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Exploring strategies in mathematical proficiency in social sciences research

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ABSTRACT

Objective - This paper explores the mathematical proficiency espoused by Kilpatrick et al. to improve teacher and learner mathematics performance in South Africa. A mixed-method approach involving interviews and questionnaires was used.
Methodology/Technique – The sample included 7 principals or deputy principals, 7 departmental heads who supervised mathematics, 1 mathematics teacher who taught mathematics in grades 10 to 12, 1 mathematics teacher who taught Mathematics, and 1 learner from each grade 8 to 12 was included in the sample. Each participant was interviewed and had to complete a questionnaire.
Finding – Kilpatrick et al. (Kilpatrick, Swafford, & Findell, 2001), who viewed Mathematical Proficiency as a five-stranded process involving conceptual understanding, productive disposition, procedural fluency, strategic competence, and adaptive reasoning, were used as a lens through which this study was conducted. We discovered several systemic, societal, and pedagogical challenges that teachers and students faced, all of which had an impact on their Mathematics teaching and learning. Our findings were in line with what was found in the literature review. The researchers concluded that there were always intervention strategies that could help to reduce or eliminate the challenges that Mathematics teachers and students face.
Novelty –The researchers concluded there were always intervention strategies that could assist in minimizing or eradicating the challenges faced by the teachers and learners of mathematics, thus improving their socio-economic standing.
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1. Introduction

The performance of high school students in Mathematics has a direct link to a country's scientific and technological advancement. The student's ability in Mathematics and Sciences is critical to their social and economic well-being (Mahmood et al., 2012) (Reddy et al., 2015).

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According to the 2015 TIMMS report, the slow rate of change in the context conditions contributes to the country's levels of poverty and nature of inequality, and this rate of change is insufficient to meet the country's educational expectations and needs (Reddy et al., 2016). Reddy, et al. conclude in the 2019 TIMMS report that the rate of improvement in Mathematics has slowed (Reddy et al., 2020). The analysis of the Grade 12 National Senior Certificate Results from 2016 to 2019 of the high schools in the Phambela Circuit, revealed that learners' performances in Mathematics have had a negative impact on the overall pass rate of Grade 12 learners, within each high school, in the Phambela Circuit. Furthermore, parents expressed concern that the low Mathematics pass rate will prevent their children from enrolling in Mathematics and Science-related courses at institutions of higher learning. It is in this context, the researchers set out to investigate the status of teaching and learning of Mathematics in the Phambela Circuit and explore possible strategies that would assist to improve its teaching and learning.

2. Literature Review

The preliminary need of mathematical knowledge by individuals in society is fundamental for the success of any technological and economic development. According to Coombes, the old model of healthy teaching, which focused on assisting children and teachers in achieving academic success, has shifted to focusing on how students will achieve college and career readiness after high school (Coombes, 2013). He goes on to say that the goal is to be mathematically literate. As a result, we must educate students so that they can apply their mathematical knowledge later in life. The overarching goal of mathematics instruction is to help students improve their mathematical skills, which include the ability to understand, judge, do, and apply mathematics in a variety of situations, to mathematize the child's thinking, which necessitates consistency of thought, the pursuit of theories to logical conclusions, and the ability to deal with abstractions in their approach to problem solving (Jonsson et al., 2014) (Ramanujam, R., Sachdev, P. L., Subramanian, R., Bhattacharyya, A., Mukherjee, A., & Kumari, 2006). For this study we realised the need for a theory to guide us into exploring ways of improving both teacher and learner mathematics performance. With this in mind, we resorted to the theory of mathematical proficiency developed by (Kilpatrick, A., Swafford, J., & Findell, 2001).

(Kilpatrick, A., Swafford, J., & Findell, 2001) agree that no single word adequately expresses all aspects of mathematical skill, competence, understanding, and facility, so they coined the term mathematical proficiency to describe what they believe it takes for everyone to learn effectively.

Furthermore, according to (Kilpatrick, A., Swafford, J., & Findell, 2001), teaching for mathematical proficiency necessitates the following interrelated components: conceptual understanding of the core knowledge of Mathematics, students, and teaching activities required for teaching; procedural fluency in the execution of specific teaching routines; and strategic capacity to plan successful teaching and solve problems that arise during teaching. They add that teachers of Mathematics and learners offering Mathematics must justify and explain their practices through adaptive reasoning and reflection, as well as have a productive attitude toward teaching, learning, and the improvement of mathematical skills.

To begin with, successful math teachers create, demand, and use sound knowledge as a foundation for learning and responding to all of their students' mathematical needs (Anthony & Walshaw, 2009). According to research, teachers can only assist students in developing mathematically based understandings if they have extensive material and pedagogical skills (Bansilal et al., 2014) (Brijlall, 2009) (SRI, 2009). Teachers must have a thorough understanding of relevant content and how to teach it, as well as how to model and use examples to strengthen student thinking, objectively assess student solutions, and provide appropriate and constructive feedback (Anthony & Walshaw, 2009). (Allsopp et al., 2007) describes these characteristics et al. as the "What" and "How" of Mathematics practices (Anthony & Walshaw, 2009). Secondly, a teacher must not only possess this knowledge, but also apply it in the classroom when the opportunity arises. When the need arises, they must be able to adapt and change their teaching routine (Anthony & Walshaw, 2009) (SRI, 2009) (Kilpatrick, A., Swafford, J., & Findell, 2001)

Professional development in the wider educational community, such as working groups of supportive Mathematics colleagues, district teaching and learning services, and professional Mathematics organizations, helps teachers develop their knowledge (Anthony & Walshaw, 2009) (Grouws & Cebulla, 2000).

The knowledge that students bring to a new lesson has an impact on their understanding of new concepts (Anthony & Walshaw, 2009) (D'Ambrosio et al., 1990) (Ramanujam, R., Sachdev, P. L., Subramanian, R., Bhattacharyya, A., Mukherjee, A., & Kumari, 2006). Successful teachers should not dismiss such ideas as "wrong thinking", but rather as a natural and often required stage in a learner's conceptual development.

To learn mathematics, students must be arranged in three diverse ways. Primarily, they require time to think and work alone, away from the demands of the entire classroom. Second, students should work in pairs or small groups to share ideas and learn from one another. Third, they must be active participants in a purposeful whole-class discussion (Anthony & Walshaw, 2009) (D'Ambrosio et al., 1990). (Dhlamini & Mogari, 2013) (Grouws & Cebulla, 2000) (Sullivan, 2011) are of the opinion that low-achieving students should be taught using whole-class methods that accommodate their needs, regardless of whether classes are heterogeneously grouped, from the perspective of student confidence and school resources. When low-achieving students fall far behind, individual, or small group attention is recommended.

According to (Adler, 2002) (Anthony & Walshaw, 2009), "code switching," in which the teacher replaces a Mathematical term with a home language expression, phrase, or sentence, can help students understand the underlying context.

Silvernail and Buffington (Silvernail, D., & Buffington, 2009) conducted a randomized control study with 24 Maine school Mathematics teachers to assess the effect of a professional development curriculum based on incorporating one-to-one laptop technology into classroom teaching. According to the study, this type of professional development was found to be effective in improving the practice of teaching with technology, which in turn contributed to improved student success on standardized Mathematics tests.

ANA (discontinued), TIMMS, SACMEQ, and the Department of Basic Education's Grade 12 Senior Certificate Examinations have all been used to comment on the performance of South African learners in external assessments (D'Ambrosio et al., 1990) (MacCarthy, J., & Oliphant, 2013) (Reddy et al., 2020) (Smith et al., 1999) (Spaull, 2011). Internal teacher assessments, such as classroom questioning, quizzes, projects, investigations, informal and formal assessments, and how they can help improve Mathematics learning, receive less attention.

Teachers simply do not learn everything they need to know about mathematics in teacher training programs, such as how students learn mathematics and how to teach it effectively. As a result, teacher education is viewed as a continuous process, and teachers require a foundation for ongoing learning (Kilpatrick, A., Swafford, J., & Findell, 2001). Teachers, according to (Kilpatrick, A., Swafford, J., & Findell, 2001), must adapt to changing curriculum and new material. All successful professional development programs aim to help teachers better understand the mathematics they teach, how their students learn it, and how to support their learning (Kilpatrick, A., Swafford, J., & Findell, 2001).

Singapore's educational system provides each teacher with one hundred hours of professional development. This includes paid training leave, a modular approach to teacher training that allows teachers to upgrade their skills to various depths in various subjects, online learning to supplement face-to-face training, and formal recognition and accreditation of teachers for courses taken, thus connecting professional training to advanced degrees and higher salaries. South Africa's Staff Personnel Administrative Measure (PAM) document mandates that 80 hours be set aside for teacher professional development outside of the school day. These 80 hours include the implementation of agreed-upon policies within the school, such as the Integrated Quality Management System (IQMS, which includes Developmental Appraisal and Performance Management) as well as the Whole School Evaluation within the school and periodic content workshops conducted by the

Department of Basic Education in collaboration with Labour Teacher Unions, Labour Union meetings and conferences.

From 2017 to 2018, four high schools in the Phambela Circuit collaborated with the Joint Education Trust on the Mr. Price Foundation Programme. This program aimed to improve principals' school management skills, as well as teachers' content knowledge in Grade 11 Mathematics, Science, and Life Skills for students. To supplement content delivery, teachers were given access to online learning.

District officials (Circuit Managers and Teaching and Learning Service Personnel) have a special responsibility to prioritize teaching and learning and to provide leadership and management skills to principals, department heads, and students. They also use reliable data to determine which schools and students have a history of inferior performance across grades and subjects; which teachers and principals have had these students in common; and what other characteristics of these schools might help explain these outcomes.

The (Kilpatrick, A., Swafford, J., & Findell, 2001) model of the five strands of achieving 'Mathematical proficiency,' which is based on Vygotsky's theory of concept development, served as the foundation for exploring what possible teaching strategies could be recommended to improve learners' mathematics performance in the high schools in the Phambela Circuit.

3. Research Design and Methodology

In this study, the researchers adopted a mixed-mode approach. Both the researchers conducted interviews and questionnaires. During their visits to identified high schools, the researchers conducted interviews and then completed a questionnaire with the identified role players in the teaching and learning of Mathematic. The sample included seven principals or deputy principals, seven departmental heads that supervise Mathematics teaching and learning, fourteen teachers of Mathematics (one Mathematics teacher who teaches in grade 8 and/or 9 and one Mathematics teacher who teaches in grade 10 to 12) and thirty-five learners (one learner from each grade from 8 to 12) from each of the seven high schools in the Phambela Circuit. The entry age for a Grade 1 learner is 6 years. Researchers assumed that the age of learners in grades 8 and 9 would be between 13 to 16 and the ages of learners in grades 10 to 12 would be 15 to 20 years. Again, in the category of learners, purposive sampling was used as it the most cost-effective and time-saving method of sampling.

The population (See Table 1) for this research consisted of principals, deputy principals, departmental heads that supervise Mathematics teaching and learning, all teachers of Mathematics, and all grade 8 to 12 learners who offer Mathematics in the seven high schools in the Phambela Circuit. The researcher used intentional (purposive) sampling. In this analysis, the criteria of the chosen sample, are participation in management, supervision, teaching and/or learning of Mathematics in high schools in the Phambela Circuit.

(Smith et al., 1999) defines research designs as "plans that direct the arrangement of conditions for data collection and analysis in such a way as to combine significance for research purposes with economics". A research design is a timeline that specifies how the research will be carried out to answer the research questions.

Many academic researchers today agree that the scope of current educational problems in Mathematics education necessitates multifaceted study designs, some of which combine qualitative and quantitative approaches to explain educational practices in context and provide recommendations that can assist policymakers in making educational decisions (Hart et al., 2009). Socioeconomic conditions, cultural diversity, physical and human resources, language of learning and teaching, and the rurality of the area are just some of the contextual educational factors affecting learner Mathematics performance in the Phambela High Schools.

Learning mathematics with understanding is a complex process, according to (Hart et al., 2009), who argue that mixed-methods research is an appropriate response to calls for greater generalisation of results while maintaining sufficient detail on teaching and learning processes to be valid and useful. Five of the Phambela Circuit's seven high schools are deep rural, with the remaining two in the Ilembe District's semi-rural area.

Because time and travel distance posed a challenge to the researchers in this study, they chose to conduct interviews and

Researchers use research methods (instruments and/or techniques) when investigating or study, and it is the researchers' responsibility to select the most appropriate instrument for their study (Cohen et al., 2007). In this study, the researchers used a mixed-method approach that included an adapted sequential transformative technique. The key methods used in this mixed-method study were a combination of closed-ended and open-ended questionnaires, structured interviews, and a literature review. The information gathered through interviews and questionnaires supplemented one another, enhancing the data's quality and reliability. Most of the qualitative data was collected through interviews and observations, while the quantitative data was collected through questionnaires.

According to (Kumar, 2018), there may be times when data obtained by someone else and you must retrieve the details you require for your research (Cohen et al., 2007). Secondary tools were used to collect data in both qualitative and each interview was recorded using a digital audio recorder application on a smart phone and saved in folders labelled A to G for the seven schools. The researchers assigned interview with codes - AP (for principal/deputy principal), ADH (for Departmental Head), AFET (for a teacher offering Mathematics in grades 10 to 12, AGET (for a teacher offering Mathematics in grades 8 and 9). For learners, labels A8, A9, A10, A11, and A12 were used for each interview with learners offering Mathematics in grades 8 to 12.

The researchers in this study administered the questionnaire immediately after the interview and were able to explain (if necessary) any of the questionnaire's questions. The questionnaire's clarity was aided by questions being presented in both English (LOLT) and IsiZulu (IsiZulu) (Mother-tongue). The information gathered through interviews and questionnaires supplemented one another, enhancing the data's quality and reliability. Most of the qualitative data was collected through interviews and observations, while the quantitative data was collected through questionnaires.

4. Data Analysis

For the researchers, data analysis was an ongoing process that began with reading the literature about the study, determined the suitability of theoretical frameworks and methodology that would suit this study, and ended with the writing of the last chapter (Naicker, 2011). The researchers focussed on participants' context in relation to the phenomenon to extract categories, themes, patterns, and symmetries from the data from interviews (Cohen et al., 2007). Through the phases depicted in Table 2, the researchers presented a qualitative analysis of data from the interviews, followed by a quantitative analysis of the questionnaires.

4.1 Phase 1 (a) Interview Data Reduction, coding, and display

As shown in Table 3, the researchers decided to listen to each audio interview and convert each interview into a tabular form for each category of participants. The researcher was able to clean up the data because of this. During data reduction (describing, summarizing, and interpreting, to present a clearer picture), the researchers dealt with data from each interview question separately for each participant (Murray & Beglar, 2009).

Even though the researchers identified 63 people for this study, only 57 interviews and questionnaires were completed. On the day of the visit, two schools did not have a Department Head (DH), a third school's DH was on sick leave, two teachers were attending a workshop, and one learner was absent. The data from the fifty-seven interviews was examined and analysed. Instead of using the raw reduced data from interviews, the researcher used codes to represent what was going on in each response. Codes are one- or two-word concepts that describe what is going on in the data in a clear and concise manner (Hart et al., 2009).

With the use of Atlas.ti version 8, the researchers uploaded each interview's data reduction and codes were assigned to individual participants' responses (quotations). All the data from the interviews with principals/deputies, mathematics teachers, and students (one from each grade 8 to 12) was coded, and these codes were examined to see if they could be meaningfully grouped together (Smith et al., 1999). To look for patterns in the data, the codes were compared and analysed (Saldhana, 2009) and codes with similar themes were organized into Code Groups. Following that, the code group was depicted as a Network. A network is a Code group with expanded codes that correspond to original quotations associated with the data reduced document.

4.3 Phase 2(a): Qualitative data represented statistically

Figure 1 shows that Learner Attitude and Behaviour, Unawareness of the Effect of Annual Teaching Plans (ATP) and School Based Assessment (SBA) on Mathematics Learning, Shortage of Learner Support Materials (LTSM), and Language Barrier, Unawareness of the Teaching Mathematics for Understanding Framework, and Staffing problems are the major challenges supervision and monitoring of Mathematics, make up 45.2 percent (n=57) of the codes created to represent the quotations from the interviews. The most difficult aspect of improving Math performance is student behaviour. Teachers' attitudes are also cited as a source of concern by students. Even though most students expressed satisfaction with teacher lesson presentations, the lack of procedural fluency initiated by Mathematics teachers is highlighted.

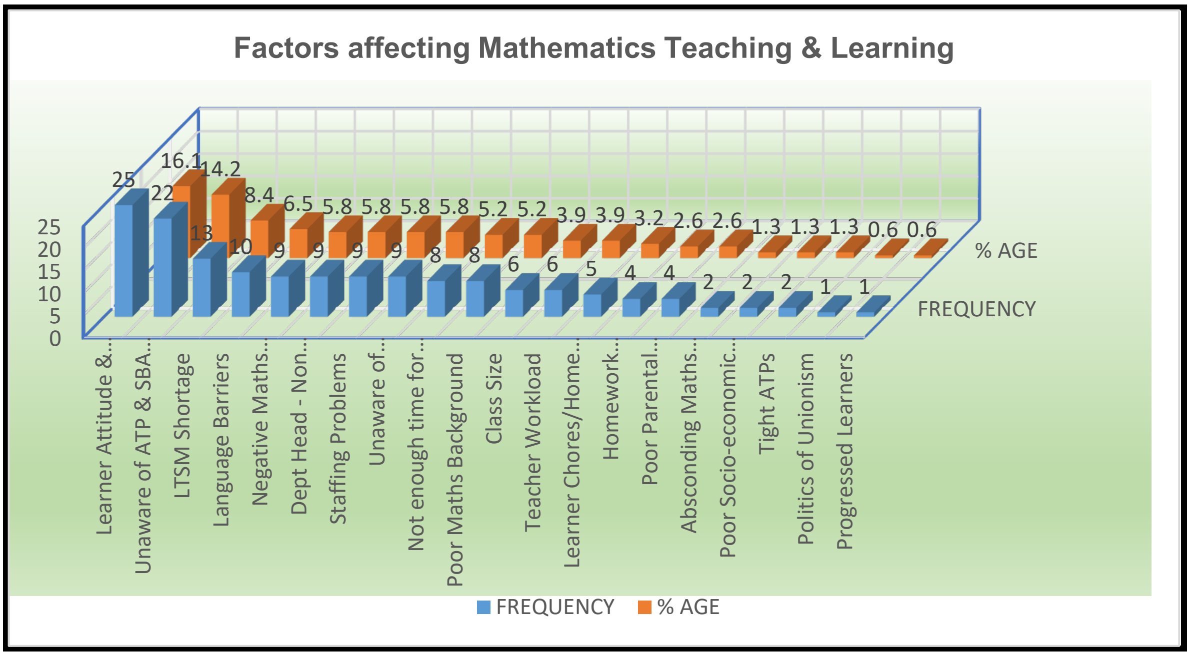

Figure 1: Factors affecting Mathematics Teaching & Learning

4.4Phase 1 (b) Quantitative (Questionnaire) Data Reduction

The researchers made use of SPSS Data editor.

Table 4 gives the overview of Principals' responses to the questionnaires.

Table 5 is the summary of responses from Departmental Heads who manage Mathematics teaching and learning in the Phambela High Schools.

Table 6 shows the summary of responses to the questionnaire from teachers of Mathematics.

Table 7 is the summary of responses to questionnaires from Learners offering Mathematics in Phambela High Schools.

4.5 Phase 2 (b) Translation of Quantitative data into narrative data and analysed qualitatively

The researchers then analysed the different questionnaire categories, which included Principals/Deputy Principals, Departmental Heads, Mathematics Teachers, and Mathematics Learners. A frequency descriptive statistic of all variables relating to the research questions was presented, as well as statistics for various variables in all categories of questionnaires.

The most difficult challenge to improving mathematics performance is learner behaviour. Teachers' attitudes are also cited as a source of concern by students. Although most students expressed satisfaction with teacher lesson presentations, the lack of procedural fluency initiated by Mathematics teachers is high-lighted. Most teachers believe that their students' poor mathematical backgrounds and language barriers contribute to them skipping Math classes. Class sizes in the GET phase contribute to misbehaviour by those who are uninterested in passing Mathematics.

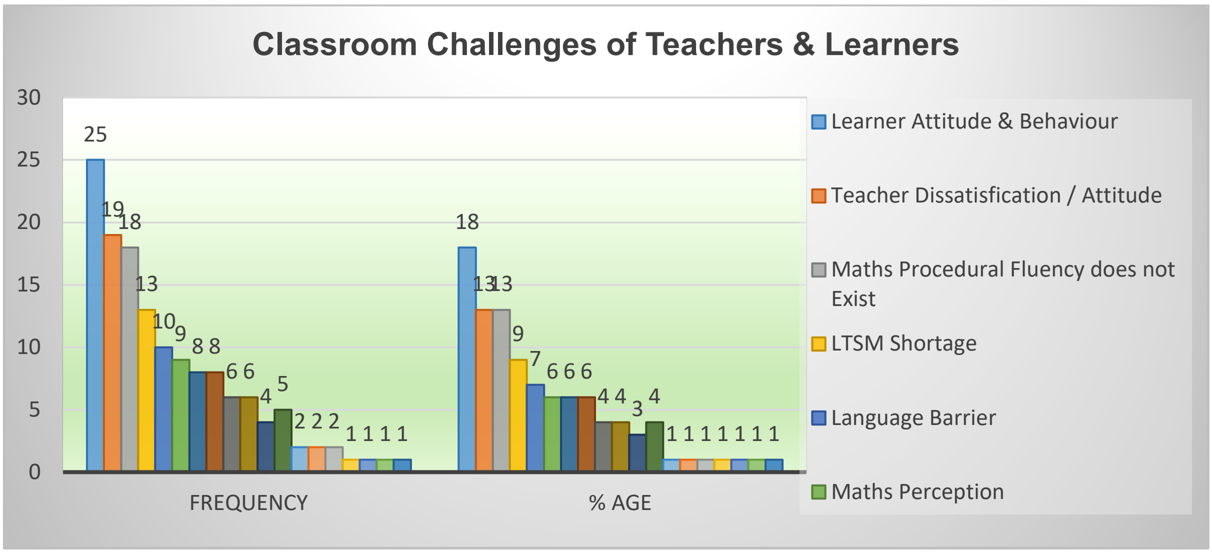

Figure 2. Classroom Challenges of Teachers & Learners

4.6 Phase 3 Correlation of interview data with questionnaire data

The researchers looked at the interview and questionnaire data (see appendix) to see if there was any evidence of a link between them. The following correlational themes from interview data and questionnaire data emerged:

a. Status of SMT Curriculum Monitoring and Supervision
b. School Management Teams Supervision and Monitoring Challenges
c. Non-inclined Mathematics School Management Teams
d. Submission of School Based Assessments by learners
e. Impact of Annual Teaching Plans (ATPs) and School Based Assessments (SBAs) on Mathematics Teaching and Learning
f. Mathematical Procedural Fluency. Exists or not?
g. Curriculum Support for Teachers and Learners
h. Parental Involvement & Cooperation.
i. Socio-economic status of learners' families.

4.7 Phase 4 Consolidation of Interview and Questionnaire Data

Aside from the aspects that indicated a link, the researchers combed through the remaining interview and questionnaire data for themes (see appendix) that were closely related to the study's research questions. Both sets of data's themes were combined. The following themes were identified:

a. Awareness of the Teaching Mathematics for Understanding Framework.
b. Learner Behaviour in the Mathematics classroom.
c. Poor Mathematics Background.
d. The language barrier.
e. Learners negative Mathematics perception.
f. Teacher’s use of Alternate Teaching Strategies.
g. LTSM Shortage.
h. Class sizes.
i. Staffing Problem.
j. Tight ATPs.
k. Non-governmental educational service providers.

4.8 Phase 5 Data Comparison

Nine themes emerged from the previously discussed data correlation, and eleven themes emerged from the consolidation of interview and questionnaire data. Learners were pleased with how their teachers’ delivered lessons. This is not consistent with teachers' responses to their students' behaviour and attitudes in mathematics classes. According to SMT members, learners often skipped math classes by learners. “Students are not present in the classroom during Math class. They despise mathematics.” “They are struggling in Math, as evidenced by their GET Maths results,” one principal stated. On the one hand, students claim to enjoy their teachers' lessons, but on the other, they refuse to exhibit acceptable classroom behaviour and attitude.

4.9 Phase 6 Data Integration

(Creswell, 2014) and (Bryman, 2006) both agree that the research questions drive the methodological choices. According to Bryman, “one of the most visible manifestations of the pragmatic approach to the issue of combining quantitative and qualitative research is the importance that is frequently assigned to the research question.” The researchers arranged the themes discussed thus far to address the research aims/questions after transforming, correlating, consolidating, and comparing the interview and questionnaire data. The researchers provide the following table (see Table 8) to demonstrate how data from both methods was integrated.

5. Results and Discussion

5.1 Learners’ Poor Mathematics background

According to this study, Phambela Circuit Mathematics teachers are unable to complete the respective grade ATPs because they spend extra time re-teaching fundamental Mathematical concepts that were taught in previous grades. Mathematics teachers should consider students with weak mathematical foundations to be in different zones of proximal development. Teachers must investigate various scaffolding options to get these students to complete the work on their own.

5.2 Learner Behaviour in the Mathematics Classroom

In the Mathematics classroom, poor learner behaviour, according to this study, poses the greatest challenge to teachers and interested students. To begin, the Math teacher must figure out what is causing the students' bad behaviour. Large class sizes, a lack of mathematics background, a negative attitude toward mathematics, peer pressure, insufficient LTSM, and the language barrier were all discovered in this study. Teachers of mathematics have concluded that disruptive behaviour causes students to avoid learning mathematics and to skip classes. The researchers suggest implementing collaborative and cooperative learning in small groups, as well as credit accumulation in exchange for rewards.

5.3 Learner awareness of ATPs and SBAs

The results of the study revealed that two-thirds of the students interviewed were unaware of the ATPs and SBAs documents, which contain the year's Mathematics topics, the time frame for completing the topics, and the school-based assessments (with dates) that will be used throughout the year. These documents should be condensed and distributed to all parents/learners at the start of each academic year.

5.4 Awareness of the Teaching Mathematics for Understanding Framework

This document outlines a change in thinking in the way mathematics is taught in schools soon. The document advocates for a conceptual approach to mathematics education. The researchers recommend that this document be updated to include more exemplars to help Math teachers implement conceptual approach lessons in their classrooms. The document should cover a variety of Math topics, with examples demonstrating how conceptual understanding, procedural fluency, strategic competence, and reasoning are interconnected and impact the learning-centred classroom.

5.5 Teacher preparedness for the Modern classroom

Math teachers, according to this study, used outdated teaching methods and strategies when delivering lessons. Lesson planning that was adapted to the learners' challenges was lacking in today's classrooms. Mathematics teaching methods today are not based on "stand and deliver" "chalk and talk" or "one size fits all" mentalities. It is all about getting to know your learners, their emotional and behavioural disorders, anxieties, and social challenges that they bring to the Math class. There is a need for collaboration and communication between mathematicians and teachers to figure out how to adapt teaching to modern learners with various learning styles. The researchers recommend the formation of high schools and higher institutions of learning, Mathematics PLCs to explore innovative ways of adapting teaching styles for the modern learner.

5.6 Alternate teaching techniques

Learners in this study complained that they were unable to complete classwork or homework without the assistance of the teacher. They argue that current inclusive classroom teaching styles and strategies do not meet the needs of all students. Another alternative teaching strategy is the 'Rotation Method.' According to the needs of the school, the rotation method entails the teacher moving with the class from one grade level to the next, such as from grade 10 to 12 or from grade 9 to 12. This method allows the teacher to identify students with learning disabilities as well as their preferred learning style. The researchers also recommend a 'Blended Teaching/Learning Strategy.' Blended teaching/learning occurs when a teacher provides instruction in both traditional "face to face" classroom interaction and computer-assisted online learning. At the time of writing this chapter, South Africa was under COVID-19 lockdown. Some teachers chose to work from home due to comorbidities. Teachers with technical knowledge of how to use the internet, email, and social networking chat groups such as WhatsApp, Facebook, Instagram, and Twitter to engage students in lessons found that using the internet, email, and social networking chat groups such as WhatsApp, Facebook, Instagram, and Twitter to engage students in lessons was extremely beneficial. The researchers recommend that the Department of

Education promote and fund CAPS Blended teaching and learning to improve learners' academic performance in Mathematics.

6. Conclusion

According to this study, Phambela Circuit Mathematics teachers are unable to complete the respective grade ATPs because they spend extra time re-teaching fundamental Mathematical concepts that were taught in previous grades. Mathematics teachers should consider students with weak mathematical foundations to be in different zones of proximal development. Teachers must investigate various scaffolding options to get these students to complete the work on their own.

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Appendix of Tables

Table 1

Population of high schools in the Phambela Circuit (2019) for this study.

Position	**HS A**	**HS B**	**HS C**	**HS D**	**HS E**	**HS F**	**HS G**	**Total**	
Principal/A Principal	1	1	1	1	1	1	1	**7**	**Learner Teacher Ratio**
Dep. Principal	1	1	1	1	1	1	2	**8**	
Dept. Head	1	1	1	1	1	1	1	**7**	
Grade 8&9 Math Teachers	4	1	2	2	1	2	3	**15**	
Grade 10,11&12 Maths Teachers	4	1	3	1	1	2	3	**15**	**119:1**
No. of Gr 8&9 Maths Learners	436	144	379	113	80	294	693	**2139**	

No. of Gr 10,11&12 Maths Learners	473	91	208	107	3	48	496	**1426**	**3565**

Source: Stanger Circuit Office

Table 2

Adapted Six Phases in the mixed-method data analysis process

Phase in the Mixed methods analysis of data process	**Application in qualitative data analysis using Atlas.ti**	**Application in the quantitative data analysis using SPSS**
Phase 1 (Data Reduction, capture, coding and display)	1(a) Qualitative data reduction, data capture, coding, charts, and diagrams	1(b) Data capture, data Display (descriptive stats, tables, and graphs)
Phase 2 (Data transformation)	2(a) Qualitative data is represented statistically	2(b) Quantitative data is translated into narrative data that can be analyzed qualitatively
Phase 3 (Correlation of Data)	Correlation between qualitative with quantitative data	
Phase 4 (Consolidation of Data)	Qualitative and quantitative data are combined.	
Phase 5 (Comparison of Data)	Qualitative and quantitative data are compared	
Phase 6 (Integration of Data)	Qualitative and quantitative data are integrated into a coherent whole (Final findings and discussions)	

Source: (Onweugbuzie & Combs, 2011)

Table 3

Data Reduction

Interview Question	**School A**	**School B**	**School C**	**School D**	**School E**	**School F**	**School G**
2. How does a Mathematics School Assessment Plan and an Annual	Aware of ATP and Assess Plan. Cover work before	Not aware of an ATP or Assessment Plan.	Has heard of ATP and Assess Plan. Wrote 1 Investigation, 1 Assign	Not aware of ATP and Assess Plan. Completed Test, Assign and	Is aware of ATP and Assess Plan. Completed Assign, March Test, Investigation.	Is aware of an Assess Plan and ATP. Is not aware of the SBAs	Helps me to break down my work and focus

Teaching Plan help you in your learning?	teacher learns. Brother a universit y student assists with problems outside school.		and March test Will study Calculus next.	Investigation . Does not know what is to be taught and tested, although teachers have given us the scope. The ATP will help to complete the work faster than the teacher. Attend extra classes at MLS Stg. He gave us tips on how to study.	Assess Plan keep me in alignment. ATP helps me to complete all topics	in the subsequen t terms. Is aware of the ATP showing all sections and weighting of sections.	on the topics that carry more marks

Table 4

Principals/Deputies – Statistics Summaries

Principals Summaries[a]									
No	Position	AgeGroup	Years_In_Service	Highest_Qualification	Subject_Specialisation	FrequencyMonDHs	SupMonChallenges	SBAMonitoring	LevelOfSupportDHTchrs
1	Principal	31-50	11-20	Diploma	Commerce	Once a Quarter	Moderate Challenges	Moderate Challenges	Average Support
2	Acting Principal	31-50	11-20	Degree	Languages	Once a Month	Many Challenges	Few Challenges	Little Support
3	Acting Principal	31-50	11-20	Degree	Languages	Once a Month	Many Challenges	Moderate Challenges	Average Support
4	Deputy Principal	20-30	8-10	Degree	Commerce	Once a Month	More than Moderate Challenges	Moderate Challenges	More than Average Support
5	Deputy Principal	31-50	21-30	Post Graduate	Humanities	Once a Month	Few Challenges	Moderate Challenges	No Support
6	Acting Principal	31-50	31+	Post Graduate	Languages	Once a Month	Moderate Challenges	Moderate Challenges	More than Average Support
7	Principal	31-50	31+	Diploma	Humanities	Once a Month	Few Challenges	More than Moderate Challenges	Average Support
Total	7	7	7	7	7	7	7	7	7
Mean	2.0000	1.8571	2.5714	2.0000	2.4286	2.1429	3.4286	3.0000	2.8571
Median	2.0000	2.0000	2.0000	2.0000	3.0000	2.0000	3.0000	3.0000	3.0000
Std. Deviation	0.81650	0.37796	1.13389	0.81650	1.39728	0.37796	1.27242	0.57735	1.06904

Table 5

Summary of Reponses from Departmental Heads

Departmental Heads - Case Summaries[a]										
	AgeGroup	YearsInServiceDoE	HighestProfQual	HighestMathsQual	NoYearsTeachMaths	HighestGradeTaught	FreqMon_Supervision	Mon_SupervsionChallenges	FreqMonitoringSBA	SupportLevelTeachers
1	50+	31+	Degree	Diploma	21+	Grade 12	Once a Month	Little Challenges	More than Four Times a year	High Level of Support
2	41-50	11-20	Post Graduate	None	0-5	Grade 8	Once a Month	Moderate Challenges	Four Times a Year	More than Average Support
3	41-50	31+	Diploma	Diploma	21+	Grade 12	Once a Month	Little Challenges	More than Four Times a year	High Level of Support
4	41-50	21-30	Diploma	None	0-5	Grade 12	Once a Month	Many Challenges	Three Times a Year	Average Support
Total	4	4	4	4	4	4	4	4	4	4
Mean	3.2500	3.2500	2.2500	3.5000	2.5000	4.0000	2.0000	3.0000	4.2500	4.2500
Median	3.0000	3.5000	2.5000	3.5000	2.5000	5.0000	2.0000	2.5000	4.5000	4.5000
Std. Deviation	0.50000	0.95743	0.95743	0.57735	1.73205	2.00000	0.00000	1.41421	0.95743	0.95743
Skew ness	2.000	-0.855	-0.855	0.000	0.000	-2.000		1.414	-0.855	-0.855

Table 6

Summary of Responses from Teachers of Mathematics

Case Summaries[a]															
	AgeGroup	YISDoE	HighProfQua	HighMathsQual	NoOfYearsTeachMaths	HighestGradeTaught	MotherTongue	LOLTMaths	ChallengesTeachMaths	ATPCompletion	LearnerUnderstanding	SBASubmission	DHSupport	TLSSupport	ParentalCooperation
1	26-40	0-10	Degree	Degree	6-10	Grade 11	IsiZulu	English & IsiZulu or English & IsiXhoza	More than Fair amount of Challenges	81 - 90%	25% of Learners Understand my Lesson	81 - 90%	Very Good Guidance & Support	Very Good Guidance & Support	Average Co-operation
2	26-40	0-10	Post Graduate	Degree	6-10	Grade 12	IsiZulu	English & IsiZulu or English & IsiXhoza	More than Fair amount of Challenges	76 - 80%	25% of Learners Understand my Lesson	51 - 75%	No Guidance & Support	More than Average Support	No Co-operation
3	41-50	0-10	Degree	Degree	0-5	Grade 9	IsiZulu	English & IsiZulu or English & IsiXhoza	More than Fair amount of Challenges	81 - 90%	50% of Learners Understand my Lesson	81 - 90%	Average Guidance & Support	Very Good Guidance & Support	Little Co-operation
4	26-40	0-10	Degree	Degree	0-5	Grade 12	IsiZulu	English & IsiZulu or English & IsiXhoza	Many Challenges	81 - 90%	50% of Learners Understand my Lesson	81 - 90%	Average Guidance & Support	Average Guidance & Support	Little Co-operation
5	18-25	0-10	Post Graduate	Degree	0-5	Grade 12	IsiZulu	English & IsiZulu or English & IsiXhoza	More than Fair amount of Challenges	81 - 90%	50% of Learners Understand my Lesson	51 - 75%	No Guidance & Support	No Guidance & Support	No Co-operation
6	26-40	0-10	Post Graduate	Post Graduate	0-5	Grade 10	IsiZulu	English & IsiZulu or English & IsiXhoza	Many Challenges	81 - 90%	50% of Learners Understand my Lesson	51 - 75%	No Guidance & Support	More than Average Support	No Co-operation
7	26-40	0-10	Degree	Degree	0-5	Grade 12	IsiZulu	English & IsiZulu or English & IsiXhoza	More than Fair amount of Challenges	100%	75% of Learners understand my Lesson	81 - 90%	Little Guidance & Support	More than Average Support	Satisfactory Co-operation
8	26-40	0-10	Post Graduate	Diploma	6-10	Grade 12	IsiZulu	English & IsiZulu or English & IsiXhoza	Fair Amount of Challenges	100%	25% of Learners Understand my Lesson	91 - 100%	More than Average Support	Very Good Guidance & Support	Average Co-operation
9	26-40	0-10	Degree	Degree	6-10	Grade 12	IsiZulu	English & IsiZulu or English & IsiXhoza	More than Fair amount of Challenges	100%	50% of Learners Understand my Lesson	81 - 90%	More than Average Support	Average Guidance & Support	Little Co-operation
10	26-40	11-20	Post Graduate	Degree	11-20	Grade 12	IsiZulu	English & IsiZulu or English & IsiXhoza	Little Challenges	100%	75% of Learners understand my Lesson	91 - 100%	More than Average Support	More than Average Support	Satisfactory Co-operation
11	26-40	0-10	Post Graduate	Post Graduate	0-5	Grade 11	IsiZulu	English	Fair Amount of Challenges	51 - 75%	50% of Learners Understand my Lesson	51 - 75%	More than Average Support	More than Average Support	Little Co-operation
12	41-50	11-20	Diploma	None	0-5	Grade 8	English	English	Many Challenges	81 - 90%	50% of Learners Understand my Lesson	76 - 80%	More than Average Support	More than Average Support	Little Co-operation
Total	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Mean	2.0833	1.1667	1.5833	2.0833	1.5000	4.0833	1.9167	4.3333	3.9167	4.0833	2.9167	4.4167	3.0000	3.8333	2.2500
Median	2.0000	1.0000	1.5000	2.0000	1.0000	5.0000	2.0000	5.0000	4.0000	4.0000	3.0000	5.0000	3.5000	4.0000	2.0000
Std. Deviation	0.51493	0.38925	0.66856	0.79296	0.67420	1.37895	0.28868	1.55700	0.90034	0.90034	0.66856	1.16450	1.41421	1.11464	1.05529
Skewness	0.211	2.055	0.735	1.152	1.068	-1.424	-3.464	-2.055	-0.712	-1.082	0.086	-0.174	-0.463	-1.505	0.522

Table 7

Summary of Responses from Learners

Statistics - Learners of Mathematics															
		Grade	Age Group	Mother Tongue	Mathematics Medium of Instruction	Lives With	Family Income	Luxury Access	Distance to School	Mode of Travel	Challenges in Maths Learning	Awareness of SBA & ATP Impact on Maths Learning	Teacher Assistance with Difficulties in Maths Learning	Learner Attempts to Solve Difficulties	Procedural Fluency Exists or Not
N	Valid	34	34	34	34	34	34	34	34	34	34	34	34	34	34
	Missing	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mean		2.971	4.941	1.941	4.176	2.147	2.176	4.235	2.471	2.235	2.971	1.765	1.853	2.529	1.765
Median		3.000	4.000	2.000	5.000	2.000	2.000	4.000	2.000	2.500	3.000	2.000	2.000	2.000	2.000
Std. Deviation		1.446	2.348	0.239	1.642	1.500	1.290	1.075	1.107	1.257	0.969	0.431	0.821	0.825	0.431
Skewness		0.054	0.568	-3.925	-1.523	1.279	1.090	-0.035	0.221	0.207	-0.151	-1.306	1.681	0.416	-1.306
Std. Error of Skewness		0.403	0.403	0.403	0.403	0.403	0.403	0.403	0.403	0.403	0.403	0.403	0.403	0.403	0.403
Percentiles	25	2.000	3.000	2.000	5.000	1.000	1.000	4.000	2.000	1.000	2.750	1.750	1.000	2.000	1.750
	50	3.000	4.000	2.000	5.000	2.000	2.000	4.000	2.000	2.500	3.000	2.000	2.000	2.000	2.000
	75	4.000	7.250	2.000	5.000	3.000	2.250	5.000	4.000	3.000	3.250	2.000	2.000	3.000	2.000

Table 8

Integration of interview data with questionnaire data

Overall Themes	**Sub-themes**	**Themes Identified**
Challenges that affect Mathematics teaching & learning in high schools in the Phambela Circuit	External Barriers	- Non-Math's inclined SMT - Parental Involvement & Cooperation - Socio-economic status of learner families - Poor Mathematics background - Language Barrier - Learner negative Mathematics perception - LTSM shortage - Class sizes - Staffing problem.
	Internal Barriers	- Impact of ATPs and SBAs on Mathematics teaching and learning. - Awareness of the Teaching Mathematics for Understanding Framework - Learner behaviour in the mathematics classroom - Tight ATPs.