

Research Article

Teachers' needs for instructional support at early number sense: analysis in terms of (lens) the concerned based model for teacher development

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Abstract

Early number sense requires teachers to have explicit knowledge and understanding to develop learners' skills and knowledge of early number sense. Early grade teachers play a critical role in ensuring learners develop appropriate number sense. The South African National Curriculum Statement allocated 65% of time towards teaching Numbers Operations and Relationship which forms the basis of number sense. Most South African teachers in the early grades are not mathematics specialists and are dependent on support from their school's head of department and the subject curriculum specialist from the district offices. This paper explored teachers' experience of the support they received from their head of department in the early grades and the curriculum specialist for the Foundation Phase. This study used the qualitative approach and Fuller's Concerned Based Model for Teacher Development as a theoretical lens to investigate the phenomena. This was a single case study research conducted at one school in the Gauteng Province with three Foundation Phase teachers, one head of department and one subject advisor. Findings revealed teachers understanding and knowledge of number sense and their ambivalent views regarding the support they received. All teachers concluded that the support they received from their department head and subject advisor were partially beneficial to them. They were very concerned with level and depth of the training provided to them. They were unhappy with the once-off short training. Teachers recommended they needed more intensive training on pedagogical content knowledge and content knowledge. Professional development training should be ongoing and that the network learning communities should be established in each district.

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Introduction

South Africa is one of the participants in the Trends in International Mathematics and Science Study (TIMSS) that assess learners' mathematics and science knowledge globally. The 2019 TIMSS results revealed that South Africa was one of the five lowest-performing countries in mathematics globally (Human Science Research Council [HSRC], 2020). The poor performance of South African learners is well documented in the Annual National assessments [ANA] (Department of Basic Education, 2011a) and the TIMSS. The TIMSS and the ANAs highlighted number sense as a significant problem experienced by most learners. The reasons cited for the poor performance is due to mathematical content knowledge and mathematics teaching practices (Morrison, 2013). Moloï and Chetty (2010) believe that to improve the mathematics performance of learners, there is a dire need to increase teachers' content knowledge through appropriate and effective mathematical support. This would raise the level of mathematics teaching and learning in South African classrooms. Table 1 below is an excerpt from the TIMSS 2019 result.

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Table 1.*Ranking of South Africa by 2019 TIMMS Mathematics Average Scores*

Country	Mathematics mean (SE)
Singapore	625(3.9)
Hong Kong SAR	602(3.3)
Korea, Rep. of	600(2.2)
Morocco	383(4.3)
Kuwait	383(4.7)
South Africa	374(3.6)
Pakistan	328(12.0)
Phillippines	297(6.4)

Source: TIMSS 2019. Highlights of South African Grade 5 Results in Mathematics and Science

The table is an excerpt from the TIMSS 2019 results which presents the top three countries which are all from East Asia, Singapore (with an average scale score of 625), Hong Kong (602) and Republic of Korea (600). The three countries with the lowest achievements were South Africa (374), Pakistan (328) and the Philippines (297), with the South African achievement score significantly higher than Pakistan and Philippines.

For this study, the author asked the question: *How are foundation phase mathematics teachers supported to raise mathematic teaching and learning levels, especially number sense?* The DBE has developed *the National Policy Framework for Teacher Education and Development in South Africa* (DBE, 2006). According to this policy, teacher education in South Africa is designed to develop a teaching profession that is ready and competent to cater for the South Africa's population. This policy highlights the need for continuing professional training and development, and it emphasises conceptual and content knowledge and gives prominence to pedagogical knowledge for effective teaching and learning. Despite the DBE's vision for teacher development, the level of support teachers receive in teaching number sense has met with ambivalence. This qualitative study explored teachers' experiences in the foundation phase who are responsible for teaching early numeracy skills. It also explored the kinds of support they (teachers) received from the various stakeholders: heads of department and the curriculum subject advisor.

Number Sense in the Foundation phase

Early numeracy skills are critical and relevant for learners' mathematical development at school, especially in the early grades when much mathematics learning relies on early numeracy competencies and understanding. Early number sense includes learned skills that involve explicit number knowledge. Number sense is defined as a learner's general understanding of numbers, operations and relationships (Department of Basic Education, 2011b). Van de Walle, Karp and Bay-Williams (2015) describe number sense as a complex phenomenon – an individual's skill to use, recognise and manipulate numbers by understanding and knowing their relative values.

Early grade teachers play a crucial role in strengthening young learners' knowledge and understanding of number sense; however, most teachers experience various challenges in teaching early number sense within the South African context. According to Whitacre, Henning and Atabas (2017:205), early number sense includes “learned skills that involve explicit number knowledge, such as counting items, using number words and comparing numbers represented symbolically as a numeral.” In the last ten years, there has been much emphasis on developing appropriate early numeracy skills and their relevance for later mathematics learning. To support and improve mathematical knowledge and skills the DBE's (2011b) National Curriculum Statements [NCS]: Curriculum and Assessment Policy Statement [CAPS]: Mathematics Foundation Phase ensure that the mathematics curriculum covers five content areas. The table below highlights the content areas and the weighting of each area for each grade in the Foundation Phase.

Table 2.*Weighting of Mathematics Content Area in Foundation Phase*

Weighting and Content Areas	Grades		
	Grade 1	Grade 2	Grade 3
Numbers, Operations and Relationships	65%	60%	58%
Patterns, Functions and Algebra	10%	10%	10%
Space and Shape (Geometry)	11%	13%	13%
Measurement	9%	12%	14%
Data Handling (Statistics)	5%	5%	5%
Total	100%	100%	100%

Source: DBE (2011b) CAPS

The policy stresses that in the early grades, it is of great importance that the content area Numbers, Operations and Relationships (of which number sense is embedded) is the main focus of mathematics. All learners must leave the Foundation Phase with appropriate knowledge and understanding of number sense and its operational fluency. The policy expects all learners to be competent and confident with numbers and calculations. For this reason, there is an increase in the notional time allocated to Numbers, Operations and Relationships in comparison to the remaining four content areas (DBE, 2011b:10).

Unfortunately, many children across the country do not have ample opportunities to learn and practice early numeracy skills in an acceptable manner (Aunio, Mononen, Ragpot & Tormanen, 2016) due to various reasons. Venkat and Spaul (2015) believe that the poor performance in mathematics among South African learners is due to teachers' mathematical competencies and knowledge. Other reasons cited for the poor performance can be related to professional teacher development, qualifications and the lack of ongoing support to teachers. Spaul and Kotze (2015) state that these were evident in the national and international assessment reports, which highlighted the reasons for the performance of many learners below the expected grade level in the first years of primary schooling.

Teachers Pedagogical Knowledge Content and Ongoing Professional Development

There has been much emphasis and recognition for the importance of teachers' mathematical subject knowledge. For good teaching and learning to occur, teachers must have sound pedagogical knowledge and subject matter knowledge. This knowledge impacts learners' learning and understanding of early number sense. Briand-Newman, Wong and Evan (2012) state that pedagogical content knowledge (PCK) has been acknowledged, accepted and recognised by researchers and practitioners as an essential factor for improving students knowledge, understanding and achievement. Shulman (1986, 1987) states that pedagogical content knowledge is the knowledge that is exclusive to teachers and is based on how teachers relate what they know about teaching (pedagogical knowledge) to what they know about what they teach (subject matter knowledge). Briand-Newman et al. (2012) state that Shulman's conceptual framework incorporates seven categories of teacher knowledge of education contexts, the purpose of education, content knowledge, curriculum knowledge and pedagogical content knowledge.

Research by Tsao and Lin (2012) found that many teachers exhibit weaknesses in mathematical understanding, incorrectly apply mathematical rules, lack knowledge of the true meaning of mathematical concepts, and are often unprepared to teach the mathematical subject matter given to them for which they are responsible. Venket and Spaul (2015) also identified similar findings among South African teachers, who found it challenging to identify the barriers experienced by learners and how to adapt their teaching to address these barriers. Kathirvello, Puteh and Matematik (2014) agree that PCK plays a significant role in the teaching and learning of early mathematics and classroom instruction. They agree with Briand-Newman et al. (2012) that PCK involves teachers' competencies in delivering conceptual approach, relational understanding and adaptative reasoning of the subject matter. It is vital that teachers possess the capacity to transform the knowledge to be taught to learners to be easily understood. To effectively teach number sense in the early grades, teachers must be skilled, knowledgeable and have deep insight into the subject matter. According to the DBE (2006) and the National Council of Teachers of Mathematics (2000), teachers must be professionally developed and capacitated to adapt the curriculum to teach mathematical concepts effectively. Effective teaching requires knowing and understanding mathematical content, which can happen through ongoing professional development.

Continuous professional development of teachers is viewed as an influential central factor for the efficiency of teaching and learning. Blomeke and Delaney, cited in Schwarz and Kaiser (2019), found a correlation between professional development and students' achievement. Teachers who attended ongoing professional development and support effectively adapted their teaching and learning to accommodate learners. Braseth (2021) argues that leadership plays a significant role in teacher learning. During the 'teacher learning process' (professional development), they found that mathematics teachers changed their focus from passive and reserved individual to more active involvement and collaboration in the practice-based development programmes.

For an effective change in the classroom environment, it is necessary to design a quality and focused teacher-professional development programme. These programmes should be well-planned and coordinated to ensure that teacher development is an ongoing process, rather than a once-off training. Pokhrel and Behera (2016) agree that teachers must become actively involved as their continuous growth depends on their efforts.

Theoretical Framework

A theoretical framework provides an overview of perspectives and research results regarding the proposed topic (Ferreira, 2012). Fuller's Concerned-Based Model of Teacher Development (CBMoTD) was used as a theoretical

framework for this paper. This framework provided the lens through which teachers' concerns are noted and acknowledged so that they can be supported to teach number sense in the early grades.

This model, developed by Fuller (1969), identifies three stages of teachers' concerns regarding teacher development. These are teachers concerns about the self – this reflects on their knowledge and understanding of number sense in the early grades; concerns about the task – this refers to their ability to transfer content and pedagogical knowledge to learners and finally, concerns about learners and the impact of their teacher – this refers to the effect of their PCK and CK in teaching learners about number sense for gain a deeper understanding of mathematical concepts.

Further clarification of the three stages are as follows: (i) *Self-concerns* summarise how teachers view themselves in their teaching and learning environment. A question that teachers often ask in this section is “*Do I know how to teach number sense in the early grades and do I have the experience to implement the CAPS curriculum?*” When teachers do not know how to implement and teach number sense concepts, it will negatively affect learners' acquisition of early numeracy skills and understanding, negatively impacting them as they go into the higher grades. The study aims to determine how teachers are supported by their heads of department and curriculum advisors to teach number sense concepts in the early grades effectively. (ii) *Tasks or situation concerns* focus on the everyday task and duties of a teacher (Veldsman, 2018). Questions that arise are “Am I equipped with sufficient knowledge and understanding to teach number sense in the early grades?”; “Do I understand the pedagogical content and subject matter knowledge?” and “*Did I plan this lesson consciously for success?*” The daily responsibilities should be set out in the planning through appropriate and ongoing support from the head of the department and curriculum subject advisor. (iii) *Concerns of impact on learners' learning* include teachers' abilities to support learners to reach their full potential (Fuller, 1969). Questions that could be asked are “*How can I support learners who experience a barrier to learning mathematics?* “ and “*Do I know how to support learners who experience challenges in the early number sense?* “

Fuller (1969) and Conway and Clark (2003) agree that these three stages should be viewed as a general movement that progresses from one stage to the next. Therefore, early grade teachers, head of department, and the curriculum subject advisor must have good content and pedagogical knowledge of the subject matter (number sense). According to Franey (2016) and Veldsman (2018), this model aims to identify and eliminate teachers' concerns regarding the successful implementation of the content area Numbers, Operations and Relationships.

To start with, the first focus is on the different phases of the concerns faced by teachers in teaching number sense in the early grades. Conway and Clark (2003) argue that researchers who implement the CBMoTD usually adopt this model to ensure that teachers are provided with the necessary support to ensure effective and efficient content delivery to learners. Since this study aimed to support teachers to effectively and successively teach number sense in the early grade, this model is appropriately suited for this study. According to Fuller (1969), this model can be seen as a successful theoretical model since it continuously engages with teachers to identify their needs to improve the quality of teaching and learning.

Research findings by Vermunt (2009) and Veldsman (2018) explained that teachers are more concerned regarding the lack of professional development and ongoing support to improve their teaching pedagogy. This framework provides an opportunity to build capacity amongst teachers to teach mathematical concepts with appropriate knowledge and confidence. This model creates the opportunity for teachers to be self-reflective and articulate their needs for ongoing support; reflect on how they are presenting their lessons in their classes and finally evaluating the effectiveness of their teaching and learning through the support they have received from their head of department or the curriculum subject advisor.

Aim and Problem of Study

The study's primary purpose was to explore the kinds of support early grade mathematics teachers receive from the heads of department and curriculum subject advisors in teaching early number sense and their knowledge and understanding of the phenomena. This study focused on Foundation Phase teachers in one district in the Gauteng Province in South Africa. The study was explored through the Concerned Based Model for Teacher Development (CBMoTD) lens. This model postulates that teacher development in early grade mathematics is crucial for quality teaching and learning, which impacts later mathematical success.

Methods

Research Model

It was agreed that the qualitative research method was most suitable for this study. It allowed for the description of the participant's responses, providing an in-depth analysis of the phenomenon using an interpretivist research

paradigm (Maree, 2017). The researcher opted for the descriptive design since it aims to accurately and systematically describe lived experiences of the support received and given to teachers by the head of department and curriculum subject advisor. Creswell (2014) states that descriptive research aims to answer what, where, when and how questions; and in this study the researcher asked the following questions: what kind of support did teachers receive; how often did they receive the support; what are the participants qualifications in mathematics, their knowledge and understanding of number sense.. Both the head of the department and the curriculum advisor were asked similar questions to that of teachers. The descriptive design allowed the researchers to gain a detailed account of the support teachers received to capacitate them to teach number sense in the early grades. A single case study approach was used; since the study focused on a particular phase and cohort of teachers in one district (Gustafsson, 2017).

Participants

The participants in this study consisted of three (3) teachers, one from Grade 1, 2 and 3 and the head of department from the same school. One (1) curriculum subject advisor was purposively selected from the Tshwane West district office since she was responsible for providing support to the teachers at the school. All the participants were from Tshwane West District in Gauteng Province. The participants were purposively selected with the following inclusion criteria: all teachers had to teach in the Foundation Phase in grades 1, 2 or 3. They had to be professionally qualified with a degree or diploma in Foundation Phase teaching; they must have experienced some support from both the HoD and subject advisor during their years of teaching and they had to have attended workshops organised by the subject advisor. The subject advisor had to be responsible for supporting the selected school. For the purpose of anonymity and confidentiality, Table 3 below indicated the codes used for each participant; for example T1-F refers to T- for Teachers; 1 – for Grade 1 and F – for Female.

Table 3.

Structures of Participants

Participant No	Gender	Age	Code
Teacher 1- Female - Gr1	F	42	T1-F
Teacher 2 – Female - Gr 2	F	40	T2-F
Teacher 3 – Female Gr 3	F	45	T3-F
Head of Department – Female Gr 3	F	48	H1-F
Subject Advisor – Female	F	47	SA1-F

Data Collection Tools

The researcher used a semi-structured open-ended interview schedule (Appendix 1) and document analysis as the data collection tool in this study. The researcher also analysed the following documents: teachers' planning files; DBE Rainbow workbooks, the Gauteng learner workbooks and the CAPS policy document.

Semi-structured Interview From

The researcher developed the semi-structured interview form. The semi-structured interview form collected asked questions about the kinds of support teachers received, their knowledge and understanding of number sense, their qualifications and frequency of the support. In developing the semi-structured interview schedule, the researcher followed the guidelines proposed by Maree (2017), that questions should be open-ended to allow participants the opportunity of sharing their lived experiences; use language that the participants can understand; avoid negative or leading questions and keep questions as short as possible. To ensure validity of the questionnaire, it was presented to two staff members in the Early Childhood Education department to critique and advise whether the questions were clear, concise and unambiguous. There were no serious modifications which indicated that the instrument was considered valid for the study (See Appendix 1).

Data Analysis

The researcher used Creswell's steps in data analysis. The data were transcribed and analysed. After that, the data was organised into sections. Patterns were identified in the information which was organised in themes (Creswell, 2012). These were shared in this study below.

Ethics

Ethics approval was granted by the ethics committee of the University of Pretoria and the Gauteng Department of Education. All participants were formally invited and signed the consent forms agreeing to participate in this study. They were informed of voluntary participation and were not obligated to remain throughout the study. All five participants consented to participate in the face-to-face interview. They were guaranteed anonymity and confidentiality

of their participation. They were informed that during the reporting phase, pseudonyms would be used. The table above presented the codes used in the findings section of the study.

Procedure

The researcher conducted one group interview of approximately 40 minutes with the three teachers and two individual interviews with the head of the department and the curriculum subject advisor. Separating the interviews allowed teachers to express their views confidently and without feeling intimidated by their head of department and the curriculum subject advisor. Teachers felt that they would not be comfortable and free to articulate their views in the presence of their senior managers. Interviews took place during April-May 2019 at the schools where the staff were employed. All interviews took place after school hours to prevent disrupting class time. The interview with the subject advisor was arranged and the researcher and the subject advisor met at the school.

Results

This study aimed to explore how Foundation Phase mathematics teachers were supported to raise the levels of mathematics teaching and learning of number sense. Emanating from the interviews, two (2) primary themes emerged:

- The importance and understanding of number sense in the early grades
- Teachers' views of the support received from the HoD and Subject Advisor

Verbatim quotes have been used in sections.

The Importance and Teacher's Understanding of Number Sense in the Early Grades

A young child's early experience and understanding of mathematics lay the foundation for later mathematical success. Mathematical knowledge and skills encourage learners to think logically, strategically, creatively and critically (DBE, 2011). Therefore, the importance of early number sense (mathematical knowledge and skills) cannot be overemphasised in the formative years. Many researchers argue that number sense is a significant construct that separates superficial understanding from subject mastery. With this information as background knowledge, the researcher posed the question to teachers, HOD and subject advisor on the importance of number sense and their understanding of number sense in the early grades.

All the participants T1F, T2F, T3F, H1F and SA1F agreed that early number sense is an important focus area of mathematics teaching. They indicated that without a sound understanding of number sense, learners will not be competent and confident in mathematics in later grades. They all agreed that if learners do not have a good foundation of early number sense, then these learners will always experience barriers in mathematics in higher grades. Number sense forms the basis of all mathematical teaching and learning. For these reasons, the CAPS document also mandate teachers to place much emphasis on early number sense.

T1F stated,

“As a grade 1 teacher, I place a lot of emphasis on teaching the understanding of basic numbers and their values. I emphasise rote counting at the beginning of the year and progress to rational counting. I believe this will lay a good foundation when my learners start to do computation.” T2F indicated, *“In my Grade 2 class, I spend more time on getting my learners to understand place value and computational skills apart from teaching them the normal counting and number value. Getting a good understanding of early numbers and their values will assist in problem solving activities.”* According to the Grade 3 teacher, she stated, *“In my class, I follow the CAPS curriculum very closely and teach every aspect – counting, computations skills; place value, properties of number and a host of other aspects as outlined in the CAPS curriculum. These are all important concepts that young children must understand and have deep knowledge.”*

Both the H1F and SA1F also shared similar views of teachers on the importance of early number sense in the foundation phase. They too agreed that learners would continuously be challenged with understanding mathematics without appropriate number sense during their early schooling. According to H1F, she stated, *“I have found many learners leaving the foundation phase without a strong understanding of number sense and basic computational skills. This creates many problems for both teachers and learners in the intermediate phase.”* SA1F shared her experience of learners understanding of number sense in the entire district. She stated

Number sense is the basis of all mathematical understanding. In my district and the schools that I visit, most learners struggle with number sense. This is evident in the national and international results. We must make sure that our learners understand number sense before they exit the foundation phase. As a subject advisor, I stress the importance to teachers to emphasise early number sense before moving into the next topic. The CAPS curriculum is explicit on weighing number sense in each grade, therefore teachers need to spend enough time teaching this topic.

From the findings and the participants' voices, there is evidence that all participants recognise and acknowledge the importance of early number sense in the foundation phase. They all agreed that without a sound foundational knowledge and understanding of the various conceptual and procedural knowledge of number sense, learners would often experience challenges in later grades. This is evidence of South African learners results in the national and international, where most learners experienced challenges with basic number sense.

There has been sufficient research done that focused on the mathematical performance of learners; however, less research has dealt with teachers' knowledge and understanding of number sense and its importance in the early grades. To effectively teach number sense in the early grades, teachers must have a sound knowledge of the content and pedagogy of number sense. The researcher asked the participants to explain their understanding of number sense and how they approached the teaching of number sense in the early grades. The responses varied from teachers to the HoD and the subject advisor to this question.

All participants T1F, T2F, T3F, H1F and SA1F agreed that number sense is an important focus area in the Curriculum and Assessment Policy Statement. To substantiate the importance of early number sense, participants stated that,

Without a sound knowledge of basic number sense in the early grades, children will struggle with mathematics concepts in later grades. We understand that every child must have good number sense before they exit the foundation phase, and it is mandatory in the CAPS policy document. As teachers, HoD and subject advisor, we have to monitor content coverage and the amount of time spent in teaching number sense in the early grades.

Added to the understanding of number sense, the grade 1 teacher T1F stated, "For Grade 1, CAPS has emphasised the importance of number sense. It is given the most weighting (65%) in comparison to Grades 2 (60%) and 58% in Grade 3. I believe that since young children are beginning to understand basic mathematical concepts, this is why Grade 1s have a high weighting. I place much emphasis on understanding of numbers, number names, number values and identification of numbers in Grade 1.

Both T2F and T3F stated that they approach their daily lessons with counting activities. Children are expected to counting forwards, backwards, skip counting, counting in multiples. They then begin with basic mental calculations and thereafter learners are given problem solving sums to do. All of this begins prior to the actual lesson for the day.

From the response, it is evident that teachers are aware of the importance of number sense in the early grades and their focus is on ensuring that learners have a sound understanding of basic number sense. From the evidence in the learners books and the teachers planning file, the researcher noted the different kinds of activities and strategies teachers have adopted to improve early number sense. The researcher also noted that learners were fully engaging with the DBE's Rainbow workbooks and the Gauteng learners workbooks. In teachers planning files there were evidence that the CAPS policy document was being followed very carefully and that teachers had a 'content coverage checklist' for each term.

To delve into teachers' understanding of number sense, the researcher probed further and asked teachers, the HoD and subject advisor if they had any qualifications in mathematics. He also asked if they knew what content was expected to be taught in each grade.

Regarding their qualifications in mathematics T1F, T2F and T3F stated that they did not have a 'pure mathematics qualification.' All three teachers stated that,

They completed a three year Diploma in Foundation Phase teaching during the apartheid era in South Africa. The quality of training they received cannot compare with the current university qualifications. Mathematics was a module in each year during their studies. Their highest qualification in mathematics was done in grade 9. At the teacher's college the focus of the mathematics curriculum was mainly on the 'how to teach' rather than understanding the content of mathematics.

According to T2F and T3F they stated that most of the content knowledge of mathematics teaching was gained through their own reading, research and workshops organised by the department of education. They agreed that there should be some advance programmes for foundation phase teachers to participate in where the focus is specifically on content knowledge.

Both the HoD and the subject advisors indicated that they were not qualified as mathematics specialist for the foundation phase. They have taught mathematics in the Intermediate Phase (Grades 4-6). The knowledge about the Foundation Phase was gained through years of experience and through participation in workshops and departmental training. Both the HoD and subject advisor do not have a qualification in the Foundation Phase. According to the subject advisor, she stated, "I applied for the Foundation Phase post in the district office, and I was surprised to have been appointed. I was informed that my appointment was due to the teaching experience I had in the Foundation Phase and my knowledge of mathematics."

The findings revealed above indicate that the support structure whom teachers depend on for growth, knowledge and development are not appropriately qualified for the phase. Although they may have some knowledge of mathematics, this knowledge is not phase appropriate. All the teachers, T1F, T2F and T3F agreed that the incorrect appointment of senior staff in leadership and support positions can seriously compromise the effective teaching and learning of mathematics in the foundation phase.

All participants T1F; T2F, T3F, H1F and SA1F were able to clearly articulate the content that has to be taught in each grade. They also indicated that the number range progresses from grade to grade for example, in grade 1, the number range is 50; grade 2 is 200 and grade 3 is 1000. There was evidence that teachers were using the CAPS document and were following the content guidelines carefully. All participants were able to highlight the eight teaching focus areas of number sense in the early grades, namely: Number concept development: count with whole numbers; Number concept development: represent with whole numbers; Number concept development: Describe, compare and order whole numbers; Number concept development: place value; Solve problems in context: problem-solving techniques; Addition and subtraction; Repeated addition leading to multiplication; Grouping and sharing leading to division; Sharing leading to fraction; Money and Context-free calculations.

Despite participants' knowledge of the content that has to be taught in early number sense, when the researcher asked the participant their understanding of how to teach each content, teachers' facial expressions and body language changed immediately.

T3F stated,

"I may know all the different aspects to teach, my biggest challenge is how to teach the content. My training at the Bantu teacher's training college of education did not equip me with the appropriate knowledge and skills to teach most of these concepts. I teach the way I was taught."

T1F response to this question,

I try to follow the Gauteng workbooks and the DBE Rainbow workbooks on how to teach sections such as decomposition and breaking down. This is the biggest challenge in my class. To make matters worse, I do not have the necessary resources in my class. I must admit I am struggling with breaking down methods for subtraction. The addition is easy, but subtraction is giving me many problems.

T1F shared her view,

In my grade 1 class, I don't know how to teach children with language barriers. I find it very difficult to teach my learners place values, number names, and numerical values. The CAPS curriculum does not provide ample time for me to spend teaching and consolidating these sections. Furthermore, we were trained during the apartheid years in inferior colleges and now we are teaching in the township and urban schools. Children are experiencing a significant problem with language and comprehensibility.

According to the HoD, she stated

We are forced to adapt the curriculum content, which is a big problem for me. I do not understand curriculum adaptation and accommodation as stipulated in White Paper 6 on Inclusive Education. For me, the biggest problem is teaching problem-solving mathematics, and I find there is a big difference between 'word sums' and 'problem-solving sum.'

Although all the participants have some knowledge and understanding of number sense in the foundation phase, teachers are experiencing challenges with the 'how to teach the content.' They may understand the importance of number sense; if teachers are not supported with a profound understanding of the pedagogy, they would either teach the way they were taught or will not teach specific topics.

Teachers' Views of Support Received from HoD and Subject Advisor

Continuous professional development is an integral part of ongoing teacher development. Several studies have highlighted the importance of continued professional development in mathematics. In this study, the researcher wanted to elicit teachers' views on the support they received to assist them in teaching number sense in the early grades.

All three teachers, T1F, T2F and T3F, indicated that they had received some support in the Foundation Phase. However, the support they received was very brief and short, focusing mainly on generic issues regarding mathematics teaching. They all stated that they met with the HoD at the beginning of each term and the discussion was usually based on content coverage for the term, assessments and supporting learners who experience challenges in mathematics.

In her response to support regarding number sense, T1F stated,

"As a grade 1 teacher, I would like my HoD to support me in how to teach certain concepts about number sense. This is not forthcoming from her. I have requested my HoD to help us with teaching for example, 'place value' through gaming in Grade 1. Most of the time, she would say that she would come back to us, but she does not." According to T3F, she stated: *"I have received very little support from my HoD regarding the teaching of calculations in my Grade 3 class. I have requested help regarding calculation strategies. My HoD referred me to some websites and YouTube videos. What I was looking for is a training working using different calculation strategies."*

T2F was the only teacher who indicated that she had received support from the HoD regarding the teaching of number sense. She said,

"Whenever I am struggling to teach a concept on number sense, I can go to my HoD and she is very helpful. I always show me how she has taught the concept for example 'decomposition strategy. This is one-on-one support that I received."

From the discussion above, it is evident that the level of support teachers receive at the school level seems to vary from person to person. Both T1F and T3F indicated that they do not receive the desired support from their HoD compared to T2F.

When the HoD was asked how she supports the teachers, she stated,

"I often meet and discuss mathematical issues every term with my teachers. Regarding specific mathematics teaching and learning, I often support teachers one-on-one, and I address specific problems with each teacher. When I don't know how to explain a certain content area, I always call the subject advisor and ask for her advice."

The HoD also stated that she often attends all mathematics workshops organised by the district or the provincial offices. She often shares this information with her teachers on her return to school on her return to school.

"I make sure that I share whatever information I get from the workshops at the province with my teachers. In this way, my teachers are aware of the expectations from the department of education."

According to teachers, although there is sharing of information with them from meetings, the needs of teachers are specific. According to the CAPS document, various strategies are provided to teachers to teach number sense. They need to understand how to use these classroom strategies, such as the use of base 10; geoboards; gaming in mathematics, dot cards, manipulatives, decomposition, subitising, number lines, and number facts. T1F said,

"I have heard of subitising, but I don't know how to teach this concept in my grade 1 class. I would prefer a workshop on subitising." T2F said, *"I have challenges to adapt the curriculum, yet White Paper 6 – Inclusive Education Policy, clearly states we must adapt our teaching and learning – I need support on how to adapt some of the topics and subtopics in number sense in my grade 2 class."*

Regarding the support from the Subject advisor, all the participants agreed that the subject advisor usually invites all teachers to their districts once or twice a year. They conduct workshops on number sense or other specific topics in mathematics. At these workshops, advisors try to train teachers on concepts for one or two hours. In most training, subject advisors often 'speed' through the content, and there is very little participation or engagement with the teachers. T1F said,

"The last training I attended on using number lines in mathematics, I did not get an opportunity of asking any questions. The handouts were given, the subject advisor presented the lesson, indicated to us to read certain sections of the handouts and referred us to the Power-Point presentation." T2F also had a similar experience. She stated that at the workshop on *"Number sense – developing by building number relationships"*, *the subject advisor also raced through the presentation; however, she gave us some excellent strategies such as number medley, five frames, using fingers, and making a two-more than and two-less than sets. These were helpful strategies, but we needed a deeper understanding of implementing them in the classroom."*

From the participants' views above, it is evident that participants are not receiving the desired support they require to teach number sense in the early grades.

Discussion

This study aimed to explore how teachers were supported to teach number sense in the early grades with a small sample of teachers, HoD and subject advisor in a district in Gauteng Province. The study also delved into teachers understanding of number sense and how they approach the teaching of number sense.

The findings revealed that all teachers had a good understanding of the concept of number sense. Their understanding aligns with [Van de Walle et al. \(2015\)](#), who state that number sense includes a person's ability to use and understand numbers by knowing their relative values and names. This view also concurs with explaining number sense in the CAPS policy ([DBE, 2011](#)), which states that number sense is more than just identifying and naming numbers. It is about gaining an in-depth knowledge of how numbers work together into a meaningful whole. The DBE further states that a sound understanding of number sense facilitates problem-solving, reasoning, and discussion around mathematical ideas.

Despite all participants having a good understanding of the content of the CAPS policy and the aspects that have to be taught under the topic Numbers Operations and Relationships, all participants indicated that they lacked the "how-to" part of teaching the concepts. There was evidence that teachers lacked knowledge and understanding of how to teach decomposition of numbers, how to introduce place value, number lines for computations, problem-solving, subitising and using games in mathematics.

According to [Pittalis, Pitta-Pantazi and Christou \(2015\)](#), all teachers should have a good understanding of how to teach the various aspects or subtopics of number sense. [McLellan \(2012\)](#) agrees and acknowledges that a sound knowledge and experience of number sense is fundamental for later mathematical abilities and competencies. From the evidence in this study, foundation phase teachers are challenged with teaching number sense concepts. This could be evidence of the low performance in mathematics in the national and international assessments. [Haylock \(2010\)](#) believes that effective learning of mathematics depends on a good understanding of early number sense ; therefore, it requires teachers who understand the curriculum and can explain the content and concepts at an age-appropriate level. The findings revealed in this study concur with the theoretical framework of this study CBMoTD, whereby teachers are concerned about their levels, knowledge and understanding of how to teach number sense in the foundation phase. This raises a significant issue for ongoing professional teacher development.

Regarding participants' views on the support they received to enhance their knowledge and understanding of the teaching of number sense, there is evidence that this support was not to their advantage. Although the HoD and subject advisor for mathematics offered some support to teachers, it is evident that teachers needed more than just a one or two-hour training session on basic concepts of number sense. According to [Briand-Newman et al. \(2012\)](#), professional development for teachers need to provide both theoretical knowledge and practical implementation of that knowledge in the classroom. On-going professional teacher development must focus on content knowledge and pedagogical content knowledge and that teachers should be supported from within the school (HoD) and external support (subject advisor and other relevant stakeholders) ([DBE, 2006](#)). [Bray \(2011\)](#) agrees that professional teacher development should focus on content-specific issues; in this study, the focus should be on the teaching of number sense, for example, the theory and practice of decomposition; insight into place value; subitising and the theory of number sense. Hill et al., cited in [Briand-Newman et al. \(2012\)](#), state that teachers knowledge of mathematics should contain both general and content-specific knowledge. Common content knowledge should include the use of correct mathematical terms and notations and be able to recognise when learners give incorrect answers. According to [Aunio et al. \(2016\)](#), if teachers are confident to use and teach various mathematics topics, there will be a significant improvement in learners understanding of mathematical concepts. Teachers' confidence level in mathematics directly depends on the kinds of support they receive to teach mathematics and their qualifications. [Briand-Newman et al. \(2012\)](#) have found agreement amongst teachers and other mathematics stakeholders that teachers need ongoing professional development to refine and revise their understanding of mathematics content to meet the many demands of teaching. For this reason, ongoing professional development for foundation phase mathematics teachers should focus both on the theoretical and practical application of mathematics in a classroom context. [The Education Alliance \(2006\)](#) agrees that if teachers do not have the appropriate content knowledge and if they lack understanding of mathematical concepts, there is a dire urgency to upgrade teachers pedagogical content knowledge.

Conclusion

In the Foundation Phase, the profound understanding of early number sense has been recognised as a fundamental section of mathematics. Every child needs to have a good understanding of number sense before leaving the Foundation Phase ([DBE, 2011](#)) to avoid any challenges or barriers in mathematics learning at a later stage in their

schooling. Several studies have confirmed the importance of early number sense and its association with later mathematical achievement. For these reasons, teachers' pedagogical content knowledge has been widely acknowledged as a significant factor for improving learners' knowledge, understanding and achievement in mathematics. Teachers need ongoing professional development rather than once-off training to ensure that they are kept abreast of the latest approaches to teaching specific content in an early number sense.

Recommendations

The author recommends the following strategies to improve support to foundation phase teachers. Teachers should participate in a further mathematics course that focuses on number sense and the strategy to strengthen the teaching of number sense content. Through continuous professional development, teachers should be capacitated to integrate number sense into mathematics teaching. The Department of Basic Education should collaborate and partner with the higher education institutions to develop an intensive training programme on early number sense and various approaches to teaching specific content. These in-service training programmes should be tailored to particular topics and contents outlined in the CAPS document. Another recommendation is to establish network learning communities where teachers can communicate with foundation phase teachers globally to share good practices. It is also recommended that teachers should be allowed to video record their teaching and critically examine and reflect on their practices – they could learn from their teaching and improve their strategies for future lessons. Teachers should also become involved in 'lesson study' an approach that has been very successful in Japan (Huang & Shimizu, 2016).

Recommendation for Further Research

Since this study was limited to one school in one district in the province, it is recommended that further studies of a similar nature be carried out with a larger sample of teachers in all districts in the province. The authors envisage findings dissimilar due to the professional qualification of heads of department and curriculum subject advisors.

Limitations of Study

The research was limited to a tiny sample in a single school in one district in the Gauteng Province in South Africa. The author believes that the findings may be similar in other districts since the national and international assessments have revealed poor mathematics results among South African learners.

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Appendix 1.*Semi-structured Interview Schedule***Questions to Teachers and Foundation Phase Department Head**

- Have you been trained to teach mathematics in the Foundation Phase?
- What is your highest qualifications in mathematics?
- Briefly explain your understanding of number sense.
- Explain your view of teaching number sense in the early grades.
- Describe the kinds of curriculum training you received from the Department of Education regarding mathematics in the Foundation Phase.
- Did you receive training and development specifically to teach number sense in the early grades?
- Explain the support you received from your head of department.
- Explain the support you received from the FP subject advisor regarding teaching of number sense?
- Describe kind of support do you require to strengthen your ability to teaching number sense in the early grades.
- How often do you attend workshops and training to teaching mathematics (number sense) in the Foundation Phase?

Department Head

- Have you been trained to teach mathematics in the Foundation Phase?
- Describe the kinds of curriculum training you received from the Department of Education regarding mathematics in the Foundation Phase.
- Did you receive training and development to teach number sense in the early grades?
- Explain the support you received from your head of department.
- Explain the support you received from the FP subject advisor regarding teaching of number sense?
- Describe kind of support do you require to strengthen your ability to teaching number sense in the early grades.
- How often do you organise workshops for the teachers in the Foundation Phase?

Curriculum Subject Advisor

- Have you been trained to teach mathematics in the Foundation Phase?
- Describe the kinds of curriculum training you received from the Department of Education regarding mathematics in the Foundation Phase.
- How long have you been a curriculum subject advisor?
- Did you receive training and development to support the teaching of mathematics in the early grades

