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PROMOTING AND HINDERING FACTORS IN MATHEMATICS TEACHING IN SOUTH AFRICAN HIGH SCHOOLS

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Abstract: This study explores what factors enable or prevent South African educators from carrying out effective mathematics teaching. The objectives are to explore the qualifications and experience of those involved, which skills, tools, and resources they use and what barriers they encounter. A qualitative approach using an interpretivist paradigm with multiple case studies was used. Eighteen participants were interviewed, and the data were analysed using qualitative content analysis. Findings showed that the barriers impeding effective mathematics teaching included lack of resources, teachers leaving the profession and many principals not attending workshops or professional development programmes. From the findings, we recommend the Department of Basic Education encourage more teachers to specialise in mathematics and that more funding is directed toward allocating the necessary resources to schools where resources are lacking. The department can provide incentives to encourage more student teachers to pursue mathematics teaching.
Key words: mathematics teaching, qualitative content analysis, school resources, qualifications

1. Introduction

There is growing global concern concerning South African learners' mathematics achievement. South Africa participated in the SACMEQ[1] II, III and IV to monitor and measure learners' reading and mathematics achievement performance. Sadly, South Africa performed lower than the mean average score of 500 in the SACMEQ II (Moloi & Strauss, 2005) and SACMEQ III (Department of Basic Education [DBE], 2010; Moloi & Chetty, 2011) studies. However, in the SACMEQ IV study, learners scored an average of 552 points in mathematics (DBE, 2017), which was higher than the international SACMEQ score of 500. This upwards improvement was attributed to the streamlining and strengthening of the national curriculum between the SACMEQ III and IV and monitoring of teaching and learning (T&L), among others (DBE, 2017). However, such improvement bears little significance as South African learners illustrated poor achievement in mathematics with the release of the Trends in International Mathematics and Science Studies (TIMSS) 2019 results. South Africa participated in TIMSS 2019 on Grade 5 and Grade 9 levels, respectively. At Grade 5 level, 64 countries participated, with South Africa being amongst the lowest of the 64 countries, with an achieved score of 374, well below the international benchmark of 500 points (Reddy et al., 2020a). At Grade 9 level, 46 countries participated, and South Africa was second from the bottom in mathematics achievement; only above Morocco (Reddy et al., 2020b). These results are alarming, given that South Africa has had many intervention programmes to improve the educational system over the last few years. The Gauteng Department of Education (GDE) introduced intervention projects such as the Dinaledi project (Blum et al., 2010) and the Secondary School Improvement Plan (SSIP) (Center for Education Innovations, n.d.), intending to improve South African learners' mathematics achievement. The Dinaledi project was launched in 2001 to improve mathematics performance and increase participation in mathematics

[1] SACMEQ stand for "Southern and Eastern Africa Consortium for Monitoring Educational Quality"

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in 2012, the Dinaledi Unit was created to boost the project's work, particularly in teaching mathematics for females. The SSIP was first only introduced to Grade 12 learners in 2010, with Grade 12 being the highest school level in South Africa, and since then, it has been introduced to Grade 8 and 9 (in 2012) and Grades 10 and 11 (in 2011) where Grade 8 is the entry-level of high schools in South Africa. More recently, there have been other strategies, for example, the Gauteng Primary Literacy and Mathematics Strategy (GPLMS) and revising the school mathematics curriculum to ensure a greater alignment between the schooling and university curriculum (Shay, 2020). Despite such initiatives by the DBE at both national and provincial, district and circuit levels, South African learners' mathematics achievement remains poor. Various aspects could be associated with poor learners' mathematics achievement, for example, the shortage of or inadequate resource allocations (Adebayo et al., 2020; Juan & Visser, 2017; Makofane & Maile, 2019), poor leadership (Zuze & Juan, 2020) and learners' attitudes toward mathematics (Elçi, 2017). Zuze and Juan (2020) showed that the quality of school leadership and management is important for T&L, particularly in schools with acute resource deprivation. According to Visser et al. (2015), "the consensus amongst South African studies is that the availability or scarcity of key school resources impacts educational outcomes, with higher availability of resources being linked to better educational outcomes" (p. 1). Furthermore, the shortage of mathematics teachers in South Africa is widely reported by various authors, however, it remains a growing concern for the Department of Basic Education and the country at large. The lack of qualified mathematics teachers is also a major contributing factor to the shortage (Shole, 2019). Furthermore, the lack of teachers' skills to teach mathematics was found to be a significant hindrance to learner achievement (Asli & Zsoldos-Marchis, 2021). The impact on learners' learning is becoming more and more clear as the country struggles with a scarcity of qualified mathematics teachers. Although Smith et al. (2022) found no statistically significant effects of teacher qualification, experience and subject specialisation, Olufsen et al. (2022), revealed that learners who are taught by a suitably qualified mathematics teacher (specialised in mathematics) displayed a faster learning progression in the subject than those taught by a non-specialized teacher. The country's poor performance in international mathematics assessments has made the shortage of mathematics teachers a challenge that has gotten worse. This shortage has made it more difficult for the country to produce learners who have the mathematical proficiency needed to compete in the global economy.

This study aims to explore what factors enable or prevent South African educators from carrying out effective T&L of mathematics in South African schools. The objectives are to explore the qualifications, teaching experience, and management experience of those involved with teaching mathematics in South African schools, which skills, tools, and resources they use when teaching mathematics, and what barriers they encounter in teaching mathematics effectively.

2. Theoretical framework

This study was guided by the socio-ecological model (SEM) of Bronfenbrenner (1977). It was first introduced as a conceptual model for understanding human development by Bronfenbrenner in the 1970s and later formalised as a theory in the 1980s (Kilanowski, 2017). Socio-ecological models were developed to further the understanding of the dynamic interrelations among various personal and environmental factors. This investigation is regarded as ecologically valid because it was carried out in a naturalistic setting and involves participants and activities from everyday life (Bronfenbrenner). And therefore this theoretical framework fits the purpose of the study. Furthermore, understanding how individual, contextual, and systemic elements interact to form educational practices is facilitated by the SEM. In the case of the current study investigating the factors that facilitate or impede successful mathematics instruction in South Africa, the model can help to clarify the relationship between the identified barriers and their broader contextual and systemic underpinnings.

3. Research methodology

3.1. Methodology

A qualitative approach with multiple case studies was used to develop an in-depth understanding (Nieuwenhuis, 2019) of the factors that enable or prevent South African educators from carrying out

effective T&L of mathematics. An interpretivist paradigm was used as this approach is used to understand the viewpoint of the subject being overserved rather than that of the observer (Kivunja & Kuyini, 2017). Interviews with 18 participants were conducted, and qualitative content analysis was used to analyse the data. The latter involved preparing the qualitative data for analysis by firstly, transcribing the data and getting a sense of the data as a whole and organising the data. This was followed by assigning codes to the data that capture the meaning of the text, grouping the codes under higher order headings and formulating a general description of the research topic through generating categories and subcategories, and reporting the results (Vaismoradi et al., 2013).

3.2. Research questions

The primary research question is:

- What teacher-related factors are associated with effective teaching and learning of mathematics in South African public and independent (Private) high schools?

The following secondary research questions guided the study:

- What qualifications, teaching experience, and management experience do those involved with teaching mathematics in South African high schools have?
- Which skills, tools, and resources do those involved in teaching mathematics in South African high schools use?
- What barriers do those involved with teaching mathematics in South African high schools encounter in teaching mathematics effectively?

3.3. Sampling and participants

We relied on both the convenience sampling method and purposive sampling method to select six research sites. The six research sites were constituted by a total sample size of 18 participants consisting of six public high school principals and 12 mathematics teachers from schools in the Johannesburg Central, Johannesburg North and Johannesburg South districts (2 principals and 4 teachers per district). Convenience sampling meant that participants nearby the researcher's workplace were selected and purposive meant that principals and teachers in South African schools with at least five years' experience in teaching mathematics were selected. Detailed descriptions of the research sites are intentionally limited to conceal the identity and maintain the anonymity of participating sites and individuals. The education district and the location of the schools were provided instead of the schools' names. A short description of each research site sampled for this study follows.

3.3.1. School Site A. The school is situated in the Soweto Township in the Johannesburg Central District. The average class size of Grade 9 was 50, with an enrolment of over 1,500 learners from Grade 8 to 12. The school is a no-fee school (Quintile 1) and mostly relies on the Gauteng Department of Education (GDE) for procurement processes. The school offers a wide range of African languages, including Isizulu, Isixhosa, Xitsonga, Sesotho, and uses English as First Additional Language (FAL) and Language of Learning and Teaching (LoLT). The school's infrastructure is well maintained both outside and inside. However, the school's grounds are poorly maintained as the public litter onto the school grounds. The majority of teachers are permanently employed by the GDE, while the School Governing Body (SGB) employs a few as additional staff.

3.3.2. School Site B. The school is situated in the Soweto Township in the Johannesburg North District. The average class size of Grade 9 was 55, with an enrolment of over 1,450 learners from Grade 8 to 12. The school is a no-fee school (Quintile 3) and mostly relies on the GDE for procurement processes. The school offers a wide range of African languages, including Isizulu, Isixhosa, Xitsonga, Sesotho, Setswana, Tshivenda and English as FAL and LoLT. The school's infrastructure is not well maintained, the school's grounds are poorly maintained as members of the public litter onto the school grounds. The majority of teachers are permanently employed by the GDE, while the SGB employs few as additional staff. The GDE employs teacher assistance personnel on a contractual basis.

3.3.3. School Site C. The school is situated in the Soweto Township in the Johannesburg Central District. The average class size of Grade 9 was 60, with an enrolment of over 1,050 learners from Grade 8 to 12. The school is a no-fee school (Quintile 3) and mostly relies on the GDE for procurement processes. The school offers a wide range of African languages, including Isizulu, Isixhosa, Xitsonga, Tshivenda and English as FAL and LoLT. The school's infrastructure is not well maintained, the roofs and ceilings of certain classrooms are in a state of disrepair, and the school's grounds are poorly maintained, there are open manholes on the school premises. The majority of teachers are permanently employed by the GDE, while a few are employed as teacher assistants on a contractual basis. There is a lack of an administration block that should cater to the principal and the deputy principal's office and HODs and teachers' staff rooms. Due to this shortage, two classrooms are used as the principal's office and teachers' staff room, respectively.

3.3.4. School Site D. The school is situated in the Lenasia Suburb in the Johannesburg South District. The average class size of Grade 9 was 50, with an enrolment of over 1,013 learners from Grade 8 to 12. The school is a fee-paying school (Quintile 5) and mostly relies on the school fees and allocations from the GDE. The school offers Afrikaans and a selected few African languages as well as English as FAL and LoLT. The school's infrastructure is well maintained; however, it is very old, and some of its classrooms are constructed with asbestos. The majority of teachers are permanently employed by the GDE, while the SGB employs few as additional staff. The GDE employs teacher assistance personnel on a contractual basis.

3.3.5. School Site E. The school is situated in the Johannesburg South suburb in the Johannesburg South District. The average class size of Grade 9 was 45, with an enrolment of over 1,340 learners from Grade 8 to 12. The school is a fee-paying school (Quintile 4) and mostly relies on the school fees and allocations from the GDE and fundraising. The school offers Afrikaans and a selected few African languages as well as English as FAL and LoLT. The school's infrastructure is well maintained; however, it is very old, and the staircases of certain buildings are not safe for all to use. The classrooms are too small and were designed to accommodate 25 learners. Most teachers are permanently employed by the GDE, while the SGB employs a few as additional staff. The GDE employs teacher assistance personnel on a contractual basis.

3.3.6. School Site F. The school is situated in the Lenasia suburb in the Johannesburg South District. The average class size of Grade 9 was 55, with an enrolment of over 1,300 learners from Grade 8 to 12. The school is a fee-paying school (Quintile 4) and mostly relies on the school fees and allocations from the GDE and fundraising. The school offers Afrikaans and a selected few African languages as well as English as FAL and LoLT. The school's infrastructure is well maintained; however, it is very old and was never designed to be a public school. The classrooms are too small and were designed to accommodate 20 learners while others can accommodate 25 learners. There is a shortage of classrooms, and temporary mobile classrooms are used to accommodate learners. Most teachers are permanently employed by the GDE, while the SGB employs a few as additional staff. The GDE employs teacher assistance personnel on a contractual basis.

3.4. Quality assurance

Trustworthiness can be established by credibility, transferability, dependability, and confirmability. Credibility refers to "confidence in the truth value of the data and interpretations of them" (Polit & Beck, 2018, p. 415). Credibility was established by providing direct verbatim quotations from the participants (Connelly, 2016). Transferability refers to "the extent to which qualitative findings have applicability in other settings or groups" (Polit & Beck, 2018, p. 416). We have provided sufficient information about the research sites and participants and rich and vigorous findings with direct quotations to enhance transferability of our research findings. Transferability is primarily the duty of the person conducting the generalising from a qualitative standpoint (Kyngäs et al., 2020). For this study, an individual who intends to "transfer" the results to a different context is then in charge of determining whether the transfer is reasonable. To ensure dependability, we acknowledged that humans are subjective beings, and throughout the research process, we reminded ourselves to be aware of how we perceived the research process and how our own background and paradigm may have influenced our perceptions of the research outcomes. Member-checking was also done as soon as the

transcriptions were available (with a turnaround time of two days) to ensure dependability further. We demonstrated the confirmability of this study by "providing rich quotes from the participants that depict each emerging theme" (Cope, 2014, p. 89).

3.5. Ethical considerations

Ethical clearance was obtained from the University of Pretoria (Ethics Clearance Number: EDU022/20) and the GDE. Consent letters were signed by participants that participated in this study voluntarily, and pseudonyms were used to protect their identities.

4. Findings

Three main themes emerged, namely, Theme 1: Pedagogical content knowledge in mathematics teaching (with four sub-themes), Theme 2: Resources used in mathematics T&L (with two sub-themes) and Theme 3: Practical implication of skills and tools (with two sub-themes). Theme 1 is considered first.

Theme 1: Pedagogical Content Knowledge in Mathematics Teaching

Principals were asked about the skills they have that ensure that T&L of mathematics take place. The practice of appointing principals in South African schools should be based on excellence, qualifications, experience and competency (Dube & Tsotetsi, 2020). Even though there are no stringent criteria for the appointment of principals or prerequisite qualifications, principals do have the potential to lead and manage efficient and successful schools (Naidoo, 2019) when qualifications, experience and competency are the prerequisites for such appointment. It was interesting to note that the majority of principals are qualified mathematics teachers; five out of the six (as mentioned earlier). One of the principals, Donaldson, stated that: "I have majored in mathematics to the level of an Honours degree, and I've also been doing other certificates as required by the new curriculum for mathematics".

Leanne, also a principal, stated that she is also "a qualified mathematics teacher and have a Master's degree". Eleven of the twelve teachers are qualified mathematics teachers. However, the twelfth teacher is a qualified teacher but did not major in mathematics. It was distressing to note that the shortage of qualified mathematics teachers remains a problem in South Africa (Nel & Luneta, 2017). This problem of educators teaching subjects without specialising in that specific field was confirmed by one teacher, Nancy, who stated that, "I didn't do a mathematics in varsity, but I am a qualified teacher". It is crucial to note that research has shown that learners taught by mathematics teachers with relevant qualifications have a positive association with learners achieving higher educational outcomes (Lee & Lee, 2020). It may be argued that poor learners' mathematics achievement is caused by the shortage of suitably qualified mathematics teachers. The rest of the teachers demonstrated that they are qualified mathematics teachers. Some of the responses of the teachers include Daphne's answer that, "I've got a Master's degree in mathematics" and Freddie's response that:

> I'm a qualified mathematics teacher. I hold a Bachelor of Science in mathematics, Honours in mathematics, yes. I also have the advanced certificate.

According to Lee and Lee (2020), there is a positive correlation between teacher qualifications and learners' achievement. Perhaps this association explains why countries around the world devoted much of their resources to ensure that highly qualified teachers teach learners (Feng & Sass, 2018; Popova et al., 2022).

Theme 1 is grouped into four sub-themes, namely qualifications, teaching experience, management experience, and skills development workshops/training.

Sub-theme 1.1: Qualifications

In South Africa, candidates who aspire to become teachers may opt to complete a 4-year Bachelor of Education degree (B.Ed.) or a 3- or 4-year Bachelor's degree, followed by a one-year Postgraduate Certificate in Education (PGCE), formerly known as Higher Education Diploma (DBE, 2021).

Principals were asked about the skills they have that ensure that T&L of mathematics take place. Five of the principals are qualified mathematics teachers. Their qualifications range from a diploma to a Master's degree; none of them has studied beyond a Master's degree. There is one principal with a Master's degree, two with a B.Ed. Honours degree, two principals with Higher Education Diploma, one principal with a PGCE. The principals' teaching experience ranges from ten to thirty years which is in line with the prerequisite for a principal position which is at least seven years of teaching. Teachers were asked the same question as the principals, i.e., about their skills to ensure that mathematics T&L occur effectively. Eleven of the teachers are qualified mathematics teachers. The twelfth teacher is a qualified teacher but did not major in mathematics. The teachers' qualifications range from a diploma to a Master's degree, similar to the principals; none of the teachers studied beyond a Master's degree. There is one teacher with a Master's degree, three teachers with B.Ed. Honours degree, four teachers with B.Ed. degree, two teachers with BSc degree, one with BTech degree and one teacher with Higher Education Diploma.

Sub-theme 1.2: Teaching Experience

This category investigated the teaching experience of principals and teachers. The principals' and teachers' responses have shown that the majority of the principals and teachers have adequate mathematics teaching experience. Principals play a crucial role in the development and maintenance of academic standards, which include the knowledge and skills that learners are expected to learn per subject per grade (Dhuey & Smith, 2018; Shelton, 2020). Each principal has more than seven years of teaching experience. The following are the responses of two principals. Leanne responded that she has "23 years of teaching experience", with Donald's number of years also being more than two decades, "I have been in the teaching fraternity for many years, 25 years to be precise". The responses from the two principals suggest that there is a wealth of teaching experience among the principals. Siyepu (2013) showed that poor mathematics learner achievement is attributed to a lack of teacher's skills and knowledge, among other factors, which are within the scope of the current study. Teacher knowledge and experience is perceived as important skills required to teach mathematics successfully in the current study. However, experience does not necessarily mean that newly appointed teachers cannot teach mathematics. From the teachers' responses, it is evident that they have experience in teaching mathematics ranging from one to thirty years. The teacher with the least teaching experience, Nathaniel, stated that, "I only have one year teaching mathematics in Grade 9, started last year". Paul, being the most experienced teacher, responded that, "I am having quite a number of years' experience, about 30 years teaching mathematics at Grade 9". Teachers' cumulative experience was found to be positively and significantly associated with learners' higher educational degree of attainment (Lee & Lee, 2020). However, management experience is also of great importance in the functioning of schools and also relates to pedagogical content knowledge. The next section discussed the management experience of principals.

Sub-theme 1.3: Management Experience

This category investigated the management experience in high schools of the principals. Kellerman (2015) stated that school principalship had become a high wire act that only the most skilled and experienced individuals are able to perform their managerial functions successfully. According to Mestry (2017), principals experience difficulty coping with changes, partly due to lacking the necessary skills, knowledge and/or attitudes to lead and manage schools effectively or are inadequately prepared for taking up a leadership position. The principals' responses showed that the majority of the principals have a wealth of management experience; for example, Prudence, Donaldson and Thomas (all principals) mentioned that they had over 20 years, 15 years and 8 years of experience in a principal position, respectively. There is an average of eleven years of management experience for all the principals. There were only two newly appointed principals with little to no managerial experience. Accordingly, one newly appointed principal, Norman, revealed that:

> I have 17 years of experience in teaching and only two months of management experience as I am new in this school.

Principals' management experience plays a key role in the day-to-day running of schools. Skills development workshops or training plays a role in upskilling both principals and teachers to ensure that T&L take place successfully and is discussed next.

Sub-theme 1.4: Skills Development Workshops/Training

Recent studies have highlighted the importance of educators continually being involved in professional development programmes (Cleary et al., 2022; Heppt et al., 2022; Liu, 2022). Skills development through workshops in South Africa is seen as an important strategy towards improving school quality output (Naidoo & Mestry, 2019). The DBE continues to up-skill principals and teachers through workshops. These workshops attempt to provide support to both principals and teachers and the health of the education system to improve learner performance. Therefore, principals need to attend skills development workshops and cluster meetings organised by the DBE and other education stakeholders. Only two principals attended such workshops and cluster meetings. Donaldson, a principal, explained that:

> There are a lot of development workshops that has been taking place that I took part in that also made me to be a very good and effective mathematics teacher.

Norman, supported the above with the following explanation:

> I attended the workshop in terms of improving the curriculum delivery in terms of teaching and learning. We will then have our cluster meetings as well to share the content and the difficult sections that we are encountering.

The responses suggest that the DBE organise workshops and cluster meetings through the local education district offices. All twelve teachers attended workshops organised by the DBE and other education stakeholders. Floyd, a teacher, stated that:

> Each and every year there is this SSIP [Secondary School Improvement Plan] training whereby we are trained on how to best teach mathematics concepts for better understanding of learners.

This response suggests that there are other skills development workshops or training to improve teachers' professional practice and improve learners' mathematics achievement. Some of the teachers' narratives follow. Nancy responded, "I've been attending mathematics workshops which were very helpful in terms of skill development. I do have the experience in teaching mathematics through the workshops that I am attending". Lisa, teaching at a different school, responded:

> I have attended the NCS [National Curriculum Statement], and the CAPS [Curriculum Assessment Policy Statement] workshops. I've attended smartboard workshops.

From the information above, it is clear that all teachers have attended some training or professional development programmes and feel that they have benefitted from it; however, only two of the six principals indicated attendance of workshops or professional development programmes. Something should be done to increase this number, as Naidoo and Mestry (2019) pointed out that it is critical that South African principals continually enhance their skills by attending workshops or professional development programmes.

Theme 2: Resources used in Mathematics T&L

Principals and teachers were asked about the tools available to ensure that T&L of mathematics takes place effectively. They were also asked about the stakeholders responsible for the supply of T&L resources. It was evident that there was a vast difference in terms of resources available amongst the sampled schools used to teach mathematics. The theme is grouped into two sub-themes, namely lack of T&L resources and responsibility of supplying resources.

Sub-theme 2.1: Lack of T&L Resources

Khechane et al. (2020) indicated that one of the challenges encountered with mathematics teachers' assessment practices in the context of the new integrated primary curriculum was a shortage of

resources. Leanne, a principal, raised a concern about the shortage of mathematics teachers and the recruitment drive of such scarce human resources by stating that:

> The way we are having challenges with human resource replacement in mathematics department; it is as if one is not winning.

The narration suggests that mathematics teachers were recruited through promotional positions offered in other schools frequently, leaving the school with the huge task of replacing such teachers when they leave the school. Donaldson, also a principal, provided the following explanation regarding resource use:

> We use a lot of the interactive whiteboard in terms of the smartboard, the charts. And the textbooks that the learners are using. There are other mathematics programs that we are also using that the National Department of Education is offering. The use of the Wi-Fi that we have in the school, majority of our learners, they are using tablets.

Adequate and relevant teaching resources give room for effective and efficient T&L of mathematics (Okori & Jerry, 2017). The teachers were asked the same question as the principals about the tools they use to ensure that mathematics T&L take place in the classroom. The responses showed that there are schools whose learners are sharing textbooks to this date. As a major conveyor of the curriculum, research has shown that textbooks play a dominant role in the education system across different school subjects, including mathematics (Lee & Zuilkowski, 2015; Madusise, 2020). Therefore, a shortage of textbooks will negatively influence mathematics learner achievement. One teacher, Teshia, reported that:

> Learners do have textbooks; however, our textbooks are not enough, and some of the learners are sharing the textbooks.

What was distressing was the revelation that the Department of Basic Education's learner handbook use in Grade 9 was described as inconsistent, confusing, and lacking logic. In contrast, others stated that it simplifies things. Lisa from another school explained the problems as, "We have Department of Basic Education learner handbooks, we are using it, but that book confuses learners because it brings so many skills in one page. It's not written properly that book." In support of this problem, Nancy, a teacher teaching at a different school, explained that:

> We use the textbooks, they [learners] have a mathematics textbook. We are using Export and what is called Department of Basic Education handbooks, but I feel like it's limiting our learners because, for each and every topic, they are directed in detail of what is expected of them to do. Also, it's a barrier.

Textbooks are a fundamental resource for teachers and learners (Spaull, 2012). Given the poor mathematics learner achievement in South Africa, learners should be provided with textbooks appropriate for advancing and improving their educational objectives. The next category discusses the stakeholders responsible for the supply of T&L resources.

Sub-theme 2.2: Responsibility of Supplying Resource

According to the South African Schools Act 84 of 1996 (RSA, 1996), the DBE prescribes norms and standards for the provision of T&L support materials, included is the provision of stationery, textbooks, and electronic equipment, among others. The provincial departments of education are responsible for implementing the norms and standards and ensuring that all learners attending public schools have textbooks (RSA, 1996). District-based Support Teams are groups of departmental professionals whose responsibility is to promote inclusive education by distributing resources to schools (South African Council for Educators [SACE], 2021). Therefore, there was no question asked to either principals or teachers regarding who is responsible for the procurements of T&L materials. In Gauteng Province, South Africa, the GDE introduced the paperless classroom programme to convert traditional classrooms into smart classrooms where digital texts are used (GDE, 2015). The programme included the installation of smartboards and providing much-needed electricity, tablets loaded with textbooks and connectivity. However, Grade 8, 9 and 10 classrooms were not included to date in the roll-out; only Grades 11 and 12 classes received smartboards. From the teachers' responses

to the interview questions, the current study established an inconsistency or contradiction in the responses of two teachers from the same school teaching the same grade regarding resource availability. The following statements illustrate the inconsistency two teachers have at the same school. Floyd stated that, "We use smartboards", while Freddie, from the same school, provided the following statement, "We don't have smartboards at Grade 9 and only use an overhead projector". Despite the DBE's initiatives to provide all grades with smartboards, only Grades 11 and 12 received the smartboards. For Grade 9 mathematics teachers to use the smartboards, they need to make prior arrangements with either Grade 11 or 12 class teachers to use the classroom at a particular time since there are no smartboards in Grade 9 classrooms. These arrangements may affect time allocation for the planned lesson and might have a negative association with the T&L of mathematics. Accordingly, the practical implication of the skills and tools used in mathematics T&L requires exploration and is discussed next.

Theme 3: Practical Implication of Skills and Tools

It is crucial to assess the health of the education system through practical implications of skills and tools used to ensure T&L. Principals were asked to reflect on the effectiveness of the skills and tools available to ensure that mathematics T&L take place in the classrooms. It is important to note that principals share their knowledge and skills acquired through their formal education, skills development workshops/training and cluster meetings with their staff members to ensure effective delivery of the curriculum in the classrooms. Darling-Hammond et al. (2017) found that teacher collaboration and content-focused strategies are among other widely shared features of effective professional development. Similarly, Akiba and Liang (2016) found that teacher-centred collaborative activities to learn about mathematics T&L seem to be more effective in improving student mathematics achievement than learning activities that do not necessarily involve such teacher-centred collaborative opportunities. Teachers in the current study were asked to reflect on the effectiveness of the skills and tools available to ensure that mathematics T&L take place in the classrooms. The majority of teachers share their knowledge and skills acquired through their formal education, skills development workshops/training and cluster meetings to ensure the effective T&L of mathematics in schools. The theme is grouped into two sub-themes, namely, the practical applications of the acquired skills and the effectiveness of the skills and tools used.

Sub-theme 3.1: Practical Applications of the Acquired Skills

Mestry (2017) asserts that poor academic standards of learners in South African public schools are caused by the ineffective instructional leadership role of principals. Therefore, it takes skillful principals to accentuate their role as instructional leaders of the school by emphasising best teaching practices and keeping their schools focused on curriculum, T&L, and assessment to meet learner needs and enhance their achievement (Mestry, 2017). Interestingly, principals share their skills acquired through workshops, cluster meetings and their qualifications with their teachers. Prudence, a principal, stated that:

> I like to engage the departmental head and the teachers that are teaching the subject, just to give them some pointers that they can utilise because mathematics is about, just making sure that they understand those basic things.

Four of the six principals demonstrated the value of sharing skills. For example, Norman explained that, "You are going to be using code-switching, explaining other terminology, or explaining other content, so that they can achieve or able to assimilate the information that you are giving them". Similar to principals' responses, it was evident that teachers share their skills acquired through workshops/training or cluster meetings with one another to ensure effective T&L of mathematics in their schools. The following explanation is an account from Terrence, a teacher:

> When we meet in those workshops, we tend to brainstorm and find out what, if we are facing the same challenges in all schools. Some schools which have managed to go past the challenge and they share, and we try to implement that.

Cluster meetings aim to address challenges teachers might have regarding their subjects, share ideas and knowledge about the subject matter, and facilitate curriculum ownership by all teachers (Santos et

al., 2020). The local education district and school management teams are responsible for seeing that teachers have the opportunity to develop their teaching skills through skills development workshops or training, which may include subject cluster meetings. In confirmation to the importance of skills development through workshops and cluster meetings, Nancy, a teacher, stated that:

> Through the workshops, that's where I learned how to gather the ways of how to teach mathematics. I do have the experience in teaching mathematics through the workshops that I am attending.

A teacher at the same school reiterated that:

> All what we get on those meetings, we have to put it into practice when we go to class because it's all about sharing those ideas, then going to class, we have to implement those ideas on how we can take our learners through most of the topics. (Nathaniel)

Despite the crucial role that skills development plays in learners' educational outcomes, it is also of great importance to assess the effectiveness of the skills and tools used in mathematics T&L is discussed next.

Sub-theme 3.2: Effectiveness of the Skills and Tools Used

Principals and teachers are seen as the main stakeholders in the education of learners, and therefore, they may be regarded as the heart and soul of T&L in schools (Boon, 2018). Therefore, their role in the education system requires adequate skills and tools to ensure effective T&L in the classroom. Principals were asked about the effectiveness of the skills they acquired and the tools they used to ensure that T&L occur. It was worth noting that three of the six principals indicated that the skills and tools used effectively ensured the T&L of mathematics in schools. Donaldson, a principal, gave the following response:

> Actually, they are very more effective, because what we have seen happening, specifically with our school, we even find the mathematics been the subject that the learner is understanding it more than any other subject.

It is assuring that the skills and tools available are perceived to be effective in the T&L of mathematics. Such a level of effectiveness may be translated into improved mathematics learner achievement. Norman's response suggests that skills and tools used in mathematics T&L are not sufficient to improve learner achievement in schools as he stated that:

> The skills and tools are effective to some extent, to some other learners, they are effective, and especially for those who are self-motivated. I can say they are effective to a certain degree which maybe, can be 50%.

Teachers were also asked about the effectiveness of the skills they acquired, and tools used to ensure that T&L occurs. It is seen from the teachers' responses that only one teacher viewed the skills and tools used in teaching mathematics to be ineffective as Freddie replied that:

> In the short term, they seem to understand, but in the long term, I don't know what will happen. In the long run, they are not effective.

In contrast, five of the twelve teachers stated that the skills and tools used were effective but to a certain extent. Daphne responded positively that:

> I'm not going to say they're a 100% effective, because learners, we need to develop a model whereby learners become the learning agents by themselves, without even, if I'm not there tomorrow, they can be able to work.

A teacher teaching in a different school than Daphne also had a positive response:

> They are effective. I think it helps a lot. I once used a smartphone with learners. I think they learn more with pictures, listening, and because they love technology, these days, it interests them a lot when it comes to learning. (Lisbon)

It is clear from the teachers' reports that the skills and tools used to teach mathematics were effective but to a certain extent. Learners may perform poorly despite the skills and tools at their disposal if they don't become self-motivated and have a strong desire to achieve.

5. Discussion

We asked principals to share with us their qualifications, teaching experience, management experience and the skills, tools and resources they use to ensure that T&L of mathematics takes place. Our expectations were that principals are suitably qualified individuals with managerial experience and have the necessary skills and tools to ensure that T&L of mathematics takes place in schools effectively. This expectation is in line with Kellerman (2015), who asserts that school principalship has become a high-wire act that only the most skilled and experienced individuals are able to perform their managerial functions successfully. We found that all principals are suitably qualified individuals with qualifications ranging from higher education diploma to a Master's degree and that the majority of the principals have a wealth of management experience ranging from 10 years to 30 years (which is in line with the prerequisite for a principal position which is at least seven years of teaching). Even though South African researchers have urged South African principals to continually enhance their skills through structured continuing professional development programmes (Naidoo & Mestry, 2019), the minority of the principals attended workshops/training organised by their district office to upskill themselves. We asked principals about the tools available to ensure that T&L of mathematics takes place. We found a vast difference in terms of resources available amongst the sampled schools used to teach mathematics and that many schools had a shortage of resources. This shortage is in line with Khechane et al.'s (2020) findings that one of the challenges encountered with mathematics teachers' assessment practices in the context of the new integrated primary curriculum was a shortage of resources. In one of the six schools, we found that there is a challenge regarding mathematics recruitment. Mathematics teachers are leaving the school for greener pastures. This places a huge burden on the SMT to recruit new mathematics teachers every time they leave the school. It is important to note that principals share their knowledge and skills acquired through their formal education, skills development workshops/training and cluster meetings with their staff members to ensure that T&L of mathematics occurs effectively. It is assuring that three of the six principals perceived the skills and tools they used to be effective in the T&L of mathematics. Such a level of effectiveness may be translated into improved mathematics learner achievement. Meanwhile, three of the six principals perceived their skills and knowledge to be insufficient to improve mathematics learner achievement in schools. One principal stated that the skills and tools are only about 50% effective. We also asked teachers to share with us the skills and tools they use to ensure that T&L of mathematics takes place effectively. We found that eleven of the twelve teachers are qualified mathematics teachers, an expansion of Long and Wendt (2019)'s findings that suitably qualified mathematics teachers positively influence mathematics learner achievement. Only one teacher did not major in mathematics and therefore is not suitably qualified to teach the subject. We also found that the majority of the teachers have a wealth of teaching experience ranging from one to 30 years. The teacher with the least teaching experience (referring here to specifically teaching mathematics at the ninth-grade level) only had one teaching experience. It is interesting to note that all twelve teachers attended various workshops organised by the DBE and other education stakeholders. Such attendance of skills development is in line with Kleickmann et al. (2013), who showed that pedagogical content knowledge is a key component of teacher competence that affects learner progress. We asked teachers about the tools available to ensure that T&L of mathematics takes place effectively. According to Okori and Jerry (2017), adequate and relevant teaching resources give room for effective and efficient T&L of mathematics. It was, therefore, necessary to find out about the tools available for use to ensure mathematics T&L in their schools. We found that learners share a textbook in one of the six schools. In our view, such a shortage of textbooks might have a negative association with learners' mathematics achievement. It remains a concern that the mathematics handbook used in Grade 9 provided by DBE was described by teachers as being inconsistent, confusing, and lacking logic. Given the poor learners' mathematics achievement in South Africa (Isdale et al., 2017), learners should be provided with textbooks appropriate for advancing and improving their educational objectives.

It is worth noting that most teachers share their knowledge and skills acquired through their formal education, skills development workshops/training and cluster meetings to ensure the effective T&L of mathematics in schools. Such sharing of knowledge and skills is in agreement with Darling-Hammond et al. (2017), who found that teacher collaboration and content-focused strategies are among other widely shared features of effective professional development and might improve mathematics learner achievement. Moreover, we found that from the teachers' responses, only one teacher viewed the skills and tools used in teaching mathematics to be ineffective. The majority of teachers perceived their skills and tools used to ensure T&L to be effective, but to a certain extent. In our view, both principals' and teachers' skills and tools available for use to ensure the mathematics T&L are sufficient but to a lesser extent. Both (principals and teachers) need to attend pedagogical content knowledge workshops to upskill themselves. This view is in line with Phelps et al. (2016), who revealed that pedagogical content knowledge plays a crucial role in improving mathematics professional development.

In summation, the barriers encountered can be summarised as follows: Schools lacking enough T&L resources; teachers abandoning the profession, resulting in a scarcity of mathematics teachers; and the majority of principals not attending workshops or professional development programmes were identified as obstacles to effective mathematics T&L. Linking these findings to the conceptual framework:

(i) The socio-ecological model explains how a lack of resources as circumstances at various levels can be a barrier to successful mathematics instruction. Individually, teachers may lack the expertise or experience essential to teach mathematics successfully in the absence of suitable textbooks, tools, and technology. At the school level, the lack of resources may be indicative of greater resource limits or financial concerns that impede the school's capacity to offer the essential support and infrastructure for mathematics instruction. At the community level, concerns such as poverty and lack of access to resources can increase the difficulties schools confront in delivering an effective mathematics education. Nationally, government policies and financing decisions can influence the availability of resources for schools.

(ii) According to the socio-ecological model, the finding that teachers quitting the profession is a barrier to successful mathematics instruction reflects a variety of individual, contextual, and systemic reasons. Individual issues such as burnout, low job satisfaction, and restricted possibilities for career progression might contribute to teacher attrition. At the school level, a lack of support and professional development, tough student demographics, and inadequate compensation might have an effect on teacher retention. Social and economic issues, such as community opinions of the teaching profession and the availability of alternative career options, might influence teacher retention at the community level. Lastly, national policies and financing decisions on teacher training, compensation, and working conditions can affect teacher retention and attrition rates.

(iii) The socio-ecological model explains how principals not attending workshops or professional development programmes can be a barrier to successful mathematics instruction. At the individual level, principals may lack the time or motivation to attend professional development programmes. At the school level, insufficient resources or support for professional growth may contribute to low principal attendance rates. At community level, there may be a lack of community awareness or comprehension regarding the significance of continued professional development for teachers and principals. At national level, government policies and initiatives connected to professional development may influence the number of principals who participate in these programs.

5. Conclusions and recommendations

We found all principals to be suitably qualified with a wealth of management experience, and the majority of teachers are qualified mathematics teachers. The barriers found that impeded effective mathematics T&L from occurring were schools lacking adequate T&L resources, teachers leaving the profession, which result in a shortage of mathematics teachers and the fact that the majority of principals do not attend workshops or professional development programmes. As research has shown, we know that the benefits of access to adequate resources, having enough qualified teachers and

principals continually improving their skills are vast. From our findings, we recommend that the DBE encourage more teachers to specialise in mathematics as it appears that there is a shortage of mathematics teachers in high schools. We also recommend that the DBE allocate more funding toward allocating the necessary resources to schools where resources are lacking. Finally, stakeholders need to find ways to keep highly qualified mathematics teachers from leaving the teaching profession for greener pastures, as this pattern was evident in the current study.

References

Adebayo, K. A., Ntokozo, N., & Grace, N. Z. (2020). Availability of educational resources and student academic performances in South Africa. *Universal Journal of Educational Research*, *8*(8), 3768-3781.

Akiba, M., & Liang, G. (2016). Effects of teacher professional learning activities on student achievement growth. *The Journal of Educational Research*, *109*(1), 99-110. https://doi.org/10.1080/00220671.2014.924470

Asli, A., & Zsoldos-Marchis, I. (2021). Teaching applications of mathematics in other disciplines: Teachers' opinion and practice. *Acta Didactica Napocensia*, *14*(1), 142-150. https://doi.org/10.24193/adn.14.1.11

Black, P., & Wiliam, D. (2010). Inside the black box: Raising standards through classroom assessment. *Phi Delta Kappan*, *92*(1), 81-90. https://doi.org/10.1177%2F003172171009200119

Blum, J., Krishnan, N., & Legovini, A. (2010). *Expanding opportunities for South African youth through math and science: The impact of Dinaledi Program*. World Bank. http://hdl.handle.net/10986/19009

Boon, Z. S. L. (2018). *Singapore school principals: Leadership stories*. World Scientific Publishing Co.

Bronfenbrenner, U. (1977). Toward an experimental ecology of human development. *American Psychologist*, *32*(7), 513-531.

Center for Education Innovations. (n.d.). *Secondary school improvement plan*. https://www.educationinnovations.org/p/secondary-school-improvement-programme-ssip

Cleary, T. J., Kitsantas, A., Peters-Burton, E., Lui, A., McLeod, K., Slemp, J., & Zhang, X. (2022). Professional development in self-regulated learning: Shifts and variations in teacher outcomes and approaches to implementation. *Teaching and Teacher Education*, *111*, Art. #103619, 1-12. https://doi.org/10.1016/j.tate.2021.103619

Connelly, L. M. (2016). Trustworthiness in qualitative research. *Medsurg Nursing*, *25*(6), 435-437.

Cope, D. G. (2014). Methods and meanings: Credibility and trustworthiness of qualitative research. *Oncology Nursing Forum*, *41*(1), 302-308. https://dx.doi.org/10.1188/14.ONF.89-91

Darling-Hammond, L., Hyler, M. E., & Gardner, M. (2017). *Effective teacher professional development*. Learning Policy Institute.

Department of Basic Education. (2010). *The SACMEQ III project in South Africa: A study of the conditions of schooling and the quality of education*. Department of Basic Education. https://www.gov.za/sites/default/files/gcis_document/201409/saqmec-2010.pdf

Department of Basic Education. (2017). *The SACMEQ IV project in South Africa: A study of the conditions of schooling and the quality of education*. Department of Basic Education. http://www.sacmeq.org/sites/default/files/sacmeq/reports/sacmeq-iv/national-reports/sacmeq_iv_project_in_south_africa_report.pdf

Department of Basic Education. (2021). *Do you want to make a difference? Then become a teacher.* Department of Basic Education. https://www.education.gov.za/Informationfor/Teachers/InitialTeacherEducation.aspx

Dhuey, E., & Smith, J. (2018). How school principals influence student learning. *Empirical Economics, 54*, 851-882. https://doi.org/10.1007/s00181-017-1259-9

Dube, B., & Tsotetsi, C. (2020). The ambivalence of comradeship in the appointment of principals: A threat to the provision of quality education. *South African Journal of Education, 40*(2), Article #1733, S1-S10. https://doi.org/10.15700/saje.v40ns2a1733

Elçi, A. N. (2017). Students' attitudes towards mathematics and the impacts of mathematics teachers' approaches on it. *Acta Didactica Napocensia, 10*(2), 99-108.

Feng, L., & Sass, T. R. (2018). The impact of incentives to recruit and retain teachers in "hard-to-staff" subjects. *Journal of Policy Analysis and Management, 37*(1), 112-135.

Gauteng Department of Education. (2015). *Roll-out of paperless classrooms making good progress – Gauteng DoE*. Gauteng Department of Education. https://www.politicsweb.co.za/politics/rollout-of-paperless-classrooms-making-good-progre

Heppt, B., Henschel, S., Hardy, I., Hettmannsperger-Lippolt, R., Gabler, K., Sontag, C., Mannel, S., & Stanat, P. (2022). Professional development for language support in science classrooms: Evaluating effects for elementary school teachers. *Teaching and Teacher Education, 109*, Art. #103518, 1-14. https://doi.org/10.1016/j.tate.2021.103518

Isdale, K., Reddy, V., Juan, A., & Arends, F. (2017). *TIMSS 2015 Grade 5 national report: Understanding mathematics achievement amongst Grade 5 learners in South Africa: Nurturing green shoots.* Human Sciences Research Council. http://hdl.handle.net/20.500.11910/11847

Juan, A., & Visser, M. (2017). Home and school environmental determinants of science achievement of South African students. *South African Journal of Education, 37*(1), Art. #1292, 1-10. https://doi.org/10.15700/saje.v37n1a1292

Kellerman, B. (2015). *Hard times. Leadership in America.* Stanford University Press.

Khechane, N. C., Makara, M. C., & Rambuda, A. M. (2020). Primary mathematics teachers' assessment practices in the context of the integrated primary curriculum in Lesotho. *African Journal of Research in Mathematics, Science and Technology Education, 24*(1), 41-52.

Kilanowski, J. F. (2017). Breadth of the socio-ecological model. *Journal of Agromedicine, 22*(4), 295-297. https://doi.org/10.1080/1059924X.2017.1358971

Kivunja, C., & Kuyini, A. B. (2017). Understanding and applying research paradigms in educational contexts. *International Journal of Higher Education, 6*(5), 26-41. https://doi.org/10.5430/ijhe.v6n5p26

Kleickmann, T., Richter, D., Kunter, M., Elsner, J., Besser, M., Krauss, S., & Baumert, J. (2013). Teachers' content knowledge and pedagogical content knowledge: The role of structural differences in teacher education. *Journal of Teacher Education, 64*(1), 90-106.

Kyngäs, H., Kääriäinen, M., & Elo, S. (2020). The trustworthiness of content analysis. In H. Kyngäs, K. Mikkonen, &, M. Kääriäinen (Eds.), *The application of content analysis in nursing science research* (pp. 41-48). Springer.

Lee, J., & Zuilkowski, S. S. (2015). 'Making do': teachers' coping strategies for dealing with textbook shortages in urban Zambia. *Teaching and Teacher Education, 48*(1), 117-128.

Lee, S. W., & Lee, E. A. (2020). Teacher qualification matters: The association between cumulative teacher qualification and students' educational attainment. *International Journal of Educational Development, 77*, 1-10.

Liu, P. (2022). Understanding the roles of expert teacher workshops in building teachers' capacity in Shanghai turnaround primary schools: A teacher's perspective. *Teaching and Teacher Education, 110*, Art. #103574, 1-9. https://doi.org/10.1016/j.tate.2021.103574

Long, C., & Wendt, H. (2019). Trends in qualification of South African mathematics teachers: Findings from TIMSS 2003, 2011, 2015. *African Journal for Research in Mathematics, Science and Technology Education, 23*(3), 344-353. https://doi.org/10.1080/18117295.2019.1692475

Madusise, S. (2020). Affordances for connecting culture and mathematics: Moving from curriculum to school textbooks. *Educational Research and Reviews*, *15*(9), 564-574.

Makofane, M. P., & Maile, S. (2019). Factors influencing poor performance in Grade 12 mathematics: A case study of Bohlabela cluster of Limpopo. *World Journal of Educational Research*, *6*(1), 37-49.

Mestry, R. (2017). Empowering principals to lead and manage public schools effectively in the 21st century. *South African Journal of Education*, *37*(1), Art. #1334, 1-11.

Moloi, M., & Chetty, M. (2011). *Quality of primary school inputs in South Africa. Southern and Eastern Africa Consortium for Monitoring Educational Quality (SACMEQ) III: Policy brief number 2*. SACMEQ. Retrieved from http://www.sacmeq.org/?q=sacmeq-projects/sacmeq-iii/reports

Moloi, M., & Strauss, J. (2005). *The SACMEQ II project in South Africa: A study of the conditions of schooling and the quality of education*. Southern and Eastern Consortium for Monitoring Educational Quality. Retrieved from http://www.sacmeq.org/?q=sacmeq-projects/sacmeq-ii/reports

Naidoo, P. (2019). Perceptions of teachers and school management teams of the leadership roles of public school principals. *South African Journal of Education*, *39*(2), Art. #1534, 1-14. https://doi.org/10.15700/saje.v39n2a1534

Naidoo, P., & Mestry, R. (2019). Instructional leadership development for principals: A South African context. *Instructional Leadership and Leadership for Learning in Schools: Understanding Theories of Leading*, 237-265. https://doi.org/10.1007/978-3-030-23736-3_10

Nel, B., & Luneta, K. (2017). Mentoring as professional development intervention for mathematics teachers: A South African perspective. *Pythagoras*, *38*(1), Art. #a343, 1-9. https://doi.org/10.4102/pythagoras.v38i1.343

Nieuwenhuis, J. (2019). Qualitative research designs and data-gathering techniques. In K. Maree (Ed.), *First steps in research* (3rd ed., pp. 79-116). Van Schaik.

Okori, O. A., & Jerry, O. (2017). Improvisation and utilization of resources in the teaching and learning of science and mathematics in secondary schools in Cross River State. *Global Journal of Educational Research*, *16*(1), 21-28. http://dx.doi.org/10.4314/gjedr.v16i1.4

Olufsen, M., Karlsen, S., Sæleset, J., & Thorvaldsen, S. (2022). The impact of specialised content courses on student teaching in a Norwegian teacher education programme. *Education Inquiry*, *13*(3), 269-286. https://doi.org/10.1080/20004508.2021.1892908

Phelps, G., Kelcey, B., Jones, N., & Liu, S. (2016). Informing estimates of program effects for studies of mathematics professional development using teacher content knowledge outcomes. *Evaluation Review*, *40*(5), 383-409.

Polit, D. F., & Beck, C. T. (2018). *Essentials of nursing research: Appraising evidence for nursing practice* (9th ed.). Wolters Kluwer.

Popova, A., Evans, D. K., Breeding, M. E., & Arancibia, V. (2022). Teacher professional development around the world: The gap between evidence and practice. *The World Bank Research Observer*, *37*(1), 107-136. https://doi.org/10.1093/wbro/lkab006

Reddy, V., Winnaar, L., Juan, A., Arends, F., Harvey, J., Hannan, S., Namome, C., & Zulu, N. (2020a). *TIMSS 2019 highlights of South African Grade 5 results in mathematics and science*. Department of Basic Education. https://www.timss-sa.org/download/TIMSS-2019_Grade-5_HSRC_FinalReport.pdf

Reddy, V., Winnaar, L., Juan, A., Arends, F., Harvey, J., Hannan, S., Namome, C., Sekhejane, P., & Zulu, N. (2020b). *TIMSS 2019: Highlights of South African Grade 9 results in mathematics and science: Building achievement and bridging achievement gaps*. Department of Basic Education. http://www.hsrc.ac.za/uploads/pageContent/1044991/TIMSS%202019_Grade9_HSRC_FinalReport.pdf

Republic of South Africa. (1996). *South African Schools Act, Act 84 of 1996.* Government Printers. https://www.gov.za/sites/default/files/gcis_document/201409/act84of1996.pdf

Santos, F., Bean, C., Azevedo, N., Cardoso, A., Pereira, P., & Cruz, H. (2020). Moving from an implicit to an explicit approach of life skills development and transfer: The case of surfing in schools. *SAGE Open*, *10*(2), 1-10.

Scheerens, J. (2000). *Improving school effectiveness.* United Nations Educational, Scientific and Cultural Organization. International Institute for Educational Planning. https://ris.utwente.nl/ws/files/5154343/Improving-122424e.pdf

Shay, S. (2020, January 10). *Why South Africa's declining maths performance is a worry*. University of Cape Town News. http://www.news.uct.ac.za/features/teachingandlearning/-article/2020-01-10-why-south-africas-declining-maths-performance-is-a-worry

Shelton, J. L. (2020). *A study of perceived principal instructional leadership and its relationship to student achievement in private high schools* [Doctoral dissertation, Southeastern Louisiana University]. Southeastern Louisiana University Library Databases. http://www.southeastern.edu/library/databases/index.html

Shole, S. M. (2019). *Exploring factors that affect the attraction and retention of mathematics and physical sciences teachers at selected secondary schools, North West Province* [Doctoral dissertation, North-West University]. Boloka Institutional Repository. https://repository.nwu.ac.za/

Siyepu, S. (2013). The zone of proximal development in the learning of mathematics. *South African Journal of Education, 33*(2), Art. #714, 1-13.

Smith, T. J., Walker, D. A., Hsu, W.-Y., Lu, Y.-Y., Hong, Z.-R., & McKenna, C. M. (2022). Teacher characteristics as predictors of mathematics attitude and perceptions of engaged teaching among 12th grade advanced mathematics students in the US. *Education Inquiry*, *13*(3), 338-353. https://doi.org/10.1080/20004508.2021.1883910

South African Council for Educators. (2021). *Teachers' safety and security in South African schools: A handbook.* South African Council for Educators (SACE) and The Flemish Association for Development Cooperation and Technical Assistance (VVOB) Education for Development. https://www.sace.org.za/assets/documents/uploads/sace_16935-2021-05-06-SACE_Handbook_aw2-web%20-%20ISBN.pdf

Spaull, N. (2012). *Equity & efficiency in South African primary schools: A preliminary analysis of SACMEQ III South Africa* [Master's dissertation, Stellenbosch University]. Stellenbosch University Library and Information Services. http://scholar.sun.ac.za/handle/10019.1/20184

Vaismoradi, M., Turunen, H., & Bondas, T. (2013). Content analysis and thematic analysis: Implications for conducting a qualitative descriptive study. *Nursing & Health Sciences*, *15*(3), 398-405. https://doi.org/10.1111/nhs.12048

Visser, M., Juan, A., & Feza, N. (2015). Home and school resources as predictors of mathematics performance in South Africa. *South African Journal of Education, 35*(1), Art. #1010, 1-10.

Zuze, T. L., & Juan, A. (2020). School leadership and local learning contexts in South Africa. *Educational Management Administration and Leadership*, *48*(3), 459-477.

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Availability of data and materials

Transcriptions cannot be released due to the protection of the anonymity of the participants.

Competing interests

The authors declare that there are competing interests.