

AN INVESTIGATION INTO THE INTERVENTION STRATEGIES IMPLEMENTED BY EDUCATORS IN ENHANCING LEARNERS' UNDERSTANDING OF NUMBER SENSE

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ABSTRACT

Global and country-specific mathematics performance constitutes a major challenge, both for educators and policymakers. Realisation of the African Union Agenda 2013 hinges significantly upon transformation of education. In this regard, mathematics and science education, specifically, are instruments for scientific and technological development to position Africa on the same level as the global league of continents in the future. It is, therefore, important to develop amongst learners a good understanding of a mathematical concept such as number sense from an early age, given that students who have a good sense of numbers can manipulate figures to simplify calculations and have the confidence to approach problems in a variety of ways. It is for this reason that the present study investigates the intervention strategies implemented by educators in enhancing learners' understanding of number sense in the Ekurhuleni North District schools, Gauteng Province, South Africa. The study used a case study design and a qualitative research approach, both of which were supported by an interpretivist paradigm. The study made use of a semi-structured interview to gather data from mathematics teachers, learners, and a principal in the selected school. Research findings revealed that although mental computation, use of concrete props, use of the number line, and a counting strategy are some of the various strategies employed to enhance learners' understanding of number sense, teachers need to develop a sound understanding of number sense and be flexible in their approaches in order to assist learners. Based on the findings, it was recommended that curriculum designers and teachers concentrate on teaching methods to help students develop learners' number sense, as this can lead to potential mathematics success.

Keywords: intervention strategies, number sense, mathematics performance

INTRODUCTION

Nowadays, there is a lot of debate on how to instruct and learn mathematics, given that a skilled population is crucial in the present world (Askew, 2012). This indicates that literacy and numeracy abilities are a necessity for all people. For successful participation in all facets of contemporary society, a certain level of understanding of mathematics, science, and technology is required (Kilpatrick, 2014). Currently, more than 20 per cent of young people, globally, fail to reach a minimum level of skills in Mathematics. There is a focus on closing the educational gap for greater achievement or better performance (Hanushek, Peterson, Talpey, & Woessmann, 2010). Mathematical development calls for a creative teacher who uses

techniques to help students comprehend relevant ideas (Kilpatrick, 2014). According to Van de Walle, Karp, and Williams (2013), effective intervention measures should be implemented to close the achievement gap between disadvantaged and privileged students worldwide. To achieve this, it would be extremely beneficial to raise the standards for mathematics intervention through efficient intervention techniques in order for children to appreciate mathematics and for the failure rate to decrease (de Boer, Donker, & van der Werf, 2014).

Trends International Mathematics and Science Study (TIMSS, 2015) listed the mathematics sub-domains as number sense, number operations, fractions, ratio and percentages, measurement and geometry, and problem-solving based on the content of international curricula (Averett, Ferraro, Tang, Erberber, & Stearns, 2018). The use of a cooperative strategy when intervention is applied to learners on number recognition is one of the strategies (Rahman, Ahmar, & Rusli, 2016). Numerous research studies have also demonstrated that educators all around the world play a critical role in guaranteeing high-quality education for all students, regardless of where they live (Sayed & Kanjee, 2013; Olawale, 2022). As such, a reflective teacher who is a skilled practitioner and implementer of intervention strategies in all mathematics sub-domain issues is required in the classroom or learning environment of the twenty-first century (Danielson, 2011; Mncube & Olawale, Mncube & Hendricks, 2022). Therefore, given that number sense is one of these subdomain subjects in the worldwide curricula, a mathematics classroom requires a teacher who can investigate and successfully execute appropriate mathematics intervention strategies (Graven, Venkat, Westaway, & Tsheasane, 2013). Hence, the present study seeks to investigate the intervention strategies implemented by educators in enhancing learners' understanding of number sense in the Ekurhuleni North district in Gauteng Province, South Africa.

LITERATURE REVIEW

Existing Intervention Strategies in the Teaching and Learning of Number Sense

Learners experience a number of potential barriers to understand worded mathematical problems, for example, limited reading; decoding and comprehension skills; and inadequate understanding and proficiency regarding arithmetic combinations and mathematics operations. When deciding on the most appropriate intervention, it must be specifically suited to the individual learner, taking into account their developmental level and the necessary skills that they may or may not possess (Provasnik, et al., 2012). Landsberg (2019) emphasized using the five recommendations on successfully teaching those learners who are at risk of failing Mathematics. These are: "use instructional scaffolding (learning from known to unknown or concrete to abstract); high expectations for all learners; making instruction very motivational; extend learners' thinking and abilities beyond what they already know; and work at gaining advanced knowledge of learners and the subject matter" (Landsberg, 2019, p.9). These guidelines can be used by educators in the Ekurhuleni North

district as a way to improve mathematical teaching and intervention in the mathematics classroom. The use of better intervention strategies is called for in all educational centres.

'Thinking Together', a form of group work, was designed by Mekonnen (2017). This mathematics interventional teaching strategy is recommended by Sayed and Kanjee (2013). The said strategy, which was initially developed in the United Kingdom, is applied to the teaching of number sense in Mexican state primary schools. It was found that the normal practice of educators in the United Kingdom was more aligned with the mentioned strategy than in the Mexican schools (Sayed & Kanjee, 2013). However, observations indicate that primary school children do not readily engage in group work classroom activities, which may be caused by lack of skills necessary to manage their joint activity (Mekonnen, 2017). In addition, Ruthven and Hofmann (2013) note that at the elementary level, group discussions need to be controlled as they are time-consuming. When employing this practice of thinking together, learners are placed in groups according to their weaknesses in a specific concept (Sayed & Khanjee, 2013).

The RIDE strategy is employed to assist learners to remember the process involved in solving number sense problems and to increase their thinking ability (Muijs & Reynolds, 2017), especially for those who experience difficulties with abstract reasoning, paying attention and memorising. The acronym RIDE stands for: remember, identify, determine and enter; the strategy concludes with calculating and checking the answer (Bryman & Bell, 2015). Mullis, Martin, Foy and Hooper (2016) found that two-thirds (61 per cent) of South African learners do not display the minimum competency in mathematical knowledge and proficiency expected internationally at Grade 5 level. This phenomenon calls for the effective implementation of intervention strategies to uplift the standards in Mathematics in South African schools.

In an effort to address this problem in South Africa, the Stellenbosch University Centre of Pedagogy (SUNCEP), as propounded by Van de Walle, Karp, and Williams (2019), provide additional education to learners who have the potential to succeed academically but have trouble grasping particular topics. For learners who were chosen in cooperation with the Department of Basic Education, quality mathematics and physical science lessons are provided for students in all grade levels during breaks from classes or on weekends (Department of Basic Education, 2012).

Theoretical Framework: Constructivist Learning Theory

This study is informed by Vygotsky's (1980) Constructivist Learning Theory (VCLT). The theory has contributed to this study by presenting three main aspects, namely, social interaction (SI), the more knowledgeable other (MKO), and the zone of proximal development (ZPD). This theory is one of the foundations of constructivism, which contextualizes the zoning of learners in terms of how they understand concepts. Starting with the first concept, namely, social interaction, the application of mathematics intervention strategies requires greater cognitive development (Venter, 2012). Cognitive development is fundamentally influenced

by social interaction (Schunk, 2012). Hence, Vygotsky argued that better cognitive development in learners is achieved through social interaction. Considering the cultural development of the child, Vygotsky believes that every function thereof occurs twice: first, in the social sphere (inter psychological), and later, on the individual level (interpersonal). Furthermore, the psychology of mathematics education is to provide a theoretical account of learning that facilitates interventions in the systematic process of its teaching and learning (Venter, 2012). In the same manner, the social interaction acknowledges that both social processes and individual sense-making play a role in the learning of Mathematics.

Secondly, the more knowledgeable other refers to any person with a better level of comprehension than the learner, with regards to some tasks (McLead, 2023). Through MKO, mathematics learners are helped to master number sense by using those who have better understanding of this mathematical domain. Usually, the MKO would be an educator or parent involved in tutoring, straightforward instruction, self-monitoring and assisting in the use of technology (use of electronic tablets). It has been found that as learners became more knowledgeable, they became more eminent in the class and shared their knowledge more willingly with their colleagues (Tsanwani, Harding, Engelbrecht, & Maree, 2014). It is, therefore, the duty of the educator to use peer-learning as an effective strategy for intervention in number sense mastering.

Lastly, the zone of proximal development refers to a learner's ability to perform a task independently and under the guidance of an educator or with peer association. Vygotsky (1980) postulates that in the ZPD, learning takes place when a child follows an adult or peers' way of doing things in using numbers and slowly develops to do the task without assistance. McLeod (2023) believes that educators can close the gap between what a learner cannot perform individually and that which they can do without help if the more knowledgeable person is introduced quite early. Vygotsky focused on the links between people and the sociocultural context in which they act and interact in shared encounters (McLeod, 2023). Vygotsky (1980) maintains that the said connections are mediated by using tools that have developed from their culture, for example, mathematical number sense skills and number figures. He suggests that children develop these tools as social functions to communicate only their needs and that once they have internalized these tools, they begin to develop higher thinking skills (Vygotsky, 1980; McLead, 2023). Therefore, the constructivist learning theory (CLT) was found suitable for this study because it provides an in-depth understanding of how knowledge is constructed, which alters the practices in most South African schools where the traditional model of learning is being promoted through knowledge transferred from the educator (a transmissionist) (Greeno & Eggestrom, 2014). The theory also emphasizes that learners must play a key role during the learning process applied in contexts that are conducive to learning.

Statement of the problem

In South Africa, poor performance in Mathematics is a concern. This is demonstrated by the report that Naledi Pandor, a former minister of education provided (Department of Basic Education, 2012). According to Pandor, only 35% of South African children are able to read, write, and count, while the other 65% are falling behind. According to the 2013 Annual National Assessments (ANA), the average percentage of students passing each grade was 49% in Grade 3, 38% in Grade 6, and 13% in Grade 9 (Department of Basic Education, 2012). The trend is very noticeable that the higher up the earning streams, the less favourable the pass rate becomes. In today's highly advanced environment, having strong mathematics abilities is crucial (Brijlall, Bansilal, & Moore-Russo, 2012; Mncube & Olawale, 2019). According to Brijlall et al. (2012), educators' metacognition guides, plans, assesses, and reflects their instructional behavior, including the use of intervention measures. This could encourage understanding-based learning. In 2015, the TIMSS Numeracy made an assessment of Grades 4, 5 or 6 focusing on developing economies that are developing in mathematical skills. According to the TIMSS (2015), South Africa participated in Grade 5 assessment, and it was among the economies performing close to the centre point where between nine per cent and 16 per cent of learners performed below the 400 benchmarks (Mlachila & Moeletsi, 2019). It is argued that if learners experience challenges in Mathematics in the Foundation Phase, they are most likely to experience serious problems in Grade 12 at a later stage (Machaba, 2013). As such, the TIMSS (2015) recommended renewal of instructional methods in the classroom, including effective intervention strategies. Hence, the need for the study.

Research Question

What are the intervention strategies implemented by educators to enhance learners' understanding of number sense?

RESEARCH METHODOLOGY

Research Paradigm

According to Stringer (2014), research philosophy, also known as research paradigm, is a precondition for perception, a world view about how the universe is viewed and interpreted. As such, McMillan and Schumacher (2010) argue that different paradigms exist in research, which include the constructivist, positivist, and pragmatist paradigms. For the present study, an interpretivist paradigm was employed. According to Hammersley (2013), the interpretivist paradigm is based on the observation that methods for comprehending knowledge in the human and social sciences cannot be the same as those employed in the physical sciences because humans interpret their environment and act in accordance with that perception while the rest of the universe does not. The interpretivist paradigm was found suitable for the study because it appreciates the differences between the different participants in the study and allows for the use of various techniques to represent various facets of the phenomenon under investigation.

Research Approach

According to Creswell (2014), research approaches are strategies and methods for conducting research that progress from general hypotheses to specific techniques for data collection, analysis, and interpretation. While there are different types of research approaches such as the quantitative, qualitative, and mixed methods approach, the present study found a qualitative research approach suitable for the study. In simple terms, qualitative research is a form of systematic empirical inquiry into meaning (Creswell & Creswell, 2018). A qualitative research approach was found suitable for the study because it focuses on analysing the social production of issues, event and practices with regards to the instructional strategies employed by teachers to enhance learners' understanding of number sense.

Research Design

The research design refers to the overall strategy that one chooses to integrate the different components of the study in a coherent and logical way, thereby ensuring effective addressing of the research problem (De Vaus & de Vaus, 2013). Given the nature of the research approach, which is a qualitative approach, a case study design was employed. A case study design is an empirical investigation that examines a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are unclear; and when multiple sources of evidence are used (Yin, 2014). The case study design was appropriate for this study because it allows the researchers to closely examine information gathered on the various instructional strategies employed to enhance learners' understanding of number sense.

Population, Sample, and Sampling Technique

Population refers to an entire group from whom some information is required and the elements in that group possess common characteristics defined by the sampling criteria established by the researcher (Silverman, 2020). For this study, the population comprises mathematics teachers, mathematics learners and the school principal in a selected school in the Ekurhuleni North district schools, Gauteng Province, South Africa. A purposive sampling technique was employed for the study to select a sample of two mathematics teachers, sixteen Grade 7 seven mathematics learners and one school principal from the selected school. The purposive sampling approach was deemed suitable because it allowed for the selection of the cases required for the sample based on presumptions about their applicability to the investigation. In this manner, samples relevant to the research subject could be gathered and used (Cohen, Manion, & Morrison, 2018).

Data Collection Instrument

For this study, a semi-structured interview was employed to investigate the instructional strategies used to enhance learners' understanding of number sense. This semi-structured interview was then held with mathematics teachers, grade 7 mathematics learners, and the school principal regarding the phenomenon under investigation. Because a

semi-structured interview enabled the researchers to ask questions to clarify responses that were unclear or incomplete, this type of interview was deemed appropriate for the study. Thus, the in-depth interview with the participants was framed by informal and formal conversation that was audiotaped and lasted between 8-15 minutes.

Data Analysis and Trustworthiness

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RESULTS AND DISCUSSION

The thrust of the study was to determine the intervention strategies used by educators to enhance understanding in number sense in Mathematics in Grade 7 in five schools in the Ekurhuleni North district of the Gauteng Province. As such, results and discussions were presented under the following sub-headings:

- Intervention strategies that enhance learners' understanding of Number Sense.

Intervention Strategies that enhances learners understanding of Number Sense

To understand the intervention strategies that foster understanding of number sense, the study participants were asked: 'What are the intervention strategies employed to enhance the understanding of number sense?' The research findings revealed that some of the strategies employed include mental computation, use of concrete props, use of the number line, and counting strategy. For instance, a participant stated that:

When trying to assist the learners with the understanding of number sense, counting-on is an important mental strategy that I employ for mental calculation. Also, counting-all is employed in the teaching and learning of number sense to develop amongst learners the ability to add sets of objects and combine them all in order to count all over from the first object. The counting in group [counting-all and counting-on] becomes an important intervention strategy in teaching and learning number sense because the activities contribute towards the improvement of learning of place value, multiplication, as well as division (Teacher 2).

Similarly, a learner who believed that the best strategies she/he has ever been exposed to is the mental computation strategy, gave this explanation:

... When dealing with number sense, I use my mind to split numbers into tens and units before adding or subtracting them. For example, for me to calculate $57 + 82$, I first split

the 57 into 50 and 7, and then I split the 82 into 80 and 2. The tens are added to give $50+80=130$, and the units are added to give $7+2=9$. The result from the tens will then be added to that of the unit $130+9=139$ to get my final answer (Learner 5).

The school principal who participated in the study also gave an insight into the available resources provided by the school to enhance the learners understanding of number sense. The participant adds:

For learners to develop a rational understanding that will assist them to understand why two comes after one and for them to be able to benefit well in the learning process, through the school management, we assist teachers in the preparation of a good learning environment with relevant resources, which gives learners the opportunity to explore what is around them in relation to number sense. So, through this means learners have access to concrete resources, also known as manipulatives, which are physical objects that they can pick up and manipulate to improve their mathematical knowledge. (School principal)

A learner shared the following:

I like it when my teacher teaches us number sense using the number line. For example, if I am sitting at desk number 5, and I decide to move by four desks to the front, then I would count 4, 3, 2, and 1. And if I move to the back, I count 6, 7, 8 and 9 (Learner 8).

From the example given by Learner 8, it is obvious that making connections between a range of representations on a number line provides learners the opportunity to build their understanding while strengthening their number sense. Another learner stated:

... my teacher asked me to add 10 to 6; then I divided 10 into two part to have 5 and 5. I will then add 5 to 6 to give me 11. I will then again add 5 to the 11 to give me 16 on the number line (Learner 3).

Based on the response from Learner 3, it is worth noting that the method used by any given learner may differ from their peers depending on the numbers involved as well as their level of comprehension and fluency. Typically, the number of steps in a calculation should also decrease as strategies become more sophisticated. Thus, it is important that teachers have a sound understanding of number sense and be flexible in their approach in order to give students chances to explain their thinking and the methods they used to solve problems on the number line.

In addition to the responses provided by the learners above, their mathematics teacher iterates that:

Learners enjoy number sense when you teach them using the number line approach and relate it to their environment. So, what I do is to give them a task and allow them to locate numbers on the number line, which requires them to understand the magnitude of numbers and compare numbers to each other. I use the number line because it promotes active construction of mathematical meaning by strengthening learners' mental representation of number magnitudes, number relationships, and mathematical operations (Teacher 1)

The research findings revealed that the use of the number line, counting-on and counting-all, and mental computation are some of the various instructional strategies that can be used to enhance learners understanding of number sense. These findings resonate with those of other researchers (Tsao & Lin, 2011; Alsawaie, 2012; Mamogale, 2019; Mncube, et al., 2019) who argue that an important aspect of number sense to flexibly solve problems is the use of appropriate strategies such as mental computation and estimation. Alsawaie (2012) added that both strategies are capable of putting problem solvers (learners) in a better position to deal comfortably with a difficult situation. The research findings also revealed that for a calculation strategy to be effectively implemented, number concepts have to be well-attained by the learners through the use of effective approaches such as approximate computation and/or estimation and the use of concrete materials, all of which are significant methods for encouraging learners to use what they already know about numbers to make sense of new numerical situations. The findings corroborate that of Tsao and Lin (2011), who posit that teaching methods for number sense include the use of process questions, writing tasks, invented methods, the use of suitable calculation tools, assisting learners in setting benchmarks, approximate computation or estimation, and encouraging internal questioning. However, to help learners improve their number sense, teachers should teach them to pose important questions to themselves before, during, and after solving problems (Tsao & Lin, 2011).

Similarly, the research findings revealed that learners' understanding of number sense can also be enhanced through the use of concrete props and counting. This finding is in line with that of Mamogale (2019) who posits that counting by grouping props assist learners to attain the next level of counting, and thus leads to the understanding of multiplication. With regards to the use of resources within the learning environment to enhance learners' understanding of number sense, Mamogale (2019) submits that the usage of environment during teaching has a great potential to alleviate the challenges of lagging behind time. This will assist the learners to use their senses to interact with mathematical concepts while learners who are challenged will get the opportunity to experiment by seeing and touching concrete objects (Mamogale, 2019). The Vygotsky's constructivist learning theory (VCLT) also encourages that in constructivist discourse, learners should be supported to construct knowledge through interacting with one another, their immediate environment, and collaboratively creating small cultures based on shared meanings (Siyepu, 2013; Mamogale, 2019). Therefore, in all activities that teachers plan for teaching number sense, progression should be carefully planned so as to indicate and keep track of the progress during the teaching and learning activities.

CONCLUSION

This study examined the intervention strategies employed to enhance the understanding of number sense amongst grade 7 learners in a South African school. The findings revealed that there are several strategies that can be implemented to assist learners. However, as indicated by the study participants, only a few have been given much attention.

As a result, the study concluded that teachers should constantly stay informed about the processes that they are applying in the teaching and learning given that good intuition and an all-encompassing comprehension of numbers, operations, and their connections are referred to as having number sense. This will assist the teachers to avoid telling learners what to do and how to do it so that learners can solve problems better by themselves rather than relying on rule-based methods. Finally, given that the success of mathematics in the classroom is influenced by learners' number sense, it becomes important to start building number sense among learner at a young age so that learning is not founded on rules or standard algorithms that are not contextual. For this reason, curriculum designers and teachers should concentrate on teaching methods that can help students develop learners' number sense, as this can lead to potential mathematics success.

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