

## Article

# Impact of Pre-Service Teacher Education Programme on Mathematics Student Teachers' Teaching Practices during School Experiences

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**Abstract:** While the pre-service teacher education (PSTE) programme holds global significance, there is a lack of evidence regarding its impact on the teaching practices of mathematics student teachers. Therefore, this study examines the impact of PSTE programmes on mathematics student teachers' teaching practices during school experiences. Grounded in a post-positivist paradigm, the study employs a mixed-methods research approach and a sequential explanatory mixed-methods design to gather data through questionnaires and semi-structured interviews. The research findings indicate that PSTE programmes have a significant impact on mathematics student teachers' ability to teach mathematical content that aligns with curriculum standards, enhances their subject knowledge, and increases their confidence. However, the programmes have minimal influence on their ability to implement differentiated instruction during their teaching practices. Based on these findings, the study concludes that although mathematics student teachers may lack the necessary skills to implement differentiated instruction, high-quality teacher education programmes can build their confidence and enable them to effectively manage their classrooms and adapt teaching practices to meet diverse learner needs. Therefore, the study suggests that stakeholders involved in PSTE programmes should provide continuous guidance and constructive feedback to help student teachers overcome challenges and improve their teaching practices. This support system is crucial for the success of the PSTE programme and has a direct impact on the quality of mathematics instruction in schools.



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**Keywords:** classroom practices; pre-service teacher education; school experience; teaching experience; teacher training

## 1. Introduction

In accordance with education regulations in South Africa, higher education institutions offering teacher education programs are required to ensure that their students are placed in schools where they can gain practical experience in classroom teaching and the broader school environment [1]. This educational practice, in which student teachers are assigned to schools to acquire teaching experience, is commonly referred to as teaching practice [2]. However, various terms, such as teaching practice, field studies, in-field experiences, school-based experience, and internship, have been used to describe this activity [3]. Therefore, the inclusion of teaching practice is a crucial component of teacher education programs because it not only allows student teachers to gain practical experience in a real classroom setting but also provides them with an opportunity to apply the theoretical knowledge they have acquired in their respective subject areas [4,5].

Over the years, one common issue that has been highlighted in various studies [6–10] is the level of mathematical knowledge possessed by teachers, particularly in relation to their understanding of subject content. Research, such as the works of [9,11–13], also indicates that pre-service teachers often lack a solid understanding of both mathematics and pedagogical knowledge, a situation that can sometimes be attributed to the nature of

their pre-service teacher training programme [14,15]. While evaluating teacher training programmes may seem straightforward, there has been an ongoing discussion about the feasibility of assessing the impact of teacher education programmes [16]. Furthermore, there is a general reluctance to address the complexities associated with identifying indicators of effectiveness, determining which aspects to measure, selecting appropriate measurement methods, and interpreting and responding to the obtained results [16]. However, the existing body of research [16–20] underscores the intricate nature of establishing a connection between teacher education programmes and concrete outcomes, such as changes in the quality of teaching practices and student learning. Therefore, although these challenges have hindered the progress of evaluation efforts, this paper aims to contribute empirical evidence on the impact of pre-service teacher education (PSTE) programmes on the teaching practices of mathematics student teachers.

### *1.1. The Nature of School Experience in the South African Context*

According to [21], in order to become a teacher in South Africa, one must complete either a four-year Bachelor of Education degree (B.Ed.) or a three- or four-year bachelor's degree followed by a one-year Postgraduate Certificate in Education (PGCE). Both pathways lead to becoming a professionally trained teacher, after which individuals must register with the South African Council for Educators (SACE) [15,21]. The curriculum includes courses in languages, mathematics, and other disciplines. The teaching practice methodology course is offered throughout the four years of study. Weekly lectures and seminars are provided, while teaching practice is sometimes organised in a block format (ranging from six to eight weeks) from July to October, depending on the institution. Students are assigned to a school where they observe and teach in the classroom. During teaching practice, trainees watch their mentor teach a set number of lessons and then have the opportunity to instruct themselves. Whenever possible, trainees observe a variety of lessons, including different age groups and levels of expertise.

During observation periods, trainees complete observation sheets provided by the host teacher and the university. These sheets are classroom observation assignments designed to enhance trainees' understanding of various aspects of the teaching and learning processes. Additionally, the school experience file includes assessment forms that require students to provide information such as the names of principals and teachers, dates of school experience and visits by lecturers, class information (including timetables, classroom layout, and term planners), and a list of learners' names, including their date of birth, gender, and primary language. Following this, student teachers must closely monitor the learners' progress. This involves describing the performance and progress of selected learners in terms of their social, cognitive, physical, and moral development. This typically includes a list of selected learners, examples of their work, and an assessment and evaluation. Similarly, student teachers are required to provide an assessment rubric for mathematics and language units/modules presented to a few learners.

Another aspect of the teacher education program is planning, preparation, and evaluation. This requires student teachers to create daily teaching and co-curricular activity schedules. They also develop lesson plans for two hours or half of the lessons per day and are expected to teach during two visits by method lecturers. The student teachers are then evaluated by their method lecturers and provided with feedback on their performance. Additionally, the method lecturers use is to assess the student teachers' lesson plans and teaching. Student teachers are also expected to demonstrate their participation in extracurricular activities and critically evaluate the knowledge they have acquired. A summative self-evaluation is required at the end of the program. Therefore, it is recommended to provide copies of previous years' summative self-evaluations, set three personal, measurable goals at the beginning of teaching practice, reflect on teaching strengths, identify areas for improvement, and comment on the influence of educational theory on practice. Student teachers are also expected to maintain a journal that demonstrates evidence of learning and critically examines their experiences, including hopes, fears, expectations,

observations, problems, memorable moments, teaching strategies and examples, specific students, feedback from lecturers, and the connection between theory and practice, all of which contribute to their professional development as teachers.

### *1.2. Pre-Service Teacher Education (PSTE) Programme and Its Impact on Instructional Practices*

Since the publication of Dan Lortie's study in 1975 [22], a growing body of evidence has emerged to suggest that teacher training has limited influence. A comprehensive examination of relevant data is presented in a meta-analysis encompassing 40 preceding investigations [23]. This study examined the transformation of views among pre-service teachers throughout their teacher education programmes. The author asserts that there is a perceived absence of alteration in pre-existing views and argues that university courses do not sufficiently provide the necessary procedural expertise for effective teaching. Moreover, the limited effectiveness of training might be attributed to the influence of prior educational experiences that individual student teachers bring to their coursework [24]. This phenomenon results in a tendency to adopt specific instructional approaches and firmly held convictions regarding the essence of teaching and learning.

According to [25], teacher educators dedicate a significant amount of time to instructing pre-service teachers in effective teaching methods to facilitate student learning. One aspect that teacher educators frequently disregard is the consideration of methods to influence the beliefs and learning techniques of pre-service teachers. According to [14,26], pre-service teacher education should be characterised by the pursuit of two interrelated objectives. Firstly, it is imperative that future educators are equipped with the necessary skills to enhance their learning abilities. Secondly, the programme must instruct individuals on how to enhance their teaching efficacy. However, the ideal way to educate teachers about the daily obligations of classroom teaching is a topic of continuous debate around the world. More recently, empirical studies have revealed that completing a teacher preparation programme prior to taking on full-time teaching responsibilities has distinct advantages. Among the advantages are enhanced teacher confidence, self-efficacy [27], and longer teaching careers [28]. Similarly, [29] demonstrated how specific features of training programmes might affect a teacher's readiness for the classroom. According to a United States-based study, pre-service teachers with some training are better teachers than those without [30]. Despite this and comparable evidence, the argument over educator preparation continues, with discussions on the practical consequences of resource allocation and the theoretical underpinning of the benefits (or lack thereof) of teacher training. Thus, the following research question guides the present study: How do the pre-service teacher education (PSTE) programmes impact mathematics student teachers' teaching practices during school experiences?

## **2. Materials and Methods**

### *2.1. Research Paradigm, Approach, and Design*

A post-positivist paradigm underpinned this study because it argues that a researcher's beliefs and unique identity influence what they see and, therefore, what they conclude. Thus, post-positivism emphasises a comprehensive understanding of the directions and perspectives of any research study from multiple dimensions and methods, rather than aiming to criticise the scientific/quantitative aspects of positivism in the research [31]. In other words, this paradigm balances both positivist and interpretive approaches. Therefore, it was appropriate for the study because it allowed the researcher to gain an in-depth understanding of the impact of pre-service teacher education (PSTE) programmes on mathematics student teachers' teaching practices during their school experience activities. For this study, a mixed methods research approach was employed. Mixed methods research combines qualitative and quantitative methodologies into one study to gain broader knowledge, depth, and support [32]. Similarly, Mason (2006) [33] asserts that combining approaches has great potential for developing fresh perspectives on the intricacies and contexts of social experience and improving our aptitudes for social explanation and generalisation.

The mixed methods research approach was suitable for the present study because the researcher was able to examine the research question from various angles through mixed methods. It also allowed the researcher to accumulate as much information as possible on the nature of the pre-service teacher education (PSTE) programme and its impact on mathematics student teachers' teaching practices during their school experiences. This study also employed a sequential explanatory mixed methods design. The design involved systematically gathering and analysing quantitative data, followed by qualitative data, in two distinct phases within a single research study [34]. The purpose of using a mixed-methods sequential explanatory design was to utilise qualitative data to provide a more comprehensive explanation of the quantitative results obtained in the initial phase. Typically, this involves initially collecting quantitative survey data, analysing the data, and then conducting qualitative interviews to offer a more detailed interpretation of the survey results [32]. Given the complex nature of the teacher preparation program, which is influenced by multiple factors, it is recommended to conduct an in-depth investigation using a research approach known as sequential explanatory mixed methods design. This approach integrates both quantitative and qualitative research methodologies.

## 2.2. Population, Sample, and Sampling Technique

According to [35], a population refers to a group of organisations or individuals that share common characteristics that distinguish them from other institutions, individuals, organisations, or items. The study examined a population of 2909 pre-service teachers who were enrolled for the 2023 academic session at the Faculty of Education of a rural university in the Eastern Cape Province of South Africa. The study employed a stratified random sampling method, as the measurement tool was specifically designed to evaluate teaching practices and school experience. As a result, the target population and sample for this study encompassed primary and secondary school mathematics student teachers who were enrolled in "practical learning and teaching" classes and were currently undergoing an eight-week teaching practicum. The strata for the study were determined based on the subject specialisation of the pre-service teachers, which in this case was mathematics. Consequently, the quantitative phase of the study included a sample of 334 primary and secondary school mathematics student teachers from the selected university. Table 1 provides the descriptive statistics for the quantitative sample in the study.

**Table 1.** Tabular representation of mathematics student teachers in the quantitative phase.

| Attribute                         | Variable                                                               | Freq (f) | Percent (%) |
|-----------------------------------|------------------------------------------------------------------------|----------|-------------|
| Gender                            | Female                                                                 | 206      | 61.7        |
|                                   | Male                                                                   | 128      | 38.3        |
| Age                               | 17–18                                                                  | 0        | 0.0         |
|                                   | 19–20                                                                  | 13       | 3.9         |
|                                   | 21–22                                                                  | 272      | 81.4        |
|                                   | 23–24                                                                  | 41       | 12.3        |
|                                   | 25 and above                                                           | 08       | 2.4         |
| Subject Combination—Senior School | Mathematics + Physical Sciences                                        | 39       | 11.7        |
|                                   | Mathematics + Life Sciences                                            | 24       | 7.2         |
| Primary School                    | Mathematics + Social Sciences                                          | 61       | 18.3        |
|                                   | Mathematics + STEM                                                     | 86       | 25.7        |
|                                   | Mathematics + Languages                                                | 124      | 37.1        |
| Teaching Phase                    | Secondary School (further education and training phase + Senior phase) | 63       | 18.9        |
|                                   | Primary School (Foundation phase and intermediate phase)               | 271      | 81.1        |
| Total                             |                                                                        | 334      | 100         |

The qualitative phase of the investigation employed maximum variation sampling. Maximum variation sampling aims to include a diverse range of individuals who are relevant to the situation being studied in order to identify any shared patterns or occurrences

across these varied cases [36,37]. Table 2 provides an overview of the participants included in the qualitative component of the study.

**Table 2.** Tabular representation of mathematics student teachers in the qualitative phase.

| Participant | Gender | Subject Combination              | Teaching Phase | Age | Interview Duration |
|-------------|--------|----------------------------------|----------------|-----|--------------------|
| MST-1       | Female | Mathematics and Life Science     | Secondary      | 21  | 15.33              |
| MST-2       | Female | Mathematics and Physical Science | Secondary      | 22  | 17.54              |
| MST-3       | Female | Mathematics and Social Sciences  | Primary        | 20  | 19.22              |
| MST-4       | Female | Mathematics and STEM             | Primary        | 20  | 23.41              |
| MST-5       | Female | Mathematics and Languages        | Primary        | 22  | 18.52              |
| MST-6       | Female | Mathematics and Life Science     | Secondary      | 21  | 22.36              |
| MST-7       | Male   | Mathematics and STEM             | Primary        | 20  | 18.47              |
| MST-8       | Female | Mathematics and Languages        | Primary        | 21  | 22.03              |
| MST-9       | Female | Mathematics and Languages        | Primary        | 21  | 23.42              |
| MST-10      | Male   | Mathematics and STEM             | Primary        | 21  | 19.14              |
| MST-11      | Male   | Mathematics and Physical Science | Secondary      | 21  | 17.33              |
| MST-12      | Female | Mathematics and Life Science     | Secondary      | 22  | 16.03              |
| MST-13      | Female | Mathematics and Physical Science | Secondary      | 21  | 16.48              |
| MST-14      | Female | Mathematics and STEM             | Primary        | 22  | 21.57              |
| MST-15      | Male   | Mathematics and Social Sciences  | Secondary      | 21  | 29.06              |
| MST-16      | Female | Mathematics and Life Science     | Secondary      | 22  | 18.35              |
| MST-17      | Male   | Mathematics and STEM             | Primary        | 21  | 21.53              |
| MST-18      | Female | Mathematics and Languages        | Primary        | 23  | 24.37              |
| MST-19      | Male   | Mathematics and Languages        | Primary        | 23  | 17.51              |
| MST-20      | Male   | Mathematics and Life Science     | Secondary      | 22  | 24.18              |
| MST-21      | Female | Mathematics and STEM             | Primary        | 24  | 15.47              |
| MST-22      | Female | Mathematics and Life Science     | Secondary      | 22  | 26.18              |
| MST-23      | Female | Mathematics and STEM             | Primary        | 21  | 18.09              |
| MST-24      | Male   | Mathematics and Physical Science | Secondary      | 22  | 15.43              |
| MST-25      | Female | Mathematics and Life Science     | Secondary      | 21  | 26.47              |

The participants for the qualitative follow-up phase were selected from among those who had participated in the quantitative portion of the study and had completed the survey. These participants willingly agreed to take part in the qualitative aspect of the study. The purpose of the follow-up qualitative phase in an explanatory design is to provide an explanation for the results obtained in the initial quantitative phase. By selecting participants from the first phase, the researcher is able to obtain more comprehensive and detailed explanations. The process of selecting participants for the qualitative follow-up continued until saturation was reached. Saturation is considered to be achieved when no new analytical information emerges from the data [38]. Given that saturation is dependent on the sample size, as indicated by [38], and that saturation was reached with a total of 25 participants, this study provides optimal results for addressing the research problem.

### 2.3. Data Collection Instruments

The study collected quantitative data from participants using a Likert Scale questionnaire. The questionnaire had two sections. The first section included demographic information such as gender, age, subject combination, and teaching phase. The second section was the Pre-service Teacher Education program impact on Mathematics Student Teacher Questionnaire (PSTEIMSTQ), which aimed to measure the impact of the teacher education program on Mathematics student teachers' teaching practices. The PSTEIMSTQ questionnaire consisted of four sub-dimensions with sixteen items. The sub-dimensions were "enhanced subject knowledge", "alignment with curriculum standards", "differentiated instruction", and "increased confidence". The PSTEIMSTQ questionnaire used a Likert Scale with scores ranging from 1 to 3, where 1 represented "Agree", 2 represented "Neutral", and 3 represented "Disagree". The validity of the instrument was confirmed through pilot testing with a sample of thirty-five graduate students. This pilot testing

aimed to ensure that the PSTEIMSTQ items encompassed all potential items and that the number of items adequately reflected the phenomenon under investigation. The results of the pilot testing indicated that the questionnaire was highly readable and understandable. After the pilot study, the researchers calculated Cronbach's alpha to assess the reliability of the questionnaire. The Cronbach alpha coefficient for section II of the PSTEIMSTQ was 0.90, indicating that the instrument demonstrated high internal consistency and reliability [39].

The study also collected qualitative data through semi-structured interviews. Semi-structured interviews involve predetermined open-ended questions, with additional questions arising spontaneously during the conversation between the interviewer and interviewees [40]. The semi-structured interviews in this study included predefined questions aligned with the study's objectives, as well as questions that emerged during the interview discussions. Twelve interview questions were initially created, focusing on the literature on school experience and pre-service teacher education programmes and primarily on the survey data results from the first part of the study. Three field specialists with PhD degrees in Mathematics Education analysed the interview questions, resulting in the removal of four questions that did not align with the study's objectives. A pilot study was conducted with fifteen mathematics student teachers from different year levels to assess the comprehensibility of the remaining eight draft questions. One question was further excluded due to its lack of clarity. Ultimately, a semi-structured interview guide consisting of seven questions was developed for the study.

#### 2.4. Data Analysis and Ethics

A total of 400 surveys were distributed to mathematics student teachers. Due to the haphazard and uneven completion of forms, a total of 347 data entries were inputted into the SPSS 27.0 software. Next, the data set was examined to identify any outliers. Box and whisker plots were utilised to identify outliers. Out of the total data set, thirteen participants' data were identified as outliers and excluded from the analysis. The remaining 334 participants' data were studied. Prior to data analysis, the normal distribution was assessed. The skewness and kurtosis values were analysed to assess the normal distribution, revealing that the data had a normal distribution. The internal consistency coefficients for the subscales were also acceptable for "enhanced subject knowledge", dimension  $\alpha = 0.78$ ; "alignment with curriculum standards", dimension  $\alpha = 0.84$ ; "differentiated instruction",  $\alpha = 0.74$ ; and "increased confidence",  $\alpha = 0.71$ . The quantitative data collected using PSTEIMSTQ were analysed using SPSS 27.0 software, and the findings were presented as standard deviations and arithmetic means.

The data collected from the interviews were utilised to expand upon and clarify the results obtained from the quantitative phase. The participants completed the interview consent forms as a necessary ethical obligation. The qualitative data, which had a range of 15.33 to 26.47 min, were collected using a notebook and transcribed verbatim. Following the transcription process, a total of 153 pages of Word documents were obtained. The researcher interpreted the data that were listened to, read, and coded using template analysis. The interpretations were enhanced and corroborated direct quotations from mathematics student teachers. Template analysis is a method employed to analyse qualitative data and used by researchers to integrate quantitative and qualitative data analyses. It can be seen as a form of content analysis [41,42]. Template analysis aims to delineate the primary categories and themes identified by the researcher. It enables the researcher to assess pre-established themes that were structured based on the outcomes of the quantitative aspect [43]. According to [37,42], the use of a priori codes in template analysis is considered a significant distinction from other methodologies. Thus, this study utilised a priori themes derived from the quantitative strand, as demonstrated by [43]. The coding technique employs a "top-down" coding approach to code segments that relate to pre-established themes. This coding methodology indicates that certain portions of the transcribed information focus on pre-existing themes that represent fundamental concepts [37,43].

According to [37], the process of combining quantitative and qualitative data at the reporting and interpretation stage is referred to as “integrating through narrative”. The “integrating through narrative approach” describes quantitative and qualitative data in a series of reports. In the weaving approach, the quantitative and qualitative findings are combined and presented in a systematic manner, organised either concept by idea or theme by topic [37,44]. This study used a weaving strategy to clarify the research topics sequentially by discussing the results. To ensure the credibility and data trustworthiness of the study, triangulation was employed through a combination of qualitative and quantitative methodologies, utilising several data sources and methods. In addition, member checking was employed as a tool to ensure the credibility of the qualitative findings in this study. Member checking, also known as participant validation, is a technique that involves providing analysed data or transcribed interviews to participants for their review and confirmation [37,45]. The transcribed data and findings were given to the participants, who were then requested to review and provide feedback on them.

For this study, ethical clearance was obtained from the university research committee board, the Department of Education, and the respective schools where student teachers were placed for school experience practices. Privacy, anonymity, and confidentiality were maintained throughout the study, except when harm to a specific person was suggested. This condition was explained and approved prior to data collection. Moreover, the consent of every participant was sought, and a detailed explanation of the study’s purpose, methodology, and data usage was provided to the respondents before their consent was requested. The respondents were also informed of their right to withdraw from the study at any time, with their data remaining unused.

### 3. Results

An analysis was conducted to ascertain the level of preparedness exhibited by mathematics student teachers in their teaching practices during school experiences. Table 3, presented below, displays the descriptive statistics of the participants’ responses.

**Table 3.** Impact of the pre-service teacher education programme on mathematics student teachers.

| Measurement Tool                                                                                              | Variables                           | <i>n</i> | $\bar{x}$ | <i>sd</i> |
|---------------------------------------------------------------------------------------------------------------|-------------------------------------|----------|-----------|-----------|
| Pre-service Teacher Education Programme<br>Impact on Mathematics Student Teacher<br>Questionnaire (PSTEIMSTQ) | Enhanced Subject Knowledge          | 334      | 1.76      | 0.59      |
|                                                                                                               | Alignment with Curriculum Standards | 334      | 1.85      | 0.48      |
|                                                                                                               | Differentiated Instructions         | 334      | 1.23      | 0.51      |
|                                                                                                               | Increased Confidence                | 334      | 1.67      | 0.58      |

Table 3 above shows the arithmetic mean of the impact of PSTE on mathematics student teachers in relation to the “alignment with curriculum standard” dimension was  $\bar{x} = 1.85$ . This can be regarded as the highest mean among the dimensions of PSTE’s impact on mathematics student-teacher teaching practices. The items in the survey that aligned with the curriculum standard dimension were related to curriculum and course structure, mentoring and supervision, modelling by teachers and faculty members, and access to resources and materials. The findings of the study proved that PSTE has a significant impact on mathematics student teachers’ ability to teach mathematical content that aligns with curriculum standards during teaching practices. The study’s qualitative findings highlighted the impact of the Preservice Teacher Education Programme on “alignment with curriculum standard” in relation to mathematics student teachers’ teaching practices during the school experience. The prominent ones are the ability to teach mathematical content that aligns with the curriculum standards in relation to access to resources and materials, as well as the modelling of effective instructions that align with curriculum standards. According to the remarks of the participants, it can be interpreted that the programme ensures that mathematics student teachers have a deeper understanding of the subject matter they

will teach, provides them with a thorough understanding of the curriculum they will be teaching, and exposes them to hands-on experiences which build confidence and reduce apprehension about entering the classroom as a certified teacher. The themes derived from the quantitative phase findings were consistent with the qualitative phase findings. The verbatim utterances that provide evidence for these findings are presented below.

*...I believe that this programme has affected my teaching practices in a very positive way because it has deepened my understanding and knowledge of what is expected in high school mathematics and the selection of teaching materials for such topics, but we have not been taught how to use these instructional materials or resources to address the specific learning challenges of each learner. This sometimes makes it impossible to be in full charge of your classroom and track learners' performance or understanding.*

(MST 19)

*...hmm, this programme has affected my teaching practices in many ways, and the impacts are positive. For instance, during the programme, we [mathematics student teachers] were already taught the contents of the CAPS [Curriculum and Assessment Policy Statement] because this is what we will be teaching our learners at high schools. Exposure to this content made us aware of the curriculum standards and guidelines set by the education authorities; this also assisted us in designing suitable lesson plans aligned with this curriculum.*

(MST 25)

*I have gained so much confidence, and I have overcome all mathematics-related anxiety when I have to teach learners as a result of this teacher education programme because we have been exposed to much content and we are well grounded. I call this a positive impact, but when it comes to addressing learners' behaviour, which is a major challenge in managing an effective classroom, we [mathematics student teachers] do not have the required skills to identify and respond to the diverse needs and learning styles of our learners.*

(MST 2)

In this study, the average of the “differentiated instruction” dimension ( $\bar{x} = 1.23$ ) was found to be the lowest when analysing the impact of MPSTE on the teaching practices of mathematics student teachers during school experience. The items in the “differentiated instruction” dimension were associated with factors such as school culture and resources, prior experience, attitude and beliefs, and personal motivation, which have an influence on the teaching practices of mathematics student teachers during their school experiences. The qualitative findings aligned with the findings of this dimension, indicating that most participants faced challenges in implementing “differentiated instruction” during their teaching practices. It can be inferred from the narratives that regardless of the nature of the pre-service teacher education program, school culture and the availability of resources such as technology and instructional materials hinder the use of differentiated instruction by mathematics student teachers during school practice. Furthermore, the verbatim utterances suggest that the beliefs and values that mathematics student teachers hold about the teaching and learning of mathematics, as well as their perceptions of learners' diversity and individuality, impact their motivation to implement differentiated instructions. The themes derived from the quantitative phase findings were consistent with the qualitative phase findings, and the verbatim utterances that support these findings are presented below:

*Although the pre-service teacher education (PSTE) programmes prepared me in such a way that I am well-grounded in terms of content, how to prepare my lessons, and sometimes select teaching strategies that can assist learners in grasping the content being taught. However, when I got to my placement school, I realised that there were limited resources and a lack of support from mentors, which overwhelmed me. Also, the heavy*

*reliance of the school on standardised testing pressures me to teach anyhow rather than implementing differentiated instructions.*

(MST 12)

*...I can say that one of the ways in which the pre-service teacher education (PSTE) programmes have impacted my practices during the school experience is that it has increased my confidence as a teacher, and with that alone, I can create a supportive classroom atmosphere, provide ongoing feedback but still struggle to use effective pedagogical approaches. This is owing to the fact that most of the assigned mentors and the school culture at large are resistant to change; they fail to provide support or even resources, and this limits our [mathematics student teachers] ability to tailor instruction to meet the individual needs of learners in the mathematics classrooms.*

(MST 5)

The mean score for mathematics student teachers on the dimension of “enhanced subject knowledge” was  $\bar{x} = 1.76$ . This suggests that the PSTE program has a positive impact on the teaching practices of mathematics student teachers during their school experience. The items in the “enhanced subject knowledge” dimension were associated with factors such as instructional quality, practical experience, curriculum design, and peer collaboration, all of which influence the teaching practices of mathematics student teachers during their school experience. The findings from the qualitative phase of the research were consistent with the results of this dimension. Therefore, it can be concluded from the participants’ statements that the quality of instruction, provided through well-structured and engaging lessons offered by the PSTE program, plays a crucial role in helping mathematics student teachers gain a deeper understanding of the subject and teach effectively during their school experience. It can also be inferred from the responses that a well-designed curriculum, which includes a balance of theoretical knowledge and practical experiences, enhances the subject knowledge of mathematics student teachers. Furthermore, it encourages them to engage in peer collaboration, which exposes them to multiple perspectives on the subject matter and promotes reflective practices, ultimately contributing to the enhancement of their subject knowledge. The verbatim statements related to the “enhanced subject knowledge” theme are provided below:

*During our teacher education program, we had the opportunity to observe expert educators in action. As such, we have learned effective teaching strategies, instructional methods, and classroom management techniques, all of which assist us in seeing mathematics content being taught in real time. This experience has had a very good impact on my teaching practices during this school experience because I was able to replicate a similar approach and clarify concepts that seemed to be unclear to my learners.*

(MST 17)

*...Our teacher education program emphasises the importance of collaboration with peers because it is said to assist in enhancing our subject knowledge in mathematics through shared experience, feedback, and support. ... during this school experience, collaboration with fellow student teachers, mentoring teachers in exchanging ideas, solving problems together, and learning from each other have motivated me to continue learning and growing as a mathematics teacher, which in turn positively affected my teaching practices.*

(MST 24)

The arithmetic mean of mathematics student teachers on the “increased confidence” dimension was  $\bar{x} = 1.67$ , which implies that the PSTE program also has a reasonable impact on the teaching practices of mathematics student teachers during their school experience. The items in the “increased confidence” dimension were related to factors such as opportunities for practice and feedback, a supportive learning environment, encouragement and positive reinforcement, reflection and self-assessment, and the effect on the teaching practices of mathematics student teachers during their school experiences. The findings from the qualitative phase were also similar to the findings of this dimension. It was deduced

from the verbatim utterances that the PSTE programme positively impacted the teaching practices of mathematics student teachers. During the program, they were exposed to a positive and supportive learning environment that helped them feel more confident in their abilities. Additionally, the findings revealed that providing teachers with opportunities to practice teaching mathematics in the classroom and receiving feedback from experienced educators helps build confidence in their teaching abilities. It could also be inferred from the verbatim utterances that the PSTE program encouraged mathematics student teachers to reflect on their teaching practices and engage in self-assessment. This assisted them in identifying areas of improvement and building confidence in their abilities to teach mathematics during their school experience. The verbatim utterances related to the prior theme named “increased confidence” are as follows:

*During our teacher education programme, our lecturers encouraged us in a supportive learning environment, fostering a sense of belonging and safety. This actually allows us to take risks and make mistakes without fear of judgment. As a result, this support helps in building confidence by showing that we are valued and respected. This has really heightened my level of confidence and assisted me a lot in the classroom during the school experience.*

(MST 21)

*...well, during one of our mathematics method modules, our lecturer emphasised the importance of providing encouragement and positive feedback—this assisted us [mathematics student teachers] in being more confident in our abilities. He also emphasised self-reflection and self-assessment in identifying areas of improvement. Through this, we were able to identify our strengths and weaknesses as would-be teachers. Engaging in reflective practices during our PSTE program helps us to gain a deeper understanding of our teaching methods and strategies, which in turn enhances my confidence to teach mathematics during this school experience effectively.*

(MST 15)

#### 4. Discussion

The results of the study demonstrated that the PSTE program has a significant impact on the ability of mathematics student teachers to effectively teach mathematical content in accordance with curriculum standards during their teaching practices. This outcome can be attributed to various factors, including access to resources and tools for modelling during their teacher education program, as well as exposure to demonstrations of effective instructional techniques by their lecturers that align with the curriculum standards. These findings align with previous research conducted by [46,47], which argued that a teacher education program that allows pre-service teachers to familiarise themselves with multiple instructional techniques during their training, as well as gain a realistic understanding of school settings and classrooms, provides them with greater opportunities to grasp and implement the school curriculum. Through this process, pre-service teachers are able to recognise their strengths and areas for improvement. Based on the findings of this study, it can be inferred that the program equips mathematics student teachers with a comprehensive understanding of the curriculum they will be teaching and provides them with practical experiences that enhance their confidence and alleviate their concerns about entering the classroom as certified teachers.

The study's findings indicate that the influence of pre-service teacher education (PSTE) on mathematics student teachers' ability to teach mathematical content using differentiated instruction is very low. The research suggests that regardless of the quality of the PSTE program, factors such as school culture, the beliefs and values of mathematics student teachers regarding the teaching and learning of mathematics, perceptions of learner diversity and individuality, and lack of support from mentor teachers affect their motivation to implement differentiated instruction during their school experience. This finding aligns with previous research [48] that argues teachers' beliefs serve various purposes, including

filtering knowledge, influencing how teachers perceive and approach challenges and tasks, and guiding their classroom activities. Therefore, addressing disparities and overcoming academic struggles among learners from diverse cultural backgrounds [48–50] becomes crucial. Teachers are expected to serve as cultural intermediaries, integrating the cultural attributes and previous experiences of both the school and the learners into their instructional methods [51]. In doing so, teachers should utilise learners' cultural backgrounds and personal experiences to establish an inclusive classroom environment and foster positive connections [50]. Furthermore, in terms of the lack of support from mentor teachers, it is essential for host teachers in schools to actively provide support and mentorship to pre-service teachers to facilitate their professional development [52]. Therefore, student teachers' engagement with mentors, learners, and the school environment can be beneficial for their pedagogical growth, as it enables them to gain insight into their strengths and weaknesses and improve their skills [52]. Ultimately, this engagement allows student teachers to discover relevant approaches, methods, strategies, and experiences that enhance their motivation to develop and strengthen their teaching skills.

However, it can also be argued that Preservice Teacher Education (PSTE) has had a significant impact on dimensions such as “enhanced subject knowledge” and “increased confidence” in the teaching practices of mathematics student teachers during their school experiences. Research findings pertaining to the influence of PSTE on student teachers' subject knowledge revealed that a well-designed curriculum, incorporating both theoretical knowledge and practical experiences, enhances student teachers' understanding of mathematics. Furthermore, fostering peer collaboration among mathematics student teachers allows for the exchange of diverse viewpoints on the subject matter and facilitates the development of reflective practices, resulting in improved subject knowledge and teaching practices. This finding is in line with the assertions made by [53], who contend that teacher education programs should effectively train pre-service teachers to guide and promote learning in various school settings by involving them in lesson creation that requires them to clearly articulate their comprehension of the nature and process of learning. This is because, during the process of designing lessons, pre-service teachers have the opportunity to demonstrate their understanding of how learning occurs by making intentional pedagogical decisions and providing a rationale for those decisions, particularly with regard to supporting the learning process [53]. Therefore, it is crucial to emphasise the importance of effective planning and a well-designed curriculum that combines theoretical knowledge and practical experiences in order to enhance subject understanding and enable student teachers to positively impact student learning [53,54]. It can also be inferred from the findings that high-quality instruction delivered through well-structured and engaging lessons within the PSTE program played a pivotal role in enabling mathematics student teachers to develop a deep comprehension of the subject matter and effectively teach during their school experiences. These findings align with those of [55], who investigated the effects of a teacher training program on pre-service teachers and found that it enhanced their subject knowledge, self-awareness, and confidence in their skills and knowledge [55]. Additionally, Coşkun (2016) [56] argued that a high-quality pre-service teacher program significantly improves pre-service teachers' teaching practice, subject knowledge, and lesson preparation competency.

Lastly, the research findings indicate that the provision of a positive and supportive learning environment within the program was instrumental in helping student teachers develop confidence in their teaching abilities. Additionally, the results reveal that opportunities to actively engage in teaching mathematical concepts in the classroom, coupled with feedback and evaluations from experienced educators, further enhance their self-assurance and teaching aptitude. These findings align with previous research conducted by [46], which observed the development of confidence in new teachers. Moreover, Griffin (2006) [57] asserts that the new teachers' perceived level of confidence and competency is largely influenced by their initial confidence, the quality of their teacher education program, and the level of the class they are assigned to teach. However, it is important for teacher

education programs to consider the unique demands of classroom management before assigning specific teaching responsibilities. In terms of teaching at different grade levels (primary and secondary), Griffin (2006) [57] suggests that teacher educators should be mindful of the distinct pedagogical strategies required for effective instruction at each level. Consequently, prioritising classroom management skills for teachers targeting lower grade levels and focusing on appropriate teaching methods for more academically demanding senior levels becomes crucial. Nevertheless, it is worth noting that teaching approaches do carry significance at the lower grade levels as well. The varying impact of increased or decreased teaching loads on novice teachers' attitudes and self-assurance undoubtedly affects the academic progress of students in the classroom. Therefore, implementing effective strategies to prepare and assign new teachers to appropriate grade levels will aid student teachers in navigating the early stages of their careers and ultimately have a positive impact on the students they are entrusted with.

## 5. Conclusions

This study investigated the impact of Pre-Service Teacher Education (PSTE) programs on the teaching practices of mathematics student teachers during their school experience activities. The findings revealed that the PSTE program plays a significant role in enhancing the mathematics student teachers' content knowledge and their ability to teach mathematical content that aligns with curriculum standards. Moreover, it was found that the program significantly increases the level of confidence of mathematics student teachers. Based on these findings, the study concludes that immersing mathematics student teachers in a structured and comprehensive teacher education program equips them with the necessary skills and knowledge to effectively deliver lessons that meet curriculum requirements and engage learners in meaningful learning experiences. Additionally, the study concludes that high-quality teacher education programs have the potential to enhance mathematics student teachers' confidence, enabling them to effectively manage their classrooms and adapt their teaching practices to meet the diverse needs of their learners. Finally, the study suggests that investing in quality pre-service teacher education programs has a long-lasting impact on the effectiveness of mathematics student teachers and, ultimately, on the overall success of the education system.

## 6. Recommendation

While the study extensively revealed the impact of Pre-Service Teacher Education (PSTE) programs on the teaching practices of mathematics student teachers during their school experience activities, there is a scarcity of solid research to corroborate, refute, and/or provide solutions to the problems identified. As such, the study recommends more research in this area of study with an increased level of funding for implementing interventions and research. Additionally, given that the majority of mathematics student teachers face challenges in implementing differentiated instruction in their classroom practices during school experience, the study recommends adequate capacity building for student teachers in the implementation of differentiated instruction to ensure that this program adequately prepares mathematics teachers for the evolving demands of the educational landscape. Lastly, the study recommends that actors in pre-service teacher education (PSTE) programs should provide ongoing guidance and constructive feedback that can help student teachers overcome challenges and further refine their teaching practices, given that this support system plays a vital role in the success of the pre-service teacher education program and ultimately impacts the quality of mathematics instruction delivered at schools.

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