their lived experiences and transform their learning through realisations gleaned from their reflections. In doing so, the participants engaged in internal dialogue and written journals which provided insightful evidence of deepened learning and personal transformation.

With regard to this study, the dimensions provided a framework for interpreting the data to establish insights into how the MSAP project impacted ITE students' learning and accordingly, their professional development. The source of reflection includes the learning experiences and engagement with the MSAP teaching sessions and their engagement with teaching and learning materials used for MSAP. The *target* addresses two elements, namely: reflecting on learning *and* reflecting on practice. In this study, we focus on the *source* to frame ITE students' learning gains from teaching MSAP as well as their professional growth. The third dimension, the *purpose of reflection*, is future oriented and looks at the development of conceptual knowledge and the causal influence that the acquisition of knowledge has on professional growth.

Research methods and design

Research design

This paper adopts a research design of a qualitative study aimed at exploring the impact of reflective practices on ITE students through the analysis of their reflective essays. By examining ITE students' reflections, this study seeks to contribute to the understanding of reflective practices in teacher education and inform the development of effective educational approaches for teacher preparation programmes. Creswell and Poth (2016) describe how qualitative methods are well suited for capturing nuanced insights and understanding the complexity of reflective practices in teacher education and additionally, guided by the theoretical framework of Black and Plowright (2010), the findings were analysed in terms of answering the research questions.

Participants and setting

The cohort of 138 final-year ITE students participated in the implementation of the MSAP project, teaching in various Grade 3 classes across primary schools in the Western Cape, South Africa. However, for this study, 20 reflective essays from ITE students were selected using purposive sampling. The sampling process involved selecting the top 20 performing students based on academic performance over 2 years, and their reflective essays were chosen for analysis. Selecting the top 20 performing students ensured that the sample represented the highest level of academic achievement within the population of ITE students in this study. Furthermore, this warranted that the sample selected would provide more insightful and detailed responses, leading to richer data that better addressed the research question. The ITE students' anonymity was preserved by providing each student with a unique pseudonym derived from their surname and alphabetical ranking. This allowed the researchers to maintain clarity on which texts were appearing in the coding process while protecting the students' identities (Hesse-Biber & Leavy 2011).

The selected sample consisted of individuals identified by three key descriptors: gender, age, and language. Gender was categorised as either Male (M) or Female (F). The age of all individuals ranged from 18 to 25 years. Language proficiency was classified into three categories: native English speakers (L1E), native isiXhosa speakers (L2X), and native Afrikaans speakers (L2A).

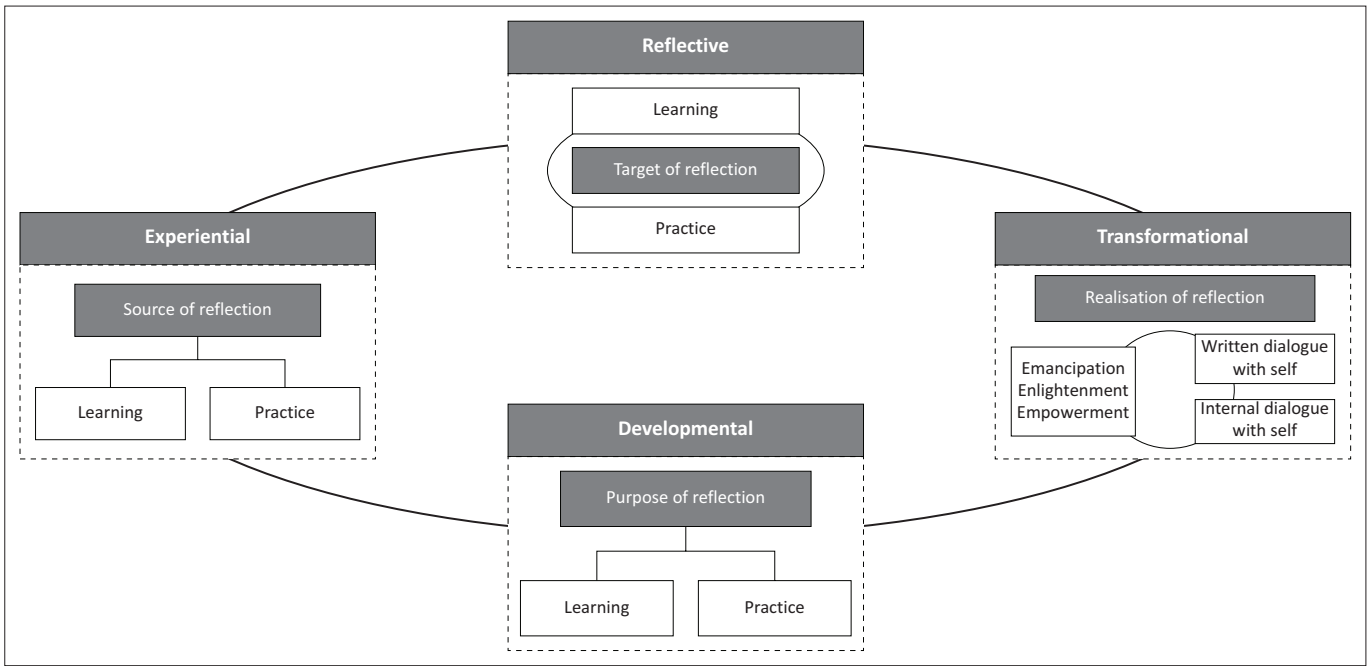
Research process

This study consisted of five stages (see Figure 2) of implementation commencing in 2022 with the training of ITE students in MSAP, specifically training in Jump Strategies.[2] During the training, they were taught how to introduce the concept, what to teach and importantly, what to write on the board. The training also included how to administer the pre- and post-tests as well as how to deliver two consolidation worksheets. Following training, the ITE students carried out the MSAP intervention in diverse schools across the Western Cape. They were then provided with 7 weeks to complete stage 3 (their reflections) and submit the tasks by the end of September 2022. Following their submission, the specific, purposively selected essays were analysed for this study in the subsequent months.

Data collection

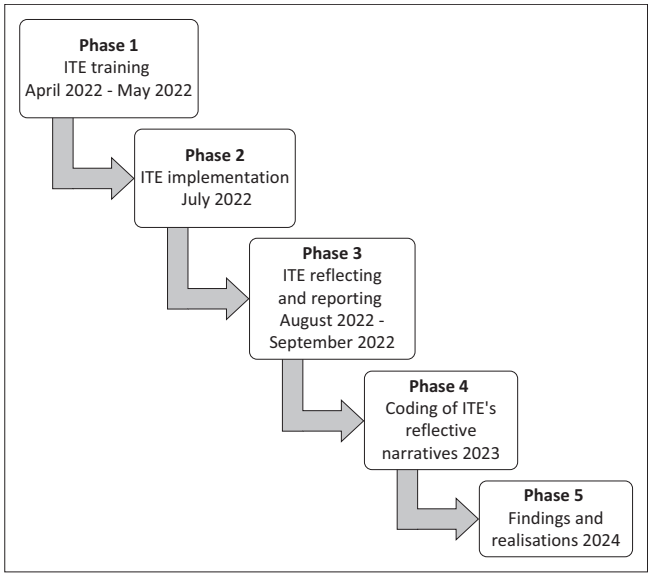
As described in the sampling section, 20 reflective essays were selected and were central to the analysis for this study. The nature of the reflective essays was guided by questions to prompt and structure their narratives to address the research question being asked. These prompts included requiring the ITE students to comment on their perceived

2.Jumping to the next multiple of 10 *after* a number (e.g., 32–40); Jumping to the multiple of 10 *before* a number (e.g., 56–50)



Source: Black, P.E. & Plowright, D., 2010, 'A multi-dimensional model of reflective learning for professional development', *Reflective Practice* 11(2), 245–258. https://doi.org/10.1080/14623941003665810

FIGURE 1: Multi-dimensional reflective model.



ITE, initial teacher educators.

FIGURE 2: The five stages of the research process.

improvement in competency and confidence in teaching mental mathematics, including the assessment and administration aspects related to the intervention. The prompts also required the ITE students to reflect on their acquisition of skills, to identify challenges encountered and strategies employed to overcome these challenges.

Data analysis

Reflective essays are unique in the sense that they provide personal accounts and investigate different contexts and experiences (Cohen, Manion & Morrison 2018). In this section, the process is detailed in four stages culminating in the categorisation of the analysis, whereby aligning with the structure of Black and Plowright (2010) multi-dimensional model. The stages included coding, textual analysis, classification of text into learning and practice categories and the alignment of these categories within the four dimensions, namely source, target, purpose and finally, realisation. In stage 1, the 20 reflective essays were imported and analysed with the support of ATLAS.ti 23 software (Scientific Software Development GmbH, Cape Town, South Africa) to arrive at common themes emerging across the different essays. Arising from this process of coding, 88 themes emerged and shed light on the research question and study objectives. For the research question and scope of study, the top five most frequently occurring themes were selected for deeper analysis. Once these themes emerged, the process of textual analysis occurred to gain inferences that aligned with both the themes and at the same time, addressed the research question. After this, the third stage entailed categorising them into learning or practice. Finally, the findings were set against the framework of the four dimensions (source, target, purpose and realisation) to ensure depth of understanding as well as to structure the findings for future possible research foci.

Ethical considerations

Ethical approval to conduct this study was obtained from the Cape Peninsula University of Technology Faculty of Education Research Ethics Committee The ethical clearance number is EFEC 5-06/2022.

Results

In keeping with the theoretical model, data were analysed as previously discussed, and the findings are presented in terms

of learning and practice with reference to the reflection model: target, source, purpose and realisation (Black & Plowright 2010). Commencing with learning, two categories emerged and referred to insights gained from the MSAP intervention. The first was learning linked to PCK, and the second was learning linked to the affective domain.

The learning and PCK refer to student reflections and challenges experienced when teaching concepts such as subtraction and the critical role of language and explanations in the mathematics classroom. Ball et al. (2008) classify important elements of PCK, which deal with knowledge of content and teaching (KCT) and knowledge of content and student (KCS). Knowledge of content and teaching refers to teachers' mathematical knowledge of the design of instruction while KCS involves teachers understanding of the interaction between specific mathematical understanding and familiarity with students and their mathematical thinking. It is evident from the comments of the ITE student that this knowledge appeared to be developing because of their engagement in the MSAP:

> 'The next challenge was that learners were confused when subtraction was introduced. I was confused because they were doing so well in understanding the lessons. To overcome this, I consulted the teacher about how they usually do subtraction and I learnt that to show subtraction on the number line, they show the jump at the bottom of the number line and addition at the top, to differentiate between the two.' (Student G6, female, L1)

The abstract describes how the ITE student engaged in reflection on her own learning as well as the knowledge of the learners, through consultation with the mentor teacher. This reflective process not only assisted her in building on her own knowledge but also in addressing her practice. Specifically, the ITE student's reflection focussed on her mental mathematics competency, highlighting how both her own learning and that of the children were being strengthened simultaneously. This dual reflection on the learner and ITE student's mental mathematics underscored the reciprocal nature of the reflective process and its role in enhancing teaching practice and PCK.

The second ITE student's narrative relates to KCS and reflects the ITE students' expectations for future engagement through learning. This student recognises the importance of adapting mathematical language to mediate learning, thereby addressing the purpose dimension of the reflection model:

> 'One of the skills I've developed is an awareness of the significance of using proper mathematical language. For instance, instead of saying "sums", I realised that I needed to say, "number sentences", which helped learners grasp what I was talking about more clearly. Additionally, I learned how to simplify my explanations so that students could understand them, and I could still finish in the allotted time.' (Student V19, female, L1)

The next category to emerge related to learning was the link to the affective domain. The ITE students were fearful of the implementation of the MSAP with learners and appeared to lack confidence in their teaching skills. However, this seemed to be unfounded as the ITE students began to make sense of the materials and experienced positive gains in terms of their knowledge and motivation. The training and materials were key features in this development and positively highlighted the need for students to experiment and reflect on these experiences. Kilpatrick, Swafford and Findell (2001) identify five strands of mathematical proficiency, one of which is the productive disposition which involves a positive and productive attitude towards mathematics. The proficient learner or teacher sees mathematics as useful and worthwhile, requiring perseverance and resilience, and challenges are experienced as opportunities for learning:

> 'At the end of the day, I was not only able to teach math and get learners to understand why we do what we do. I was able to make sense of it myself which was a stepping point in my journey as a novice teacher. This intervention was the guide I needed to distract myself from the fear I built throughout the years.' (Student M13, female, L1)

In this reflection example, the ITE student understands the link between her knowledge of mental mathematics and knowledge for teaching and through this process addresses her fear of mathematics. Through her narrative, she addresses the target component of the reflection, as she reflects on her learning and the impact it has on her practice.

The following student identifies the challenge of implementing the MSAP and tries to overcome this by seeing it rather as an opportunity for learning. Through reflection, she adapts her thinking to develop a strategy to move forward, she has purpose and realisation of the challenge and is empowered in the process:

> 'One of the challenges I have experienced while preparing myself to teach this during teaching practice was that I felt I wouldn't be able to administer this assessment. I was scared that I wouldn't meet the aims of this project. Later, I realised that the only way to overcome this challenge was to be self–motivated and not to focus too much on the aims but rather to take it step by step as I did this intervention. And too just basically GIVE IT MY ALL!.' (Student A8, female, L2A)

According to Kilpatrick et al. (2001), the attitude students hold towards mathematics plays a crucial role in shaping their academic achievements. Those who perceive their mathematical skills as unchangeable, tend to shy away from difficult problems and may quickly become disheartened by setbacks.

The next section of the findings captures the analysis of the ITE students' practice component of their reflective essays. The data from the various themes were synthesised into categories that emerged from reflecting on the implementation of the MSAP in terms of ITE students' learning and professional development. Three learner-centred categories that arose from this process are participatory engagement, responsive teaching and adaptive classroom management styles (Tabulawa 2013).

In participatory engagement, the findings indicate that the ITE students recognised the significance of learners actively

participating in the 'lesson starters' task sequence to sustain the interest levels of the learners. This was accomplished through consistent questioning and encouraging learners to clarify processes to their peers as the following text reveals:

> 'Another challenge I had when introducing learners to this new strategy was getting the learners focussed and keeping their attention on what was being taught. I tried my best to overcome this challenge by constantly asking learners questions and asking them to explain it to their peers.' (Student J10, female, L1)

In this extract, the ITE student's reflection addresses the source dimension, reflecting on practice, with the narrative originating directly from teaching.

In terms of responsive teaching, the ITE students showed growth in their abilities to adapt their practice to meet the needs of their situated contexts and growth in responding appropriately to the needs of their learners, thereby ensuring meaningful learning. These adaptations manifested in adapting their verbal instructions as well as their teaching materials. The following reflective extract depicts such a finding:

> 'When it came to teaching the task sequence, the learners were a bit confused by the add-ons such as the bridging through ten. So to assist learners in remembering the steps I created flashcards and placed them step by step on the board, which learners could refer back to when they forgot what comes next.' (Student A1, female, L1)

Here again, a source-based reflection on practice is evidenced.

Once more, in responsive teaching, the ITE students evidenced critical reflection of their pre-conceived notions related to ability groupings as this extract revealed:

> 'Two learners from the top ability group received the highest scores. However, surprisingly there was 1 student from the weak ability group who also received one of the highest scores.' (Student F4, female, L2A)

In this instance, the source-based reflection is focussed on learning.

In terms of adaptive classroom management, the ITE students reflected on the practicalities associated with time management of the pre- and post-tests as well as the associated management of expectations, negative feedback and anxiety over timing. Through adapting their management styles, the ITE students showed promising insight into managing the intricacies of the MSAP intervention as well as the importance of being open to adaptation when working with new and unfamiliar content:

> 'With the pre-test, the learners were very nervous when I told them about the time limit and that I would be timing them. I tried to assure them that it was okay if they did not finish or if they didn't know the answers, but this did not stop the anxious looks on their faces.' (Student G5, female, L1E)

In this extract, the ITE student's reflection is steering towards purpose, as the narrative describes addressing expectations for future, further engagement.

Discussion

This study explored the insights gained by ITE students in reflecting on MSAP concerning learning and practice. There is sufficient evidence to suggest that the ITE students benefitted from the opportunity to reflect on their practice through the reflection task that aligns with the findings of Tavyl (2014) and Moodley et al. (2015) when using e-journals, drawings and written reflections. The reflections revealed their KCT as well as their KCS, and the challenges experienced in developing this knowledge. The findings also point to the impact of affective factors on learning outcomes both for learners and ITE students (Kilpatrick et al. 2001). The positive gains observed in ITE students highlight the role of professional development in shaping educators' attitudes towards teaching mathematics.

It was also important for ITE students to reflect on their practice, specifically in teaching mathematics as well as broader aspects of teaching (Chikiwa & Graven 2023). Initial teacher educators students need to be equipped with the necessary skills to manage their classrooms effectively whereby creating supportive learning environments where learners feel comfortable and confident in their abilities. This research included reflecting on the process of administering assessments and interventions such as MSAP. Additionally, the findings touch upon the insights gained through reflecting on practice. Such insights included challenging traditional notions of ability groupings, whereby highlighting the importance of learner-centred approaches to achieving outcomes. Through deep reflection, the ITE students were able to consider the origin of their action (Source), the effect of their action (Target) and recognise (Realise) their goals (Purpose). This aligns with the framing of Black and Plowright (2010) multi-dimensional model. Through conscious reflection, the ITE students could arrive at a meta-understanding of effective classroom management strategies to create supportive learning environments conducive to the administering of intervention for enhanced learning. This holistic approach not only benefits ITE students' professional growth but also has the potential to elevate the overall quality of mathematics education.

Conclusion

This study investigated the influence of MSAP on the professional development of ITE students, with a particular focus on their reflections on teaching practices and effective classroom management strategies. It was found that ITE students benefited from the reflective practice, as evidenced by their increased KCT, awareness of students' needs and improved understanding of the challenges in developing this knowledge. The role of affective factors in learning outcomes for both learners and ITE students was also highlighted. Reflection provided a platform for the ITE students to critically evaluate their approaches to mental mathematics instruction, including the selection of appropriate methods, the sequencing of concepts and the identification of common misconceptions among learners. By engaging in this process, ITE students

deepened their understanding of the mathematical content and pedagogical strategies, thereby refining their PCK. Furthermore, reflection facilitated the identification of gaps or weaknesses in their mathematical understanding, prompting the ITE students to seek additional support or professional development opportunities to address these areas.

Consequently, the study underscores the importance of professional development in shaping ITE students' attitudes towards teaching mathematics and the critical role of effective classroom management in enhancing learners' mathematical performance. Reflective practices, such as those employed in the study, provide ITE students with valuable insights, including the need to challenge traditional notions of ability groupings and consider learning outcomes and classroom dynamics.

By adopting a multi-dimensional model of reflection, ITE students can achieve a deeper understanding of effective classroom management strategies, leading to the creation of supportive learning environments conducive to the administering of interventions for enhanced learning. This holistic approach not only fosters ITE students' professional growth but also has the potential to elevate the overall quality of mathematics education. Overall, the findings of this study provide valuable insights into the benefits of reflective practices for ITE students' professional development and the improvement of mathematics education.

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Competing interests

The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

Authors' contributions

R.D.L.B. oversaw the training and data collection, prepared the abstract and initiated the draft, encompassing theoretical framework selection, methodology establishment, including coding procedures and analysis. S.M.M. provided supervision throughout, aiding in data triangulation, theme coding, literature review compilation, findings integration, abstract refinement and editing numerous drafts.

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Data availability

The data that support the findings of this study are available from the corresponding author, R.D.L.B., upon reasonable request.

Disclaimer

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