TEACHING STRATEGIES USED BY MATHEMATICS TEACHERS FOR LEARNERS WITH LEARNING DIFFICULTIES

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ABSTRACT
In this paper, we report on an investigation regarding teaching strategies used by mathematics teachers and their thoughts in facilitating learning for learners with difficulties in learning mathematics. This study adopted an observational approach and open-ended post observation questionnaires with four primary school teachers. The results revealed that from all five teaching strategies, all teachers tend to use scaffolding and argued that they prefer explicit instruction. Those that attempted to use problem-solving strategy always guided learners. It was also found that teachers with special needs training used concrete objects when introducing lessons. The results also reveal that experienced teachers and those with special needs training used most of the teaching strategies successfully. Our conclusion is that all mathematics teachers (at special schools and mainstream schools) who teach learners with special educational needs (LSEN) must be well trained in the area for special needs education including the use of all teaching strategies before introducing inclusive schools.

Key words: teaching strategies; learning difficulties; special needs education

INTRODUCTION AND BACKGROUND

Since 1994 the government has been committed to building an inclusive education system (inclusion of learners of different races, classes, or religion, and also of learners with different mental and physical abilities) with the intention of accommodating as many learners as possible, including those experiencing different kinds of barriers to learning, in inclusive mainstream schools (DoE, South Africa, 2001). In this context, a public-private partnership was set up in the late 2000s that established a small number of research and development Chairs, based in South African universities aimed at developing and studying the implementation of research-based interventions to improve learning outcomes.

In South Africa, schooling is divided into mainstream education and special needs education. The intention of the government is that special needs schools must serve as resource centres for inclusive mainstream schools (DoE, South Africa, 2001). As it is Internationally, inclusive education in many countries of the Global North has developed in the early 70s from a foundation of well established special education systems (Walton, 2018). With well developed special education system, the assumption is that teachers in special needs schools must have specialised knowledge, experience and training to use teaching strategies that are effective for teaching learners with learning difficulties. Teachers can acquire specialised knowledge if they are trained as it is internationally. According to Mbengwa (2010), when implementing inclusive education internationally, teacher education realised a move from special needs as an area of specialisation to the ensuring that all teacher education should include special needs training. We concur with Mbengwa (2010) and suggest that such training be included in the programmes for undergraduate and post graduate courses for those who are intending to teach mathematics at schools and post-school, and to those teachers that have been at the schools for many years.

We argue that, before planning to have inclusive schools in South Africa, it is necessary to investigate teaching strategies used by mathematics teachers at schools for learners with learning difficulties in different subjects, and in particular for specialised subjects like mathematics which are challenging to both teachers and learners. It must be noted that the term learning difficulties is used differently in other countries. For an example, in the UK, the term learning difficulty refers to children and young ones with specific learning difficulties. while in the US and Australia they refer to the term learning disabilities, which is equivalent to learning difficulties. For the context of this study, we will use the term learning difficulties, with no intention to categorise learners due to the different disabilities. We assume that learners that are enrolled at Special Schools experience intrinsic barriers to learning. The research question for this study is: Which teaching strategies are used by mathematics teachers for learners with learning difficulties in mathematics and their thoughts in facilitating learning?

LITERATURE AND THEORY

Mercer, Mercer and Pullen (2014) argue that special needs educators are confronted with different kinds of learning difficulties ranging from mild (minor reading difficulties or mild dyslexia) to severe (severe dyscalculia or brain injuries). Learners with learning difficulties experience intrinsic barriers to learning that can impede their understanding or application of mathematical concepts. These barriers to learning include difficulties in respect of memory, attention span, processing, language, metacognitive thinking, as well as maths anxiety, learned helplessness and passivity (Allsopp, Kyger & Lovin, 2007; Dednam, 2011). Mathematics teachers and these learners are confronted with these barriers every day in the classroom. In order to enable learning, teachers cannot rely on only one type of teaching approach (Mercer et al., 2014).

Teaching strategies used mainly in special needs education are explicit and implicit instruction (Mercer et al., 2014; Lerner & Johns, 2012; Allsopp et al., 2007). With explicit instruction (direct instruction associated with behaviourism) the teacher provides an explanation or demonstrates a skill or concept in different contexts and then provides opportunities for independent practise by learners to ensure mastery of that particular skill or concept, by contrast, implicit instruction (associated with constructivism) emphasises the development of learner thinking processes (Mercer et al., 2014). Mercer et al. (2014) and Allsopp et al. (2007) believe that when learning is difficult, the teacher should provide extensive support, where the two strategies are integrated in the form on interactive instruction where instruction is based on guided discovery in a form of a dialogue between the teacher and the learner, called scaffolding.

The three key features of interactive instruction are explicit teacher demonstration (I do it), guided practice (we do it) and independent practice (you do it) (Mercer et al., 2014; Miller & Hudson, 2006). For the purpose of this study, five teaching strategies were identified from literature as follows: *teaching within an authentic context*, *building meaningful connections*, *scaffolding*, *concrete representational abstract sequencing* and *problem-solving* strategies (Allsopp et al., 2007; Lerner & Johns, 2012; Miller & Hudson, 2006; Mercer et al., 2014). It is important to note that these five teaching strategies are universal and useful in all teaching situations and not just for learners with learning difficulties. However, researchers who focus specifically on mathematics education involving learners with learning difficulties emphasise the importance of using these strategies.

Authentic context (AC). Teaching within an AC demonstrates to learners the relevance of mathematics in their daily lives, such as using the example of cutting a cake into equal smaller pieces when explaining fractions. With AC learners get an opportunity to link what they learnt to other contexts. In that case, AC help build meaningful connections.

Building meaningful connections (BMC). Learners bring prior knowledge that can either enable or impede learning. Prior knowledge can also influence how learners will organise and interpret new knowledge. The teacher should assist learners to make connections between what they already know and the new mathematical concept that is being learned (Nel & Nel, 2012). For example, the teacher could remind learners about how fractions with different denominators are added before explaining how mixed numbers with different denominators should be added.

Scaffolding (SC). With scaffolding, a learner is assisted by a teacher to complete a task that is beyond the learner's ability (Gultig & Stielau, 2012). According to Miller and Hudson (2006) the scaffolding process follows a sequence of 'I do' by the teacher; followed by 'we do' by the learner through teacher's guidance; and then 'you do' by learner alone. At the 'I do' stage, the teacher demonstrates how to solve a problem, at the 'we do' stage, the teacher will do work together with the learners. Lastly, in the 'you do' stage, the teacher will allow learners to solve problem solve by themselves.

Concrete representational abstract sequencing (CRAS). Researchers who studied the use of CRAS, specifically in LSEN schools argue that when teaching learners with learning difficulties, it is important to start at a concrete level (involving real objects), proceed to the representational level (involving pictures) and only then progress to the abstract level (mathematical symbols) to ensure that they understand (Lerner & Johns, 2012; Mercer et al., 2014; Allsopp et al., 2007; Miller & Hudson, 2006), since learners with learning difficulties have problems with abstract thinking. CRAS helps learners to build meaningful connections with previously learned work, it can be used in the scaffolding process, and it helps with problem-solving skills.

Problem-solving (PS). According to Polya (1957) problem-solving consists of four stages: the learner: recognises and understands the problem and identifies what is required to solve it; understands how the different items in the problem are connected and plans a procedural approach; decides on the mathematical knowledge required to solve the problem and solves it; and considers the answer and decides whether it makes sense or not. Problem-solving in mathematics is an important skill to master, but it is also complex. Unfortunately, many learners with learning difficulties have a problem in this area (Lerner & Johns, 2012).

Even if we have identified the above strategies to use, some researchers believe that the problem is far-fetched. These researchers argue that as we strive to build an inclusive education system for all, the focus should not be on trying to assist students with mathematics learning disabilities, the focus should rather be on " how we can learn to build a mathematics education system that no longer disables so many mathematics students" (Scherer, Beswick, DeBlois, Healy & Opitz, 2016 , p. 646).

When introducing the Universal Design for Learning (UDL), Dalton, Mckenzie and kahonde (2012) suggest that teacher training should implement UDL since it addresses the needs for a more flexible curriculum and may deal with teachers' lack of knowledge and skills. The aim of UDL according to Dalton et, al. (2012) is therefore to lower learning barriers and to include learners (with or without learning difficulties) in the learning process.

METHODS AND SAMPLING

In this study, four primary school teachers (all with appropriate teacher qualifications) were selected using purposive maximum variation sampling. A structured questionnaire was designed to cover two criteria. We considered participants' years of teaching experience in special needs schools and the participants formal training in special needs education (learning support). Two teachers had different combinations: Less than three years teaching experience, Inexperienced (I) and either with special needs training (ST) or did not have special needs training (NT). The other two teachers had different combinations: More than 10 years teaching experience, Experienced (E) and either with special needs training (ST) or did not have special needs training (NT). For example, from Table 1, Teacher 2 had two years teaching experience and had special needs training (T2(I/ST)). The teachers with special needs training had different qualifications. Teacher 2 had a PGCE diploma (majoring in Inclusive Education) and was busy with a BEd Honours degree (Remedial Education and Learning Disabilities) during the data collection period. Teacher 4 had a diploma in Minimum Brain Dysfunction. Other noteworthy information from Table 1 is the difference in age of the teachers (27 to 53 years) and the different grades they taught (Grades 4 to 7).

Table 1: Description of participants

	Teacher 1 T1(I/NT)	Teacher 2 T2(I/ST)	Teacher 3 T3(E/NT)	Teacher 4 T4(E/ST)
Age	27 years	30 years	57 years	53 years
Grade taught	Grade 6	Grade 5	Grade 7	Grade 4
Teaching experience	1,5 years	2 years	11 years	22 years
Special needs training	No	Yes	No	Yes

A structured observation schedule was used to record four lessons taught by the four teachers over a period of three weeks. The class size was ranging from between 10 to 24 learners. Though not the focus of this study, we noted that there were two to five learners in some classes who used computers for writing. These learners had cerebral palsy or low muscle tone which prevented them from writing properly with their hands. They also had assistant teachers. The collected data was categorised according to the five teaching strategies that were identified from the literature and analysed. Space was provided for other strategies that could emerge during the observations. After observations, a semi-structured questionnaire was used with all teachers (based on their thoughts).

RESULTS BASED ON OBSERVATIONS

The results revealed that T4(E/SP) used four strategies effectively in all her lessons, except problem-solving strategies that was used through teacher guidance. T1(I/NT) did not use concrete objects in all four lessons; taught abstractly and used authentic context averagely. The way she taught could be as a result of her lack of teaching experience and no special needs training. All the teachers used scaffolding in all lessons. However, none of them taught problem-solving strategies without guiding learners or using rules. One would expect that T4(E/SP) with all her experience and training in special needs education would make use of problem-solving strategies without guiding learners. For the scope of this paper, we report in depth on observations for T2(I/SP) and T3(E/NT) because their results for the use of the five teaching strategies were much similar. They had different teaching experiences. Teacher 2 had special needs training. What each teacher said in class is written in italic.

Cases: T2(I/SP) and T3(E/NT)

Authentic context was used twice by T2(I/SP). In Lesson 1 example of slices of pizza and a bar of chocolate were used to revise fractions. T3(E/NT) used authentic context in three of her four lessons. For example, in Lesson 1 the idea of equivalent fractions was used by giving three learners all R10 but in different formats; one learner received a R10 note, another learner received two R5 coins and the last learner received a R5, two R2 and one R1 coin.

Building of meaningful connections, was used three times by T2(I/SP) and twice by T3(E/NT). During Lesson 2, T2(I/SP) revised addition and subtraction of fractions with the same denominator before teaching addition and subtraction with different denominators. In Lesson 4, T2(I/SP) asked learners to explain what whole numbers and fractions were, before explaining the concept of mixed numbers. In Lesson 4, T3(E/NT) reminded learners of the addition and subtraction of fractions and explained *that one of the first steps was to change mixed numbers into improper fractions. This also applies when we multiply fractions, but we do not have to calculate the LCD* (lowest common denominator) *when we multiply fractions.*

Scaffolding was used predominantly. Both T2(I/SP) and T3(E/NT) used scaffolding in all their lessons. In Lesson 2 for example, T2(I/SP) did various mathematical problems with the learners, reminding them of the following golden rules: *The denominator have to be the same, and everything you do at the bottom you must also do at the top.* Learners were then given an opportunity to solve a problem with the teacher. Thereafter the teacher handed out a worksheet that learners had to complete on their own. When they struggled to complete the worksheet, she assisted each learner individually by pointing out their mistakes. In Lesson 3, T3(E/NT) explained how two fractions with different denominators had to be added together and gave a step-by-step demonstration to show the learners how to solve the problem. Example: $\frac{2}{3} + \frac{4}{9}$. While she was explaining the problem, she asked the learners many questions, for example: C*an I add the two fractions? What do I need to do now?* She then showed that the LCD was required first: M_3: 3, 6, 9, 12, 15 and M_9: 9, 18, 27, therefore the LCD is 9. Using a coloured pen, she added the multiplication: $\frac{2}{3}$ x $\frac{3}{3} + \frac{4}{9}$. Afterwards one of the learners was invited to be the teacher. The learner had to explain what he was doing and was also allowed to ask the other learners what he should do when he did not know how to continue. The teacher helped him from time to time by telling him what type of questions he should ask the class.

With **Concrete-representational-abstract sequencing**, the results were interesting. T2(I/SP) used the CRAS in only two of the four lessons, whereas T3(E/NT) used the concrete-representational-abstract sequencing only once. In Lesson 1, T2(I/SP) asked the learners the day before to bring paper plates to class to represent a Pizza activity. These plates were cut up into halves, quarters and eights (concrete level) (Figure1). The teacher drew a pizza on the board and divided it into halves, quarters and eights (representational) and then wrote the corresponding abstract symbol on each paper plate piece and on the representation on the board. T2(I/SP) used representational-abstract sequencing once and once taught only abstractly. In Lesson 4, she continued to use the plates from Lesson 1 to move from the representational level (pictures as in Figure 2) to the corresponding abstract level when writing the mixed number in symbol form as $1\frac{1}{2}$ and $4\frac{1}{4}$. In this fraction activity, the teacher made connections from a circular shape to a shape that resembles a square.

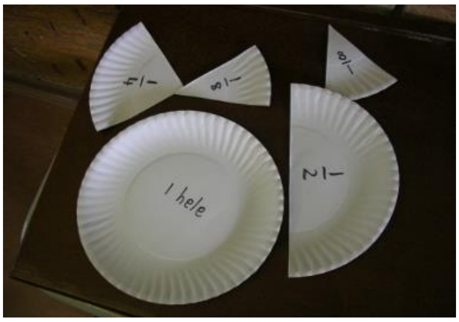

Figure 1: Using paper plates to explain the concept of fractions

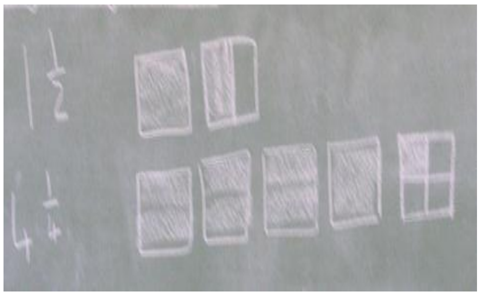

Figure 2: Representation of mixed numbers

T3(E/NT) gave each learner different wooden or plastic pieces (in Lesson 1) that represented fractions that they had to manipulate before she drew diagrams on the board and wrote the equivalent fraction in symbols next to each diagram. The learners could therefore not only listen to her and look at what she was doing, but could at the same time manipulate the pieces they had been given (Figure 3).

Neither of the two teachers taught **problem solving** according to Polya. They gave their learners steps, recipes or rules to follow in order to solve different kinds of mathematical problems. When the learners struggled to solve the problems, which happened often, the teachers always reminded them of the steps, recipes/ procedures or rules that were taught previously. For example, in Lesson 4, T3(E/NT) explained the four steps to problem solving of multiplication with fractions by using the acronym of CMMS: *change mixed numbers into proper fractions, multiply numerators, multiply denominators and simplify* (see Figure 4).

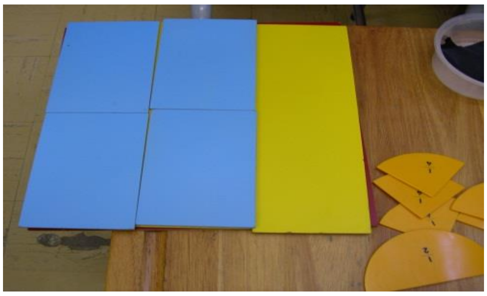

Figure 3: Representing equivalent fractions using wooden and plastic pieces

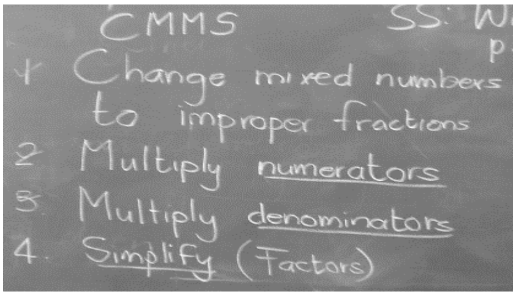

Figure 4: Four steps followed when multiplying fractions

From the results, it can be concluded that T2(I/SP), who had two years of teaching experience but had undergone further training in special needs education, and T3(E/NT), who has 11 years of teaching experience but no further training in special needs education, used nearly the same number of teaching strategies effectively.

POST OBSERVATION QUESTIONNARES

The results here (for all four teachers) reveal that some teachers prefer some strategies like problem-solving, but due to time or other reasons they were unable to implement them. Most of them prefer scaffolding. Teachers gave statements as in Table 2.

Table 2: Description of participants

T1(I/NT)	Explicit teaching is the best way to teach, since more than 80% of learners do not have motivation or competence. Many problems must be done on the board with learners.
T2(I/ST)	A combination of explicit and implicit instruction must be used.
T3(E/NT)	Many methods are not good for learners, you must lead them.
T4(E/ST	Always try to let learners discover for themselves, but there is no time, it is limited, so you end switching to explicit instruction.

REFLECTIONS BASED ON THE RESULTS

In order to respond to the question: Which teaching strategies are used by mathematics teachers for learners with learning difficulties in mathematics and their thoughts in facilitating learning? One can say that teachers tend to use scaffolding more than other strategies. It was interesting to see that teachers with special needs training used concrete objects when introducing lessons. T4(E/SP), with 53 years of teaching experience and special needs training, stood out from the rest of the teachers in using all teaching strategies, except for not teaching problem-solving strategies without guiding learners. This is in contrast to T1(I/NT), with one and half years of teaching experience and no special needs training, who did not make much use of the different teaching strategies. Teachers believe that certain strategies could be used, however they get restricted because of the type of learners they teach and the time constraints. They end up relying on explicit teaching and scaffolding and avoiding developing problem solving skills.

CONCLUSIONS

The findings of this study raise questions regarding formal special needs training. T2(I/SP), who had received formal special needs training, but had little teaching experience, compared well with T3(E/NT), who had more than ten years' teaching experience, but no formal special needs training. T4(E/SP), with 53 years of teaching experience and special needs training, stood out from the rest of the teachers. The impact of formal special needs training on the use of the five strategies in class needs to be researched with a bigger sample for results that can be generalised, so as to make informed decisions about inclusive education.

From the results of this study it can be suggested that if inclusive education is to be a success, teachers should be equipped with the necessary special needs education training as it is internationally (Mbengwa, 2010), with the main focus on different instructional strategies. We argue that teacher trainers should focus on designing relevant training or qualifications for all teachers in South Africa as a way of preparing them to teach at inclusive schools. If all teachers study courses like remedial education and learner support at universities as part of their studies, they will be able to identify and help learners who have learning disabilities. As part of the training, we suggest that in addition to remedial education, UDL be introduced in Teacher Training courses in South Africa.

As discussed earlier, the South African government is shifting its focus to having inclusive schools (DoE, South Africa, 2001). Currently many learners in mainstream schools have intrinsic barriers to learning and mathematics teachers need to be able to adapt their teaching to accommodate these learners. Further research could examine the similarities and/or differences in the teaching strategies used by teachers who teach in special needs schools and those teaching in mainstream schools. Future research could focus on teaching problem solving-strategies as none of the teachers in this study taught problem-solving strategies without guiding learners. We align with Scherer, et al. (2016) as they argue that for inclusive education system for all, the focus should not be on trying to assist learners with mathematics learning disabilities, but rather focus on building a mathematics education system that no longer disables our mathematics students. In that way, teachers will be trained to teach all types of learners despite their abilities.

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