member stopped him. It seemed the teacher did not notice the situation in that group. The learner's domination in the group might be a way of compensating for his physical disability. The emotional aspect of the learners was also nurtured in the groups. When one learner was asked during the interview why a group member had lowered a measuring cylinder for one learner during an activity, the interviewee responded by saying: "You see, M cannot go down [he means to bend] and look careful at the measuring cylinder, and she can break the measuring cylinder."

Pontecorvo (1985) argues that during the instructional interaction, collaboration among learners is helpful to the development of mathematical concepts. When learners were interviewed later and asked why they liked working in groups, they gave the following responses: "You help each other"; "If you are not good here [he means if you are not good at talking], they [she means other learners] can say you must write the measurements"; "It's like you don't forget and other children help you when you don't understand"; "It's like you share the work Teacher gives us". Such utterances from the learners suggest that learners scaffold each other by acting as sources of external memory. In addition, the physically disabled learners and the able-bodied learners' need for each other and their ability to complement each other also suggest the usefulness of group-work in the inclusive classroom as reflected in the learners' utterances.

Although working in groups was beneficial to all, the teacher's not noticing the physically disabled learner who dominated his group could be detrimental to the other learners'

inverted commas throughout this paper to indicate that these were the actual utterances.

participation by unintentionally denying them the opportunity of contributing positively to the group's discussion. The detrimental effect of the dominant learner may therefore be contravening Pirie's (1988) notion of purposeful talk and discussions on mathematical subjects in which there are genuine pupil contributions and interactions by the other group-members.

Even though there were occasional problems, working in groups was beneficial and rewarding for both the teacher and learners. In the interview, the teacher pointed out that he personally believes in group-work; he chooses tasks that encourage children to work in groups because children can easily learn when they work in groups. Again, the teacher's liking for group-work is that since learners have different qualities and strengths, combining the learners' different qualities and strengths helps them to learn more in their groups, i.e. "the groups are balanced, sort of". Therefore, employing group-work with the above motives enabled the teacher to achieve his aims and objectives. For learners, it provided an opportunity to learn the mathematical concepts with the help of peers. The learning occurred in the form of regulating the actions of other peers and by being regulated by the actions of the peers.

The teacher's working with learners was determined by the nature of the tasks. In lesson 4 on volume of irregular solid substances, the teacher moved from one group to another, to demonstrate the meniscus. The teacher also demonstrated how to take the correct reading, i.e. the eye should directly be opposite the reading one is taking. This action by the teacher was important because through it, learners did not learn mathematical concepts only, but also skills. The acquisition of skills is important in mathematics as these could inspire in learners the ability to solve mathematical problems practically, and thereby form true concepts.

(ii) The use of appropriate language

The teacher's language was appropriate and was at or just above the learners' level of understanding. It therefore meant that the teacher scaffolded within the learners' zone of proximal development. What follows are examples that provide evidence to how the teacher's use of appropriate language enabled learners to form true mathematical concepts by drawing the spontaneous concepts and scientific concepts together.

The teacher had introduced the first lesson of volume by referring to quantities of food and the containers that the food is bought in. The reference to this distinction enabled learners to understand the notion of volume as denoted by food rather than the containers. The teacher also engaged learners in a "question and answer" exchange. The questions the teacher asked were appropriate to the concepts that were dealt with at different times. In dealing with the concept "cube", the teacher asked the learners to look for the meaning of "cube" in the dictionary. When I asked him during the interview why he had preferred learners to look for the meaning in the dictionary, he responded by saying: the dictionary meaning of "cube" enabled the learners to understand "cubic" as in "cubic centimetre". It enabled learners to realise that each small block has 6 equal sides that measure 1cm each. Therefore, such precise meaning of concepts alleviates the problem of altering the correct meaning of concepts especially if the teacher is not an English speaker. This issue will not be discussed further as it does not form part of my study.

The learners understood the mathematical concepts such as volume; cubic centimetre; displacement; etc., especially since the meanings of these concepts were made clearer during experiments and group-work. It was during experiments and group-work that the teacher drew spontaneous concepts and scientific concepts together to enable the learners to form true mathematical concepts. During the interview I asked the teacher why he had explained the concept "displacement". His response was that: "Mathematics is a science that has its language which has to be understood and used correctly. This helps the children to understand what you are teaching". This implies that the use of appropriate language enhances the meaningful construction of mathematical concepts. Some learners' instances and examples of "displacement" were: "when you cook pap"; "when you get into the bath"; "when you make tea".

Although these learners' examples and answers are correct, the rest of the learners in class should also understand these. This could be attained if the teacher probed deeper into the articulated utterances by asking for further explanations. Explanations given by learners would also facilitate collaborative learning. It is therefore not enough that examples of concepts given by the learners are understood by the teacher only, by providing him with evidence that the learners who answer understand the concept that is discussed. Other learners must understand the examples so as to benefit from these.

The teacher also introduced new terminology that he linked to what the learners already knew, for example, layers and rows, thereby working in the learners' zone of proximal development. Linking new terminology with what the learners already knew demonstrated the teacher's effective use of interacting spontaneous concepts and scientific concepts to assist learners to form true mathematical concepts. In order to assist learners to understand the concepts of breadth and height with reference to the blocks the learners had constructed, the teacher associated the breadth and height (scientific concepts) with rows and layers (spontaneous concepts) respectively. The language used to form the association was appropriate and effective in enabling learners to understand the concepts of rows and layers in relation to breadth and height. Being able to associate these words (spontaneous concepts) with mathematical terms is important because understanding mathematical terms is an important aspect for the formation of true mathematical concepts and for the development of mathematical thinking. Therefore, by drawing the spontaneous concepts and scientific concepts together, the teacher enabled learners to form true mathematical concepts.

It also became evident that the learners had understood the teacher when they responded to the teacher by answering relevant and thought provoking questions that were posed to them. Such questions enabled learners to direct their thoughts to the specific concept that had to be formed. For example, the question "which things occupy space and what space do they occupy?" enabled learners to engage in mental activities that would enable them to form the concepts of occupied space that would enable the learners to understand the concept of volume.

The unique role of appropriate language in mathematics concept attainment was evident in this classroom. "While concepts and the learning of concepts are not necessarily verbal, verbalisation makes concept learning a relatively easy matter for learners" (Gagne, 1970: 118). When one learner did not mention the unit ml or cm^3 when he measured 100ml of water a peer reminded him to mention the unit: "Teacher said it is important to say the unit". During the interview the teacher's reason as to why learners should always mention the unit after a measure was that it enabled them to communicate correctly by enabling them (learners) to know from the outset what measure is being referred to. For example, if a learner or teacher were to talk of 100minutes; 100kg; 100ml;or $100cm^2$; learners were expected to know that these measures referred to time; mass; volume; and area respectively. Therefore, the teacher's use of correct and appropriate language; together with reference to spontaneous concepts facilitated the formation of the scientific concepts, which also enhanced the formation of mathematical concepts.

Towards the end of the lesson on what volume is (lesson 1) learners were required to discuss in their groups what they had learned about volume. When I asked the teacher during the interview why he had required learners to discuss this, he explained that he thought that the discussion gave nearly every learner the opportunity to think about what they had learned. This implies that learners discussed in their groups by using language that would be understood by all members of the group. Therefore, the teacher gave the learners opportunities for verbalising mathematical concepts, thus helping them to form these (Gagne, 1970; Brodie 1991).

Although the teacher had hoped that the discussion would enable all learners to think and therefore engage in constructive discussions, it is not possible to conclude that this was attained as not all learners contributed to each group's conclusions that were written on the chalkboard in the form of a summary.

The above examples of the appropriate use of language provide evidence of the teacher's use and reference to spontaneous concepts and scientific concepts and how the interaction of these concepts facilitated the formation of true mathematical concepts.

(iii) The use of concrete teaching aids

The learners' activities of performing experiments pertaining to tasks enabled learners to grasp the concepts aimed at. For example, learners were involved in physical manipulation of learning aids (wooden cubes and dice) to construct sets of different shapes by using the same number of wooden cubes. This activity enabled learners to grasp the concept of conservation of volume. One learner reported this: "Number of cubes is the same but the shapes are not the same". The learner had therefore formed personal meaning of the cultural meaning of conservation (van Oers, 1996). The teacher further explained the learner's statement. At the end of the explanation, learners participated in activities to explore the concept of conservation. Engaging learners in these activities was an effective scaffold that would result in the formation of the concept of conservation.

In another task, learners were required to discover the relationship between cm^3 and ml. In their groups, learners used water and measuring cylinders. Each group used two sets of measuring cylinders. One measuring cylinder was calibrated in cm^3 and the other in ml. Learners explored the following:

(a) 100ml = ___ cm^3

(b) 500ml = ___ cm^3

(c) 200cm^3= ___ ml

(d) 1litre = ___ cm^3 ___ = ml

(e) ½ litre = ___ cm^3 ___ = ml

Learners recorded their findings and discovered that cm^3 = ml. In one interview the learner was asked how the measuring cylinders had helped him during the lessons and he answered by saying: "To show that 150ml = 150cm^3; or 1000ml = 1000cm^3 = 1litre". Learners had done this experiment in their different groups. Therefore, the use of concrete and visual teaching aids enhanced the understanding of two measuring units and enabled the teacher to attain his aims and objectives.

In the above examples, the teacher scaffolded by using concrete and tactile learning aids. These learning aids served as effective mediational tools. To some extent these mediational tools enhanced the formation of concepts. During the interview the teacher explained that he likes learners doing practical work in solving maths problems because he thought, "children learn with ease or …they understand much quicker if they do these things on their own". Hamachek (1979) points out that good and effective teaching relies on the teacher perceiving problems experienced by the learners as real, and providing resources. Such resources could be mental, physical or emotional. The provision of resources such as appropriate learning aids was evident in this teacher's lessons as described above.

However, the teacher's notion that "learners learn with ease or they understand much quicker if they do these things on their own" does not suggest that learners should be left to decide on the type of mathematical activities to engage in or to discover the concepts on their own. Instead, the teacher should be in the forefront in the instructional situation by playing the role of director and mediator; initiating; maintaining order and discipline, and maintaining active mathematical intervention to help concept formation (Brodie, 1991).

The provision of resources and appropriate learning aids is always aimed at providing learners with mediational tools that should act as effective scaffolds. However, sometimes the opposite effect could be attained when learners deviate from prescribed activities without being noticed by the teacher. This occurred when one group focused on counting the dots on the dice instead of focusing on constructing the block as directed by the teacher. Such learners' deviations might cause the learners to miss out the opportunity of learning and forming the mathematical concepts, and the teacher might not achieve his aims and objectives of the lesson.

The above analysis of the activities indicates that learners engaged in physical and mental activities that enabled them to understand the concepts that the teacher had hoped the learners would achieve. The able-bodied learners and physically disabled learners played the major role in the teaching-learning situation by participating actively in physical and mental activities that enabled them to construct new meanings and form concepts by integrating spontaneous and scientific concepts.

(iv) The use of concrete or direct real-life situations and examples

Drawing spontaneous concepts and scientific concepts together by referring to concrete or direct experiences of real-life situations enabled the learners to experience or extract the meaning of a concept. In the teacher's introduction of the lesson on volume he referred to food (rice, potatoes, milk, etc.). His reasons for referring to food were "food is used most of the time in our lives and it is bought in different quantities. Even the physically disabled children will have an idea of what I'm talking about when I make examples of food". Such reference to learners' everyday life and real-life situations proved to be an effective scaffold. This scaffold enabled learners to experience or extract the full meaning of the mathematical concept. Skemp, (1971) points out that once the concept is formed, we may talk about examples of the concept. The extraction of the full meaning and talking about examples of the concept was displayed by a physically disabled learner's utterances during one lesson:

T: Could we buy the same amount of potatoes, i.e. 4kg, or 10kg, without the pocket?

L: Yes, maybe you put them (potatoes) in a dish or in a plastic bag like when you buy these from Checkers or Pick 'n Pay.

Although this is an appropriate example of a real-life situation, the teacher cannot assume that all physically disabled learners have some experience of doing shopping in retail stores and therefore the example made sense to all of them. Maybe the teacher might ask learners to give other examples, explanations or both in order to establish if the physically disabled learners' level of understanding of the concept(s) is appropriate.

The teacher explained during the interview that it was important to talk to learners about things learners already knew or did (spontaneous concepts) because it enabled them to understand what is learned in class (scientific concepts) very easily. He also mentioned that what was learned in class must somehow match with the outside world to facilitate easy learning. The implication is that the interaction of spontaneous and scientific concepts facilitates the formation of true mathematical concepts.

The use of examples to further facilitate the interaction of spontaneous concepts and scientific concepts surfaced when different examples were used to explain the same concept. In one lesson, the teacher had given the definition of volume as "the space occupied by something or an object". To establish whether learners had understood this definition, learners were asked which things occupy space and what space they occupy. Learners gave the following answers: "Coke in the bottle"; "Chalk in that box"; "Water in a jug and medicine in this bottle"; "Mieliemeel in a bag". Such examples demonstrated and indicated to the teacher that learners had conceptualised the notion of the distinction between space in the container *and* the contents of the container. This distinction also indicates the effectiveness of the interaction of spontaneous concepts and scientific concepts. If a learner understands the notion of the contents of the container then the learner can easily understand the notion of volume.

In another lesson learners were asked to give examples of instances where gases occupy space. Learners gave examples such as " Easigas"; "In a balloon"; "… a tyre"; etc.. These examples indicated that the learners knew that gases occupy space and therefore volume can be measured, although it was not easy to measure it. Although the use of various examples indicated to the teacher that learners had understood concepts that were dealt with, it also served the function of generalising, and the formation of concepts (Skemp, 1971). The teacher mentioned in the interview that when learners used different boxes and gave different examples of the same concept, it could be easier for them to be able to understand that the law/principle could be applied to other things. The teacher explained that the use of examples also saved learners from explaining difficult concepts (although they knew these): "You see, sometimes the children cannot easily explain what they want to say. So, rather than asking them to explain something, I ask them to give me examples of what they could have explained". Therefore, "the examples gave me some idea that the children know …". Therefore, the teacher's use of examples enabled learners to form mathematical concepts during the different lessons.

(v) Scaffolding –providing support to learners

Scaffolding entails the provision of support to learners by augmenting the learners' limited cognitive resources, and enabling the learner to concentrate upon and master manageable aspects of the task (Wood, 1991). Scaffolding therefore implies the use of qualitatively different strategies in assisting learners to manage tasks. During the interview I asked the teacher what his main teaching method was and these were his responses: "I don't have one only. But I like children working in groups"; "I like them to do practical work in solving maths problems"; "Sometimes asking children to give examples also helps". The implication put forward by these utterances suggests that he uses different teaching methods, and the methods used at a particular time are determined by the nature of tasks. Furthermore, these different teaching methods serve as different scaffolds as determined by the nature of tasks; and these scaffolds entail doing experiments and practical work; asking learners to give examples of the concept(s); the use of appropriate language; using group-work; and other scaffolds which the teacher may find appropriate in accordance with the tasks in class.

What follows are some descriptions and examples of the teacher's use of different scaffolds as determined by the nature of the tasks. Towards the end of lesson 1, the teacher asked learners to discuss in their groups what they had learned about volume. The teacher wrote the learners' answers on the chalkboard in the form of a summary. When I interviewed him and asked him about why he had written the answers on the chalkboard, he answered by saying: " Writing summaries on the chalkboard gives learners an overview of the important points of the lesson and I like it if they write these points as notes". Therefore, the teacher provided a scaffold by writing the summary of the lesson on the chalkboard.

As learners worked and discussed in their different groups, the teacher made opportunities to call the attention of all learners to clarify some issues in relation to the tasks. The use of appropriate language as an appropriate scaffold for the task was evident in the following instance: Learners were working with wooden cubes and dice to construct blocks in order to conceptualise the formula for calculating the volume of a rectangular figure and a cube. The learners had to explain how the blocks were constructed. The teacher expected the learners to come up with ideas or meanings of the words rows and layers. He asked learners how they usually sat before they moved into their groups (they sat in rows). One learner said they sat in lines. The teacher accepted the answer, but clarified it to mean rows. He then wrote the word rows on the chalkboard. He then led learners to "see" layers in their blocks, and thereafter wrote "layers" on the chalkboard.

The following example provides an explanation of how the teacher used different scaffolds in one task, and still retained the task difficulty. This is an important aspect of scaffolding (Wood, 1991). The task was based on the conceptualisation of the formula for volume The teacher requested the learners to then construct blocks by using 24 wooden cubes or dice. By referring to area, a concept which learners had learned earlier and was necessary to the understanding of the concept of volume, the teacher asked learners to give the number of wooden cubes or dice which formed the length of the blocks. Learners gave the different numbers from the blocks they had constructed, e.g. 6, 4, 3. Each number represented the same number of centimetres because each side of the wooden cubes and dice measured 1 cm.

The teacher required of learners to record those lengths. He then asked learners to count the number of rows in their blocks and also record those. One group counted the number of layers, but the teacher noticed this mistake and helped the group to rectify it. He then asked the learners to count the number of layers in their blocks and also record the number. These were the findings of the groups:

Group 1	**Group 2**	**Group 3**
Length = 6	Length = 4	Length = 3
Rows = 2	Rows = 2	Rows = 4
Layers = 2	Layers = 3	Layers = 2

The teacher led the learners to discover that the rows are breadths of the blocks. He managed to do so by referring to breadth as used in area. The teacher also led the learners to discover that the layers are the heights of the blocks by using this analogy: "the buildings go higher and higher as we add more layers". The teacher then wrote this on the chalkboard: higher →height. The learners were then requested to "substitute rows and layers with the correct words", while the teacher moved around to check and listened to the learners' discussion.

The teacher asked the learners the number of wooden cubes or dice they had used initially. The teacher wrote the following on the chalkboard: Length × Rows × Layers. Learners were then asked to "substitute rows and layers with the correct words". Length was not dealt with in any way like breadth and height. Probably it is because length retained its meaning in relation to the side it refers to. Each group was asked to report on what it had written. Each group reported that they had written: Length × Breadth × Height.

The teacher explained to the learners that that is how the volume of a rectangular figure is calculated. Learners were then given the opportunity to work on problems and apply the formula. The learners' attention was also drawn to the cm^3 at the end of the calculation by being reminded that it stemmed from the cubic centimetres, i.e. each side of the wooden cut , measures 1 cm, and ^{3} stands for cubic.

For example, in $V = L \times B \times H$

$= 4cm \times 2cm \times 3cm$

$= 24\ cm^3$, learners were reminded "it means there are 24 wooden cubes or dice with each side being 1cm." At the end of the whole exercise of employing different scaffolds, learners managed to calculate volume by using the formula.

The above description offers a comprehensive explanation of how the teacher scaffolded by effecting qualitatively different teaching strategies to enhance the formation of mathematical concepts of volume.

Reminding learners, highlighting important and crucial features of the task is a procedure or a strategy of scaffolding. Wood (1991) supports the idea of reminding learners when scaffolding: scaffolding entails holding the task difficulty constant while simplifying the learner' role as much as necessary for it to be manageable by the learner. The simplification of the learner's role comes into effect through the teacher's use of qualitatively different strategies and actions in assisting the learner to conceptualise and therefore form mathematical concepts. These strategies and actions included the use of appropriate use of language; the capturing of spontaneous concepts that would interact with scientific concepts to assist in the formation of true concepts (lines and rows to imply breadth); the use of an analogy (the buildings go higher and higher as we add more layers) and by reminding the learners (the reference to area). This is what scaffolding entails - the use of qualitative different strategies in assisting learners to manage tasks.

4.5 SUMMARY

In the above discussion I used a set of categories to analyse and interpret the interaction in the Grade 7 class. These categories come from a sociocultural perspective and assist in providing a description of the instructional situation and the teacher's effective strategies in an inclusive classroom. The discussion above indicates that the teacher was able to achieve his aims of facilitating the formation of concepts by providing the learners with the opportunity to engage in activities that would enable them to construct meaning and form concepts by integrating spontaneous and scientific concepts. Qualitatively different scaffolds were used strategically to enable the learners to construct their personal meaning, thereby forming mathematical concepts. The achievement of these aims was made possible through the use of activity, appropriate language and reference to real-life situations. Group-work and the use of relevant examples also contributed to the formation of concepts. The teacher scaffolded by using qualitatively different teaching strategies to facilitate the learning and formation of mathematical concepts.

4.6.CONCLUSION

This chapter presented the pre-test and post-test results of the Grade 7 learners. The test results indicate that the teacher's teaching strategies were more effective for the physically disabled learners than the able-bodied learners. This was indicated by the significance of the test results in four sub-tests of the Test of mathematical attainment of the physically disabled learners. The able-bodied learners constituted a small sample and the test results of this group showed no significance. This chapter further presented descriptions of the five lessons. In these descriptions, the manner of how the physically disabled learners and able-bodied learners interacted is described. It is also described how the teacher works with the different learners during the lessons.

This chapter further explored what constituted the teacher's teaching strategies by analysing and interpreting the instructional situation under five categories. These categories were groups; the use of appropriate language; the use of concrete teaching aids;

the use of concrete or direct real-life situations and examples; and scaffolding by using qualitatively different teaching strategies. The use of these categories showed that the learners' physical disabilities did not interfere too much with what was taught. The teacher's good teaching compensated for disability in the Grade 7 classroom. Such good teaching manifested itself when the teacher engaged the able-bodied learners and physically disabled learners in activities that required working in groups thereby facilitating collaborative learning. The teacher's use of simple and appropriate language, thereby working in the learners' zones of proximal development also enabled the learners to communicate effectively with each other and helped them to understand the mathematical concepts of volume. The use of concrete teaching aids and the use of real-life situations functioned as effective scaffolds by enabling the learners to grasp the concepts that were aimed at. The use of examples was also an effective scaffold as it enabled the learners to relate what was taught in class with everyday life. This relation was important as it assisted in the formation of mathematical concepts by bringing scientific and spontaneous concepts together.

In chapter five I will discuss how this data analysis provides answers to my research questions and I will draw out the implications and recommendations for further investigations from my study.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

This study has analysed effective teaching strategies that develop mathematical concepts of measurement in an inclusive classroom. It is clear from this study that certain teaching strategies can be effective in developing mathematical concepts in an inclusive classroom. What follows are the conclusions and recommendations of the study.

5.1 CONCLUSIONS

My conclusions are presented in relation to the research questions.

- **Achievement of aims/objectives in teaching concepts of measurement to all learners.**

The teacher managed to achieve his aims/objectives in teaching concepts of measurement of volume. The test results show that all learners improved in the section on volume and that this improvement is significant only in the case of physically disabled learners and the significance can be attributed to the teaching strategies. The lesson analyses show that learners understood the formula for calculating the volume of a rectangular figure. During discussions, learners recognised similarities and differences pertaining to measures and measuring instruments for measuring volume.

The ability to recognise similarities and differences pertaining to size is crucial for a learner's ability to measure. Dickson et al (1988) acknowledge this point: once attention is drawn to comparing size, in whatever way, then one is embarking on the realms of measurements. By measuring liquids with the appropriate measuring instruments, learners understood the concept of ml and cm^3. The learners also understood the concept of displacement, and learners understood that gases occupy space and therefore their volume can be measured.

The teacher's achieving his aims/objectives was not without hard work and effort: Having to think of precise examples of concepts; reference to real-life situations; selecting appropriate teaching aids that assisted in the formation of mathematical concepts; the skilful thinking for selecting appropriate tasks and effective scaffolds and the teacher's ability to try and reach out to all learners in the classroom were all instances of the teacher's understanding of learners' needs in achieving his aims/objectives.

- **Effective teaching strategies that enable the teacher to achieve his aims/objectives**

The teacher's use of qualitatively different teaching strategies enabled and also assisted learners to construct meaning and form mathematical concepts. These qualitatively different teaching strategies served as scaffolds. These scaffolds entailed the teacher's use of everyday life and real-situations; simple language, which the learners understood;

different examples used to explain the same concepts, and the provision of appropriate mental and physical resources. Group-work, whereby learners were grouped strategically and tactfully in order to work together and thereby construct meaning and form concepts was also one of the scaffolds the teacher used. The use of these different scaffolds functioned as effective strategies that enabled the teacher to achieve his aims/objectives.

Although the use of examples enabled the teacher to achieve his aims/objectives, these were sometimes not fully explained to extract the full meaning of mathematical concepts. This lack of explanation may have led to some learners not understanding clearly some mathematical concepts. During group-work, learners engaged in mathematical talk and discussion. These discussions were not without problems, for example, the domination of some learners that could inhibit others from contributing and thereby constructing meaning.

- **The teacher's use of teaching strategies for teaching measurement concepts differently with different groups of learners (able-bodied learners and physically disabled learners)**

- The teacher's use of teaching strategies for teaching measurement concepts differently with different groups of learners emerged from time to time, depending on a group's need. Working with different groups of learners was also determined by the nature of tasks and activities learners were engaged in. As each group consisted of one able–bodied learner and four physically disabled learners, the teacher used the same teaching strategies with all groups. However, these teaching strategies worked better for the physically disabled learners because these learners were used to the teacher's strategies. The teaching strategies that were used for all groups entailed demonstration of the correct use of concrete and visual aids; discussion of concepts; checking learners to see if they followed what was to be done in their groups; and listening to learners discuss in their different groups. These teaching strategies also linked with the 5 categories that were discussed in Chapter 4.

Although the teacher's working with one group at a time was effective, it sometimes caused the unattended groups to deviate from the prescribed task. Such deviations may prevent the teacher achieving his aims/objectives if these go on without being noticed.

- **The role played by the able-bodied learners and physically disabled learners during interaction on concepts of measurement**

The grouping of learners was strategic and beneficial to all learners because it enabled learners to work collaboratively with each other. Each group consisted of one able-bodied learner and four physically disabled learners. The group members complemented each other. The able-bodied learners were spontaneous in distributing concrete and visual aids. The physically disabled learners were involved in appropriate physical activities that would lead to the formation of mathematical concepts of measurements. The physically disabled learners and able-bodied learners worked collaboratively in mental and physical activities during the lessons. The physically disabled learners and able-bodied learners took decisions on the quantities of liquids, wooden cubes and dice their groups would use to perform the experiments.

The able-bodied learners helped the physically disabled learners in managing the physical tasks of using and handling measuring instruments correctly. In most groups the physically disabled learners were articulate during the groups' discussions while the able-bodied learners listened attentively. The physically disabled learners dominated the able-bodied learners and this was clear because the physically disabled learners outnumbered the able-bodied learners. Both the able-bodied learners and physically disabled learners understood each other's needs. The able-bodied learners assisted some physically disabled learners by pushing them out of the classroom so as to attend to their individual needs such as going to the physiotherapist; going to change nappies; etc..

The above discussion indicated that the teacher was effective in teaching the mathematical concepts especially with the physically disabled learners because of their history in the school, their competence in English and experience with the teaching strategies the teacher employed throughout the lessons. By working within the learners' zones of proximal development, the teacher was also effective in enabling interaction between the able-bodied learners and physically disabled learners, and scaffolding the formation of mathematical concepts through integrating spontaneous and scientific concepts, and through enabling learners to make personal meaning from cultural meaning.

5.2 RECOMMENDATIONS

The recommendations of this study will focus on four groups of people. The four groups are teachers, inclusive schools, in-service training providers, universities and colleges. It should be noted that these recommendations are not necessarily exhaustive; rather they are means towards attaining the best with regard to the teaching of mathematics, and to putting the notion of inclusion into a proper perspective for the four groups of people that have been identified above.

Teachers

Teachers have always been concerned with the content and the quantity of work they have covered or taught in their respective subjects. They have perceived teaching in terms of the amount of work in the learners' workbooks. Interestingly, learners still perform poorly in mathematics tests and assessments even after the hardest input the teachers have made. If real change in teachers' practices is to be attained, then teachers must first understand that learning does not entail providing learners with formulae; filling the learners' workbook with exercises and talking loudly to learners without stopping. Teachers should understand that learning entails creating opportunities for the learners to construct their own mathematical knowledge by engaging in activities that will enable the formation of concepts. Therefore, to create such opportunities for learning requires of teachers to use effective teaching strategies that will benefit the whole learner population in the classroom. With the use of these strategies, the teacher's scaffolds should also be qualitatively different as determined by the tasks at hand. By employing effective teaching strategies, using qualitatively different scaffolds and working within the learners' Z.P.D., the teacher can assist learners to construct meaning and form mathematical concepts.

Inclusive schools

Inclusion is an international and national issue. This implies that learners with different disabilities will be admitted to existing regular schools. The teachers should view the presence of these disabled learners positively and regard teaching of such learners as an opportunity for growth. Those teachers who have positive attitudes towards inclusion tend to employ effective teaching strategies more consistently than those teachers whose attitudes toward inclusion are negative. The teacher in this study has shown that teachers could implement ideas that are derived from the notion of scaffolding. These teachers could learn to work with effective strategies in the learners' Z.P.D.

In-service training

In-service training for teachers is an important way of making teachers who are already in the teaching profession aware of new developments in mathematics and in inclusion. The in-service providers should also be aware that some teachers attending those courses are, or will be teaching in inclusive schools and that those teachers should be catered for by including topics and issues such as teaching mathematics in classrooms comprising of various disabilities. Although the use of terminology would not be exactly the same, ideas and concepts pertaining to scaffolds and the Z.P.D. could be mentioned and communicated to teachers during in-service training. During in-service training, facilitators could also bring about issues related to helping teachers identify and implement teaching strategies that will suit all learners in their classes.

Universities and colleges

Universities and colleges are the two prominent institutions that are involved in the professional training of teachers. Now that inclusion is policy, these institutions could investigate the recommendations for different categories of teacher training for inclusion. Newly qualified teachers and teachers who have no experience of working with disabled learners are employed in LSEN schools. Therefore, universities and colleges could structure their curricula so that issues relating to inclusion are tackled, and newly qualified teachers obtain skills in special education, or a qualification whereby the student majored or specialised in teaching in inclusive classrooms. Another important issue during teacher training at these institutions is that issues relating to scaffolds and the Z.P.D. should be the main focus as these theoretical concepts could form a basis for effective teaching in inclusive classrooms.

Finally, this study has shown that learning mathematical concepts is not necessarily hindered by the physical disabilities of learners for this sample; nor does being able-bodied in an inclusive classroom necessarily enhance the learning of mathematics for the sample in the study. What is crucial are the teacher's teaching strategies that are effected by the teacher to suit the whole learner population in an inclusive classroom.

While many parents are conscious of their rights and their children's rights, for example, their right to take their children to the school of their choice as determined by the proximity of the home and school, many teachers are anxious and frightened by the notion of inclusion which is provided for in the South African Constitution. The teachers' anxiety results from the fact that they are not equipped with skills and expertise to accommodate learners with special educational needs in their classrooms. Although the parents' and the teachers' positions in terms of inclusion should not be polarised, the actual fact is that they are presently, as a result of the South African history and the effect this history has had on the education system.

My study has argued that the teacher in the study is a good teacher. He has worked effectively with both able-bodied learners and physically disabled learners. Such teachers should be commended and other teachers could also learn from their practices. This issue is important when one considers how much work is required to acquire the necessary skills in order accommodate the LSEN learners with special educational needs without feeling threatened. This also reflects on the colleges and universities, as these are the main institutions responsible for teachers' training. Are these institutions ready to equip, educate and train the teachers-to-be so that they could face inclusive education after completion of training without any fears, and therefore with good practices like the teacher in my study? These are some of the issues that should face the South African society and the education system in terms of inclusive education.

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THE TEST OF MATHEMATICAL ATTAINMENT (APPENDIX A)

TRANSVAAL EDUCATION DEPARTMENT

EXPERIMENTAL PLACEMENT TEST IN MATHEMATICS
FOR SPECIAL SCHOOLS AND CLASSES

SCHOOL: ______________________________

NAME OF PUPIL: ______________________________

DATE OF BIRTH: ____________ SCHOOL ADMISSION NUMBER: ____________

TESTER: ____________ DATE OF TESTING: ____________

SUMMARY F PUPIL'S ACHIEVEMENT

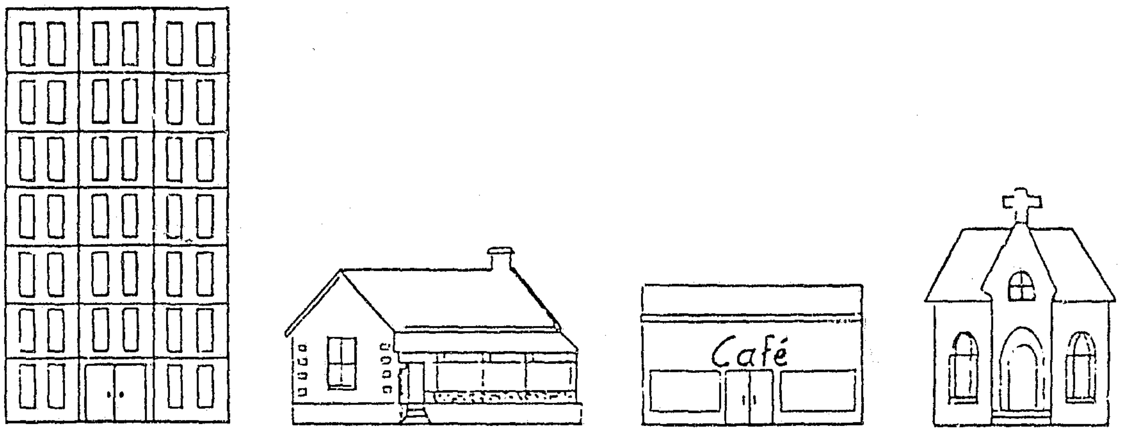
TEST	RAW SCORE	COURSE
1. NUMBER		
2. SIZE		
3. OPERATIONS ON NUMBERS		
4. FRACTIONS		
5. PROBLEM SOLVING		

GENERAL INSTRUCTIONS

1. A pupil may be placed once only by means of this test.
2. The test administrator may read any of the questions to the pupil(s).
3. The time allowed for each test should be approximately 45 minutes.
4. The tests are concerned only with the mathematical concepts. Therefore, in marking them, no marks should be subtracted for poor spelling or writing. For example, do not subtract marks for Ƨ (in the place of 5).
5. Allocate one mark for each correct answer.
6. The Tests appear on pages 2 to 22; the Placement Tables on pages 1; 23; 24 and the Marking Memoranda on pages 25 to 30.

TEST 1

NUMBER



FLATS HOUSE CAFE CHURCH

1. HOW MANY BUILDINGS ARE THERE?

....

2. What BUILDING is SECOND?

....

3. What building is NEXT to the church?

....

4. What building is BETWEEN the CAFé and the BLOCK OF FLATS?

....

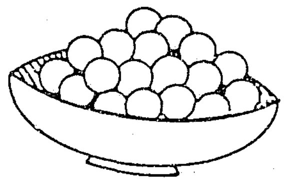
5. How many PAIRS of windows can you see in the block of flats?

....

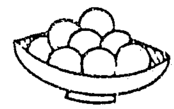
6. Does the block of flats have an even or odd number of windows?

....

7.



MEESTE



MINSTE

Watter getal is die meeste, 12 of 21?

....

8. Watter getal sal in die oop blokkie pas?

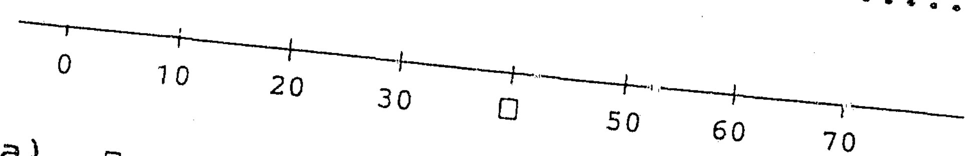
Skryf dit in.

20	19		17	16	15	14

9. Skryf die woord sewentien in syfers

....

10.



(a) □ = ...

(b) Watter getal is vierde?

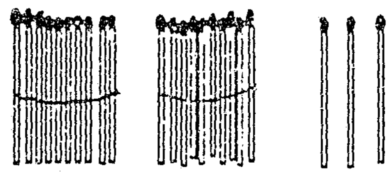
....

(c) Watter getal is tussen 10 en 30?

....

(d) Skryf die laaste getal van die getallelyn in woorde

....

11. 

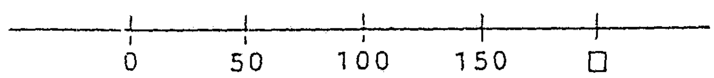
Watter getal word deur die tekening voorgestel?

(Daar is tien vuurhoutjies in elke bondel)

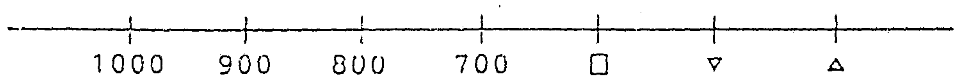
....

12. Skryf in syfers: vier honderd en sewe

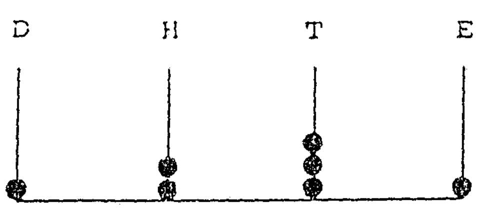
....

13. 

□ = ...

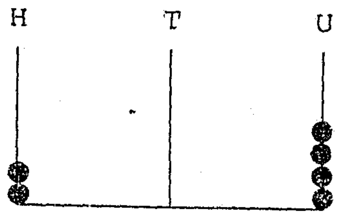
14. 

(a) □ = ... (b) ▽ = ... (c) △ = ...

15. 

Watter getal word hier aangedui?

....

16. 

What number does the drawing show?

....

17. What is the (total) numerical value of the underlined digit?

4<u>2</u>6 ....

18. Round off to the nearest ten

467 ....

19. Round off to the nearest hundred

467 ....

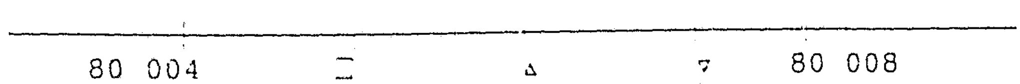
20. Write in figures

Three thousand two hundred and eight

....

21. Place < or > in the box so as to obtain a true result

2378 ☐ 597

22. 

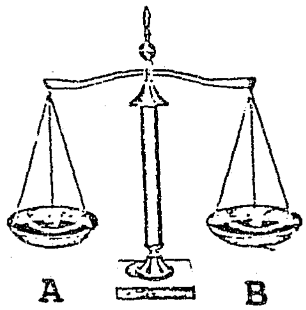
(a) □ = ... (b) △ = ... (c) ▽ = ...

TEST 2 SIZE

1. We say that an object with a GREAT MASS IS HEAVY. An object with a SMALL MASS is therefore said to be

....

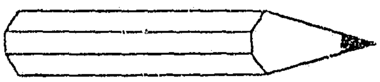
2.



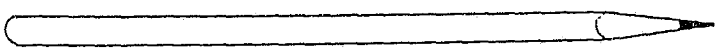
If you put TWO SPOONFULS of sugar into SCALE PAN A and FIVE SPOONFULS in SCALE PAN B, what will happen?

....

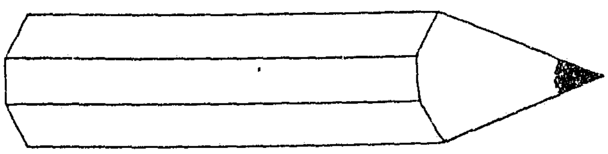
A



B



C



3. Pencil .... is the LONGEST

4. Pencil .... is the THICKEST

5. Choose "LONGER" or "SHORTER"

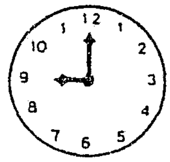
One metre is .... than one centimetre

6. Choose "MORE" or "LESS"

(a) 1 litre is .... than 1 millilitre

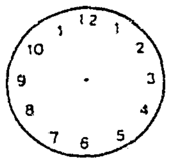
(b) 500 mℓ is .... than 1 litre

7. Write the time this clock shows



....

8. Show half past seven on this clock



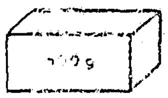
9. (a) 6 rands 75 cents = R ....

(b) 2 rands 6 cents = R ....

10. 2 rands 6 cents = ... cents

11. There are .... centimetres in one metre.

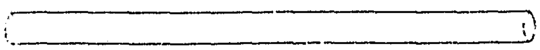
12. I need 1 kg butter.



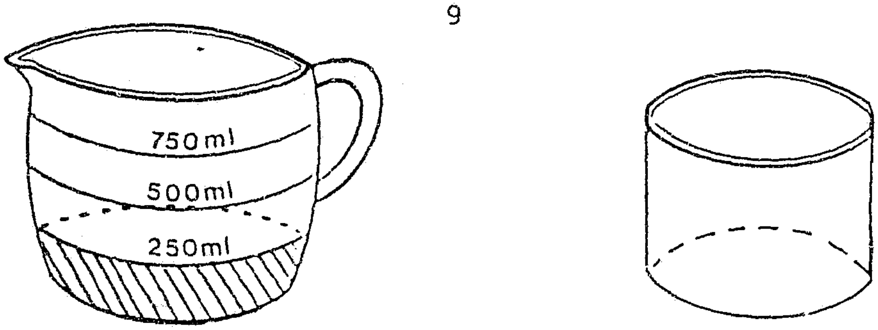
How many blocks of the butter shown do I need?

....

13. Estimate the length of the straw in centimetres



....

14. 

The glass can hold 500 mℓ water. If the water in the jug is poured into the glass, how full will the glass be?

....

15. Jake's birthday is on 2 February. Ann's birthday is one week later. When is her birthday?

....

16. Put the following words in the right places:

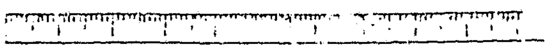
LENGTH MASS CAPACITY

(a) We use litres to measure ....

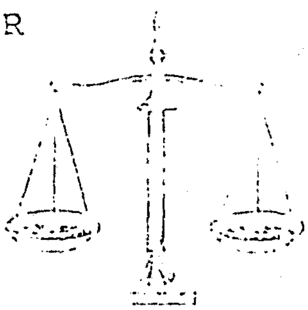
(b) We use metres to measure ....

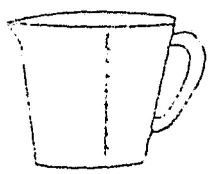
(c) We use grams to measure ....

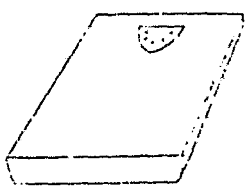
17. You want to measure out 300 mℓ of sugar to bake a cake. What will you use?



RULER







MEASURING JUG BATHROOM SCALE

BALANCE ....

18. Write in kilometres:

2 343 m ....

19. 1 m 423 mm = ...m

20. 1 m 423 mm = ...mm

21. 1 kg 23 g = ...kg

22. 1 kg 23 g = ...g

23. Choose the answer closest to the correct answer:

You bath in 10 ℓ / 100 ℓ / 1000 ℓ water

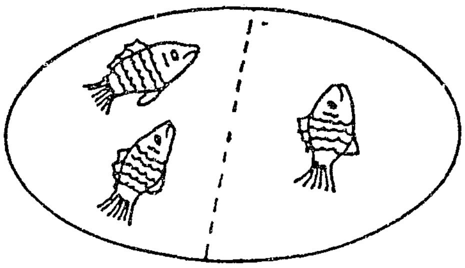
....

Score

OPERATIONS ON WHOLE NUMBERS

TEST 3

1.



Use the drawing to complete the sum □ + △ = ▽

2. ● ● ● ● ●

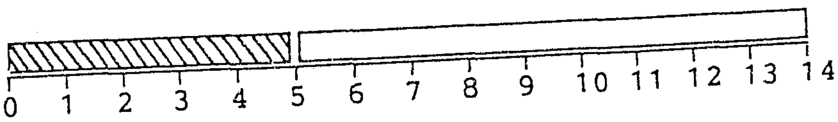
x x x

There are more dots than crosses above.

How many more?

....

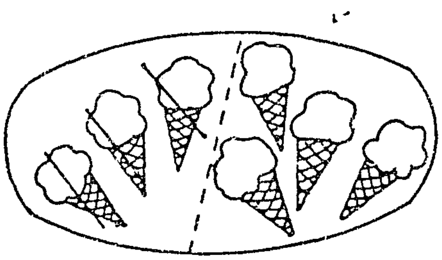
3.



□ + △ = ▽

Use the number line to complete the sum.

4.

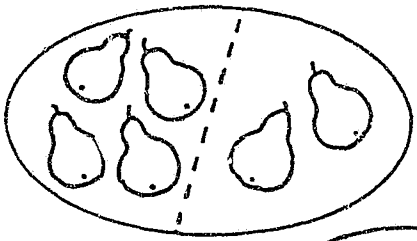


(a) 7 - 3 = □

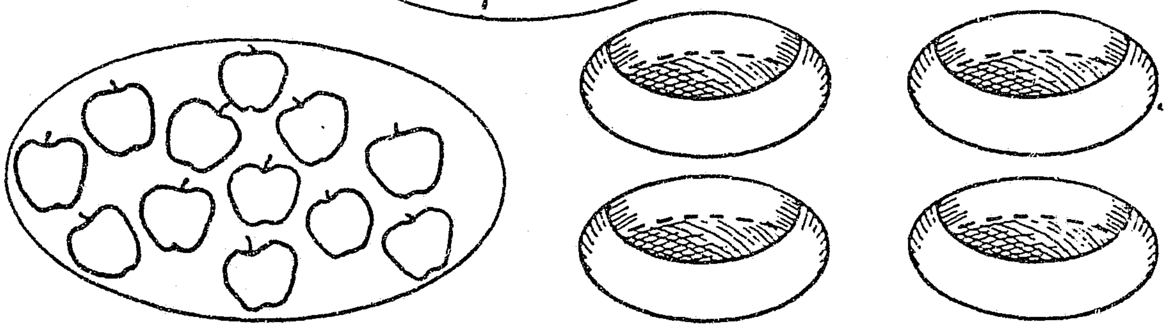
(b 7 - □ = 3

5. Complete

$4 + \boxed{} = 6$



6.



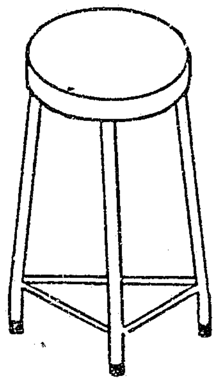
How many apples will go into each bowl if they are separated into 4 groups of equal size?

....

7.

Ben puts 2 apples in each bowl. How many bowls does he need?

....

8. 

The stool has three legs. How many legs are there altogether if there are five stools? Show how to get your answer in two ways (using different operations)

(a) ....

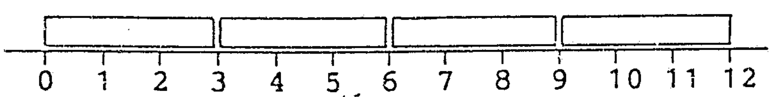
(b) ....

9. 15 − 10 = □

10. 4 + 4 + 4 + 4 + 4

= □ x △

11. 5 c + 2 c + 1 c = ...

12. 

Write a multiplication sum below for the number line picture □ x △ = ▽

13. 3 x 10 = ...

14. 500 ÷ 10 = ...

15. $\begin{array}{r} 362 \\ +\ \underline{135} \\ \end{array}$

16. $\begin{array}{r} 76 \\ +\ \underline{15} \\ \end{array}$

17. $\begin{array}{r} 78 \\ -\ \underline{23} \\ \end{array}$

18. $\begin{array}{r} 74 \\ -\ \underline{27} \\ \end{array}$

19. $\begin{array}{r} 40 \\ -\ \underline{16} \\ \end{array}$

20. $\begin{array}{r} 23 \\ \underline{\times 2} \\ \end{array}$

21. $\begin{array}{r} 47 \\ \underline{\times 5} \\ \end{array}$

22. $\begin{array}{r} 32 \\ \times\underline{15} \\ \end{array}$

23. $3\overline{)63}$

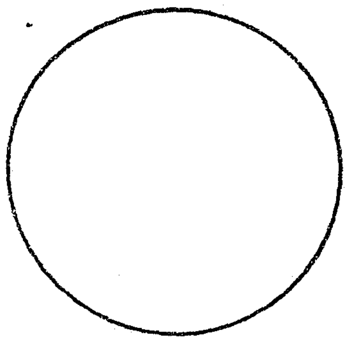
24. $4\overline{)52}$

25. $5\overline{)56}$

Score

TEST 4 **FRACTIONS**

1.



Divide into half, and colour in one half

2.

If half these cats run away, how many would be left?

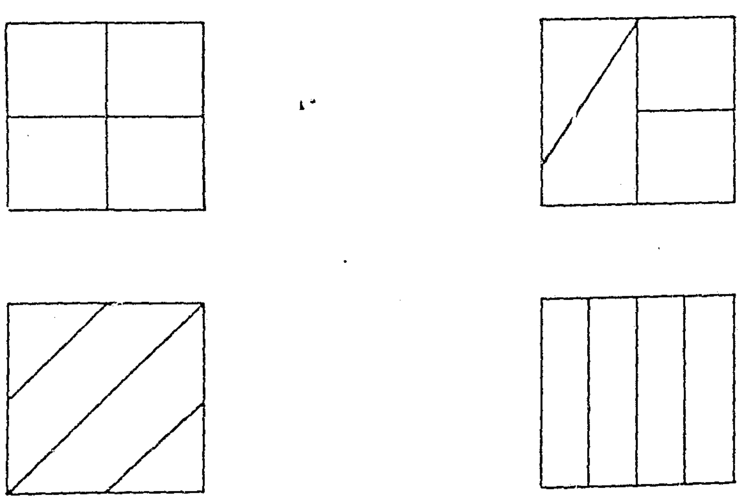
....

3. Write in figures:

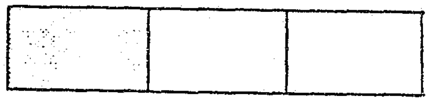
(a) one fifth ....

(b) one quarter ....

4.



Put a ring around each square that has been divided into quarters

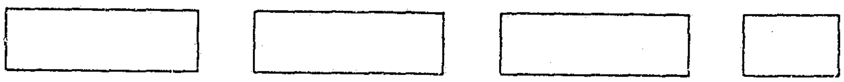
5. 

What fraction is the shaded part of the whole shape?

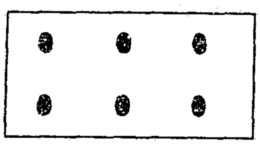
....

6.  This represents one bar of chocolate

Write in figures how many bars of chocolate there are below:



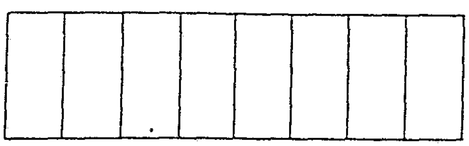
....

7. 

$\frac{1}{3}$ of 6 = ...

8. $\frac{1}{2}$ of 10 = ...

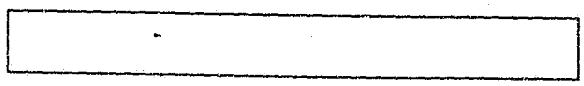
9. Write in words: $\frac{1}{8}$ ....

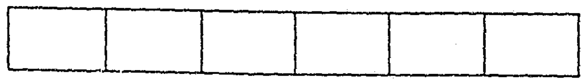
10. 

The rectangle has been divided into ....

parts equal in size. We call each part ....
of the whole rectangle.

11. Here is the whole shape



(a) 

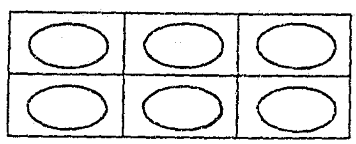
Into how many parts has the whole shape been divided?

....

(b) What fraction is each small part of the whole shape?

....

12. Here is a whole set of eggs in an egg box.



(a) How many eggs are there in the egg box?

....

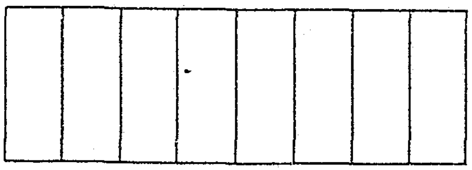
(b) What fraction is 1 egg of the whole set of eggs?

....

(c) What fraction is 2 eggs of the whole set of eggs?

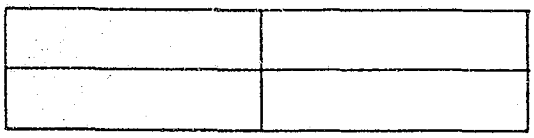
....

13.



Colour in $\frac{3}{8}$ of the above rectangle.

14.

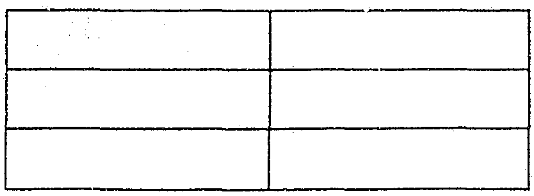


Give two equivalent fractions for the shaded part of the whole rectangle

(a) ....

(b) ....

15.



Give two equivalent fractions for the shaded part of the whole rectangle

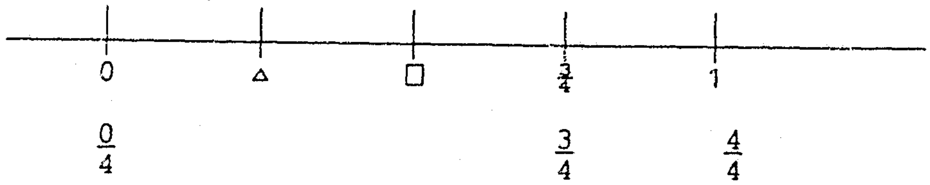
(a) ....

(b) ....

16. Complete

$$\frac{2 \times \square}{7 \times \bigtriangledown} = \frac{\triangle}{28}$$

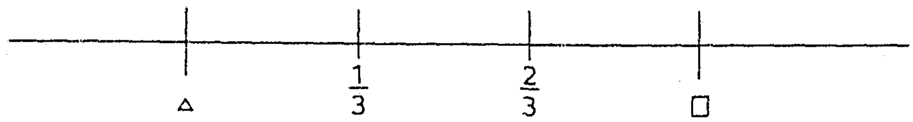
17. Complete



(a) △ = ...

(b) □ = ...

18. Complete

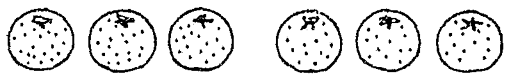


(a) △ = ...

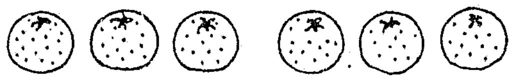
(b) □ = ...

19.

(a) $\frac{1}{4}$ of 12 = ...



(b) $\frac{3}{4}$ of 12 = ...



20. $\frac{2}{3}$ of one cold-drink can be found by dividing the cold-drink into .... parts equal in amount and taking............ of these parts.

21. If □ denotes $\frac{1}{5}$ of a chocolate bar, make a picture of $\frac{2}{5}$ of that chocolate bar.

Score

TEST 5 PROBLEM SOLVING

Simon and Rebecca are having friends to tea.

They bake pancakes and a cake.

Here are their recipes:

Pancakes	Cake
100 g flour	200 g flour
500 mℓ milk	100 g sugar
1 tablespoon melted butter	100 g butter
2 eggs	4 eggs
pinch of salt	100 mℓ milk
	8 drops vanilla essence

1. How much flour will Simon and Rebecca need for the baking of the pancakes and the cake?

   ....

2. They start with a 1 000 g bag of flour. How much will they have left when they are finished baking?

   ....

3. Next time they want to bake 3 cakes. How much of each ingredient will they use?

.... flour

.... sugar

.... butter

.... eggs

.... milk

.... vanilla

4. Last time they made half the pancake batter. How much of each ingredient did they use?

.... flour

.... milk

.... melted butter

.... egg

5. Rebecca decides to make 4 small cakes using the recipe for the big cake. How much of each ingredient should she use for ONE small cake?

.... flour

.... sugar

.... butter

.... eggs

.... milk

.... drops of vanilla essence

Score

MARKING OF TESTS

An answer is either right or wrong. Award one mark for each right answer.

The child's course level for each mathematical concept is calculated according to the table below, and transferred to the cover.

Place the pupil according to the modal course (that is, the course-level he obtains the greatest number of times). For example Dirk obtains course level 5 for 'number', 4 for 'size', 4 for 'operations' and 2 for 'fractions'. Therefore he is placed in course level 4, but for 'fractions' he should receive individualized instruction at course 2 level. If a pupil obtains 2 courses an equal number of times, place him at the lower course level.

TEST 1

RAW SCORE	COURSE LEVEL FOR NUMBER/NUMERAL CONCEPT
0 - 3	Pre-School
4 - 9	Course 1
10 - 15	Course 2
16 - 21	Course 3
21 - 22	Course 4
23 - 24	Course 5
25 - 26	Course 6

TEST 2

RAW SCORE	COURSE LEVEL FOR SIZE CONCEPT
0 - 2	Pre-School
3 - 6	Course 1
7 - 10	Course 2
11 - 12	Course 3
13 - 14	Course 4
15 - 16	Course 5
17 - 18	Course 6

TEST 3

RAW SCORE	COURSE LEVEL FOR OPERATIONS
0 - 3	Pre-School
4 - 11	Course 1
12 - 23	Course 2
24 - 29	Course 3
30 - 32	Course 4
33 - 35	Course 5
36 - 39	Course 6

TEST 4

RAW SCORE	COURSE LEVEL FOR FRACTION CONCEPT
0 - 3	Pre-School
4 - 6	Course 1
7 - 10	Course 2
11 - 13	Course 3
14 - 16	Course 4
17 - 19	Course 5
20 - 22	Course 6

TEST 5

RAW SCORE	COURSE LEVEL FOR PROBLEM SOLVING
0	Pre-School
1	Course 1
2 - 3	Course 2
4 - 5	Course 3
6 - 8	Course 4
9 - 10	Course 5
11 - 13	Course 6

MORANDUM

ST 1 (SPELLING DOES NOT COUNT) NUMBER OF MARKS

1	4	1
2	The house	1
3	The café	1
4	The house	1
5	20	1
6	Even	1
7	21	1
8	18	1
9	17	1
10(a)	40	1
10(b)	30	1
10(c)	20	1
10(d)	Seventy	1
11	23	1
12	407	1
13	200	1
14(a)	600	1
14(b)	500	1
14(c)	400	1
15	1 231	1
16	204	1
17	20	1
18	470	1
19	500	1
20	3 208	1
21	>	1
22(a)	80 005	1
22(b)	80 006	1
22(c)	80 007	1
23	70 657	1
	TOTAL	30

)RANDUM

r 2 (SPELLING DOES NOT COUNT) NUMBER OF MARKS

	Light	1
	pan B will be lower than pan A	1
	B	1
	C	1
	longer	1
;(a) (b)	more less	1 1
7	9 o' clock	1
		1
9(a)	R6,75	1
9(b)	R2,06	1
10	206 c	1
11	100	1
12	2	1
13	7 cm Accept, 5 cm, 6 cm as well as 7 cm	1
14	half	1
15	9 February	1
16(a)	capacity	1
16(b)	length	1
16(c)	mass	1
7	measuring jug	1
18	2,343 km	1
19	1,423 m	1
20	1 423 mm	1
21	1,023 kg	1
22	1 023 g	1
23	100 ℓ	1
	TOTAL	27

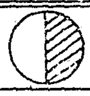
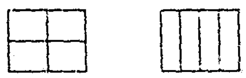
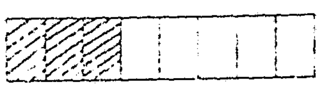
MEMORANDUM

TEST 3 (SPELLING DOES NOT COUNT) NUMBER OF MARKS

1	2 + 1 = 3	3
2	2	1
3	5 + 9 = 14	3
4(a)	4	1
4(b)	7 - 4 = 3	1
5	2	1
6	3	1
7	4	1
8(a)	5 x 3 = 15	1
8(b)	3 + 3 + 3 + 3 + 3 = 15	1
9	5	1
10	5 x 4	2
11	8 c	1
12	4 x 3 = 12	3
13	30	1
14	50	1
15	497 (Allocate one mark for each correct digit)	3
16	91	2
17	55	2
18	47	2
19	24	2
20	46	2
21	235	3
22	480	3
23	21	2
24	13	2
25	11 rem 1	3
	TOTAL	49

ORANDUM

,T 4 (SPELLING DOES NOT COUNT) NUMBER OF MARKS

		2
	2	1
3(a)	$\frac{1}{5}$	1
(b)	$\frac{1}{4}$	1
4		2
5	$\frac{1}{3}$	1
6	[illegible]½	1
7	2	1
8	5	1
9	one eighth	1
10	eight; eighth	2
11(a)	6	1
(b)	one sixth (or $\frac{1}{6}$)	1
12(a)	6	1
(b)	$\frac{1}{6}$	1
(c)	$\frac{2}{6}$ or $\frac{1}{3}$	1
13		1
14(a) (b)	$\frac{1}{2}$ $\frac{2}{4}$	2
15(a) (b)	$\frac{1}{2}$ $\frac{3}{[illegible]}$	2
16	$\frac{2 \times 4}{[illegible]} = \frac{3}{[illegible]}$	3
17(a) (b)	[illegible]	2
[illegible]	[illegible]	[illegible]

OBSERVATION SCHEDULE (APPENDIX B)

The observation schedule consists of four categories of analysis. These categories are groups; teacher/learner interaction; learners' tasks and activities; and teaching aids.

1. Groups

Categories	**Description**
a) Does the teacher use group-work?	___________________
b) Do groups consist of equal number of learners?	___________________
c) Do groups change?	___________________
d) Are learners grouped according to their physical disabilities?	___________________
e) Are able-bodied learners allowed to work with different groups? If so, when?	___________________

2. Teacher/learner interaction

Categories	Description
a) Does the teacher use different teaching strategies during the lesson?	____________
b) What is the nature of these strategies?	____________
i) Verbalisation/communication?	____________
ii) The use of concrete aids?	____________
iii) Working with learners' misconceptions and errors?	____________
iv) Analogies and explanations?	____________
v) Other?	____________
c) To what extent does the teacher try to work with as many individual learners or groups as possible?	____________

d) Does the teacher call for attention? ________________

3. Learners' tasks and activities

Categories	Description
a) Are learners actively involved during the lesson?	________________
b) What is the nature of activities?	________________
c) Do learners ask questions?	________________
d) What kind of questions do learners ask	________________
e) Do learners move freely during the lesson?	________________
f) To what extent does the teacher allow pupils to decide how long they want to remain at a particular activity?	________________
g) To what extent do learners interrupt the lesson?	________________
h) How does teacher work with different physically disabled learners to take account of?	________________

4. Teaching aids

Categories	Description
a) Does the teacher use different teaching aids?	________________
b) Do groups use different teaching aids in the same lesson?	________________
c) Does the teacher use visual and manipulative teaching aids?	________________
d) Did the learners use the teaching aids in a way which helped their understanding?	________________
e) Does the teacher give different tasks to different groups?	________________
f) Does the teacher allow general discussions concerning tasks?	________________

LEARNERS'INTERVIEW SCHEDULE (APPENDIX C)

The learners were interviewed after the teacher had conducted all lessons on volume. The categories in the schedule relate to the manner of interaction during teaching.

1. When you were working in your group, you…Why?
2. When…did…you did/said …Why?
3. Do you like working in a group? Why/why not?
4. Do you like to discuss in your group? Why/why not?
5. Which tasks do you like? Why?
6. Can you use some/all the learning aids?
7. Which learning aids can you use?
8. How do you use the learning aids?
9. What did the learning aids help you to learn?

TEACHER'S INTERVIEW SCHEDULE (APPENDIX D)

The teacher's interview was conducted after he had taught all lessons on volume. The categories focused all the main aspects of the lessons. These categories related to the main questions of this research report.

1. Aims and objectives

a) What was the overall aim of the lesson?

b) What must learners be able to do at the end of the lesson?

c) What volume concepts did you want the learners to learn?

2. Groups

a) Why did you group the learners?

b) Why were the learners grouped in that way?

c) Why were the learners involved in discussions?

d) Why were the able-bodied learners allowed to work in the different groups?

e) Was the grouping successful in helping the learners to learn volume?

3. Learners' activities

a) How did you select your tasks?

b) Why were learners given the same tasks?

c) Do you think the learners succeeded in performing the prescribed tasks?

d) Why were the learners successful/not successful in performing the prescribed tasks?

e) Did the tasks help learners to learn the concepts of volume?

f) What do you think learners need in their learning of volume?

4. Teaching strategies

a) What do you identify as your main teaching strategies?

b) How did you select your teaching aids?

c) To what extent do you think the learners are able to handle and use the teaching aids?

d) Did your teaching strategies help learners in learning the concepts of volume?

e) What do you think is your most effective way of communicating during your teaching?

f) How do you work with learners' misconceptions?

g) Do you use analogies? If so, when and how?

h) Do you use and refer to learners' concrete and real-life experiences?

i) Do you use any other strategies?

LEARNERS' INTERVIEWS (APPENDIX E)

The learners which were interviewed were selected on the basis of their manner of interaction within their groups: verbal utterances during the lesson; active involvement during the lesson; etc. and the learners were also selected from the able - bodied and the physically disabled.

1. MARCUS (A PHYSICALLY DISABLED LEARNER WHO IS ALSO A STAMMERRER)

Interviewer (I): Were you the group leader?

M: No, or I don't know.

I: But you were talking all the time, explaining to the others?

M: Yes, I was. I wanted to.

I: Doesn't your speech disturb you when you explain something to the other learners?

M: Yes, "it disturb me."

I: How does it disturb you?

M: Sometimes I forget what I want to say and some people don't have time to listen to me.

I: To listen to you?

M: Yes. It's like I'm taking their time.

I: Do you mean they don't have patience?

M: Yes, I wanted to say patience.

I: But those in your group listened to you?

M: Yes, I like to work with them.

I: Why do you like to work with them?

M: They listen when I say something and they don't laugh or tell me to speak "quick".

I: Did you choose to work with them?

M: "No, Teacher knowsthat they have ee.:...patience".

I: So, you say it's the teacher who chose them to work with you?

M: Yes.

I: I liked the way you were explaining and talking all the time.

M: Yes, Nthabiseng is always quiet.

I: So?

M: She must also talk when we are working.

I: What about Winnie?

M: Ja, she is good.

I: She is good?

M: "Ja, she give us the things Teacher said we must use."

I: Which things?

M: These things (pointing at the learning aids).

I: Do you like working in a group?

M: Yes.

I: Why?

M: You help each other.

M: Yes, I like to work with them.

I: Why do you like to work with them?

M: They listen when I say something and they don't laugh or tell me to speak "quick".

I: Did you choose to work with them?

M: "No, Teacher knowsthat they have eeh…patience".

I: So, you say it's the teacher who chose them to work with you?

M: Yes.

I: I liked the way you were explaining and talking all the time.

M: Yes, Nthabiseng is always quiet.

I: So?

M: She must also talk when we are working.

I: What about Winnie?

M: Ja, she is good.

I: She is good?

M: "Ja, she give us the things Teacher said we must use."

I: Which things?

M: These things (pointing at the learning aids).

I: Do you like working in a group?

M: Yes.

I: Why?

M: You help each other.

I: Do you always want to be helped?

M: No.

I: But you said you help each other?

M: If you are not good here (touching his mouth, meaning talking) they can say you must write the measurements.

I: Who is not good here?

M: Nthabiseng.

I: Was she writing down the measurements?

M: Yes.

I: Do you like to discuss when you work in your group?

M: Yes.

I: Why?

M: It's like you are explaining to others.

I: Do you like others to explain to you?

M: Yes. They help me when they explain.

I: Do you like it when the teacher uses things like measuring cylinders; water; stone…?

M: Yes.

I: Why?

M: "It's like you don't forget and other children help you when you don't understand".

I: Can't the teacher help you when you don't understand?

M: Teacher can help.

I: So?

M: Sometimes Teacher is not here with us.

I: Where does he go?

M: No, I mean he's with the other children.

I: Which children?

M: The other groups. Or sometimes we work after school when you are not here, or we write our homework in the dormitories.

I: Do you take anything and work with it?

M: "No, Teacher tells us what we must use and after school we sit in our class and do the homework".

I: Does the teacher give you homework?

M: Yes! A lot!

I: When?

M: "Everyday or maybe if we are not finish doing our work during his period we know it will be our homework".

I: Can you use the measuring cylinders?

M: Yes.

I: How can you use them?

M: Maybe to show that 150ml =150cm^3; or 1l = 1000ml (he demonstrates this by using water and the measuring cylinders.)

I: Did the measuring cylinders help you?

M: Yes.

I: How did they help you?

M: To show that 150ml = $150cm^3$ or 1000ml = $1000cm^3$.

I: Which measuring cylinders showed you that 150ml = $150cm^3$ or 1000ml = cm^3?

M: This one and this one [he points at two measuring cylinders - one is calibrated in ml and the other in cm^3].

I: The teacher spoke of "displacement" and you gave the example of "inside a pot, when you put salt, mieliemeel and then cook porridge". What displaces?

M: I mean if there is water in the pot and then you put salt and mieliemeel, the water in the pot will go up.

I: Can the salt displace the water?

[He pauses for sometime, and then he answers].

M: I think if you put too much salt you will see the water going up in the pot.

I: Too much salt? How much?

M: Maybe…I think a packet of salt.

I: What about the salt when you cook porridge? Can it displace the water in the pot?

M: Yes, but we can't see it.

2. MPHO (A PHYSICALLY DIASBLED LEARNER WHO DID ALL THE WRITING AND RECORDED ALL THE INFORMATION DURING GROUP - WORK).

I: In your group, you recorded all the information, and you wrote down all the measurements your group came up with. Couldn't other members of your group record your groups' measurements (findings)?

M: Mam, I choose to write because Peter can't see well and Samkelo was busy with other things [Peter has a sight problem and wears spectacles. He does not have them on because they are broken. Samkelo is an able-bodied learner].

I: Which things?

M: Like bringing water or bringing the other things for measuring.

I: What about Malcolm?

M: "Aah…He talks too much with Peter when he must write and Teacher will say it is time up.

I: But he (Malcolm) could help Samkelo bring the other things?

M: No, he won't be fast like Samkelo.

I: What do you mean?

M: It's because of the wheelchair [he means Malcolm is in a wheelchair].

I: What about Samkelo?

M: He is fast. He can carry these things [pointing at the learning aids].

I: Is it good that Samkelo is in your group?

M: Yes.

I: Who grouped you with Samkelo?

M: It's Teacher.

I: During the first lesson, the teacher asked you if you could give or say anything you have learned about volume. You said we can measure volume. You gave the example of "when you buy half-a-litre of Coke. Did you mean you first measure it when you arrive at the shop?

M: No. The people who work at Coke measure it for us and we buy it at the shop.

I: Which other things tell us that you can measure volume?

M: If you drink tea or coffee or water.

I: What do you mean?

M: 1 cup of tea, or 1 glass of water.

I: What about Coke? What volume of Coke can you drink?

M: I can drink 1 or 2 glasses of Coke. If I want to know how many ml, I will use the measuring cylinder.

I: Do you like working in a group?

M: Yes.

I: Why?

M: It's like you share.

I: What do you share?

M: Sometimes Teacher give us too much work and you can say I'm going to write, Samkelo will say I'm going to take the things and Malcolm will say I'm reading the things of the worksheet.

I: Can't you do all these things alone?

M: If you work alone you get tired quickly.

I: Who said you must record the measurements?

M: I said I will record and they said yes.

I: Who said Samkelo must give you the measuring cylinders and get the water for your group?

M: "Nobody. It's him. He always do that".

I: Do you like to discuss in your group?

M: Yes.

I: Why?

M: You help each other.

I: Do you also help others in your group?

M: Yes.

I: I saw Samkelo put the measuring cylinder next to Maria and Maria said "Ja". Did you see that? [Maria is spastic cerebral palsied. She thus has jerky and involuntary movements].

M: Yes.

I: Why did he do that?

M: He was helping Maria.

I: Why did he help her?

M: "You see, Maria cannot go down and look careful at the measuring cylinder."

I: You say Maria cannot bend?

M: Yes. And she can break the measuring cylinder. So, it's better if you help her.

I: Which ways of working do you like when you work here in class when it is maths?

M: What?

I: Do you like working alone, or doing things with other children?

M: I like to work with other children.

I: Why?

M: You don't get tired.

I: You don't get tired?

M: Yes, other children can help you if you can't do something. Like Samkelo or Winnie or anybody. But you must also help them with something that you can do.

I: Me?

M: No, I'm talking about me.

I: So, you help each other?

M: Yes.

I: Can you use the measuring cylinders?

M: Yes.

I: To do what?

M: If I want to measure the volume of water.

I: What volume of water did you measure?

M: Samkelo measured.

I: Yes, he was in your group and you were recording.

M: I think the water in the cup is 260ml.

I: Didn't you use the other measuring cylinders?

M: We used them.

I: What did you measure?

M: "We first pour 500 of water in this measuring cylinder and then we pour this water in this one"[he refers to 2 measuring cylinders: the first is round-bottomed and calibrated in cm^3, and the second is rectangular-based and calibrated in ml].

I: What did you see?

M: "Here in this one [rectangular -based measuring cylinder] we see that it is 500".

I: 500 what?

M: Ooh…500ml.

I: Here it is $500cm^3$ and here it 500ml?

M: What do you think it means?

I: I think it means you can measure this 500 of water with this one or this one [he points at the two measuring cylinders].

I: What about the cm^3 and ml?

M: "I think if you like you say cm^3 or ml."

I: Can I say 500 with this water [pointing at the cm^3 and ml measuring cylinders]?

M: You can say $500cm^3$ or ml.

I: Is 500 in this one [round - bottomed measuring cylinder] equal to 500 in this one [rectangular - based measuring cylinder?]

M: Yes.

I: Is $500cm^3 = 500ml$?

M: Yes.

I: Can we say $cm^3 = ml$.

M: Mmm…Yes.

I: Where did you see that?

M: In this measuring cylinder and this one [he points at the two measuring cylinders].

I: Can you say $250cm^3 = 250ml$?

M: Yes.

3. WINNIE (AN ABLE-BODIED LEARNER WHO PARTICIPATED ACTIVELY DURING THE LESSONS.)

I: In your group you always hand out the measuring cylinders, get water for your group and hand out the worksheets. Why is it you that does all these things?

W: I don't have a problem.

I: You don't have a problem? What problem?

W: I can walk or do anything.

I: Who cannot do anything?

W: Mpho, Happiness, Marcus, …(she names all the physically disabled learners in her group).

I: What is it that they cann ' do?

W: They cannot walk or run or hold things like me.

I: Is important that they walk or run or hold things like you?

W: Yes.

I: When?

W: Like when you measure or need water for the measuring cylinders.

I: Water for the measuring cylinders?

W: Yes. For measuring volume.

I: What volume?

W: The volume of water.

I: What volume of water did y a measure?

3. WINNIE (AN ABLE-BODIED LEARNER WHO PARTICIPATED ACTIVELY DURING THE LESSONS.)

I: In your group you always hand out the measuring cylinders, get water for your group and hand out the worksheets. Why is it you that does all these things?

W: I don't have a problem.

I: You don't have a problem? What problem?

W: I can walk or do anything.

I: Who cannot do anything?

W: Mpho, Happiness, Marcus, …(she names all the physically disabled learners in her group).

I: What is it that they cannot do?

W: They cannot walk or run or hold things like me.

I: Is important that they walk or run or hold things like you?

W: Yes.

I: When?

W: Like when you measure or need water for the measuring cylinders.

I: Water for the measuring cylinders?

W: Yes. For measuring volume.

I: What volume?

W: The volume of water.

I: What volume of water did you measure?

W: 100.

I: 100 what?

W: It was 100ml.

I: Nthabiseng said "why o sa tshele metsi a fitlhe ko 100"? [This means "why don't you pour water up to 100?"]. You asked her 100 what? Why did you ask "100 what"?

W: Teacher said it is important to say the unit.

I: What unit?

W: Maybe ml or cm^3.

I: But you did not mention the unit.

W: I am forgetting.

I: Let's talk about the things the other children cannot do. Why do you do those things that they cannot do?

W: We help each other.

I: You help each other?

W: Yes.

I: How do you help them?

W: I push Nthabiseng to the toilet or library or anywhere.

I: And here in class during the mathematics period?

W: I fetch their books or get water or measuring cylinders and then we work.

I: A . they helpful to you?

W: Yes.

I: How?

W: Mateo can read very well. He's good and he is not shy [Mateo is physically disabled, articulate and outspoken].

I: Are you shy? I don't think you are.

W: Yes, I'm shy when I don't know the answer. But Mateo is not.

4. SAMKELO (AN ABLE-BODIED LEARNER WHO PARTICIPATED ACTIVELY AND HELPFULLY DURING THE LESSONS).

I: In your group you handed out the measuring cylinders, got water for the group and handed out the worksheets. Who asked you to do that?

S: I always do that.

I: Why do you always do that?

S: The other children cannot do that. So, I do it.

I: Do you like helping other learners?

S: Yes, but they also help me.

I: They also help you?

S: Yes, Teacher says we must always sit in groups.

I: Why does Teacher want you to sit in groups?

S: Teacher says we can help each other.

I: Which things do you like to do when you work in a group?

S: I like to bring the things we are going to use. Sometimes Siyanda asks me to push him to the toilet, or to give him his books or anything (Siyanda is physically disabled and wheelchair bound).

I: You like doing all that?

S: Yes, you see, we help each other.

I: How do they help you?

S: Siyanda is good in maths and science. So, when we work together he can show us some of the things we don't understand.

I: Can you use the measuring cylinders?

S: Yes.

I: How can you use them?

S: Maybe to show that ½ litre = 500ml.

I: Did you learn about units that are the same?

S: Yes. It's ml and cm^3.

I: How do you know that these units are the same?

S: Maybe if have 500ml and pour it in the other measuring cylinder, it will be $500cm^3$.

I: Why is it still 500?

S: It means $500ml = 500cm^3$.

TEACHER'S INTERVIEW (APPENDIX F)

This interview was conducted after the teacher had presented the 5 lessons on volume. The questions asked were posed on the basis of the teacher's presentations of the lesson, i.e. what I considered significant to the conceptual understanding of volume.

Interviewer (I): I saw that throughout the lessons the learners were grouped. Why did you group the learners?

Teacher (T): Children can learn easily when they work in groups.

I: How does working in groups help them to learn easily?

T: You see, children are not the same. There are those who can lead in a group and then sort of "pull up" the weaker ones. There are those who prefer to move and help in bringing all the things they will need as a group. There are those who like to record the findings. Now if you combine all these characters from all these children, then you can help them to learn more in their groups.

I: I noticed that your groups did not change throughout the five lessons I observed. Why did the groups not change?

T: Well, I personally believe in group-work. So, I change the groups every week. Last week they were not in the groups they are in this week. Next week the groups will also.

I: How do group them?

I: I make sure that each group has one normal child [he refers to able-bodied learner]; some on wheelchairs; and some on crutches.

I: Why this combination?

T: At least I know every time that each group will work well. Those who can move can help in bringing the teaching aids; some will write down; etc.. In short I always know that the groups are balanced, sort of.

I: How do select your tasks?

T: I choose those that will encourage the children to work in groups. I also prefer tasks that can be done practically, like doing experiments. I call these tasks "hands-on" tasks.

I: What do think learners need to know in order to understand volume?

T: I think they need to know or understand perimeter, area and measurement. From there, I can help with other things in learning volume.

I: What do you identify as your main teaching method?

T: I don't have one only. But like I said earlier, I like children working in groups. I said I also like them to do practical work in solving maths problems. Sometimes asking children to give examples also helps. You must not underestimate how much they know.

I: In your introduction of the topic "volume", you used food as an example (rice, potatoes, milk, etc..). Why food?

T: I used food because it is something used most of the time in our lives and it is bought in different containers and quantities. Even the "pds"[he refers to the physically disabled learners] will have an idea of the different containers and quantities that food comes in. I think it will be easy for the learners to understand later that the different quantities could still be there without any specific container. This idea of quantity eeh... being there in

I: Why this combination?

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I: How do select your tasks?

T: I choose those that will encourage the children to work in groups. I also prefer tasks that can be done practically, like doing experiments. I call these tasks "hands-on" tasks.

I: What do think learners need to know in order to understand volume?

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T: I don't have one only. But like I said earlier, I like children working in groups. I said I also like them to do practical work in solving maths problems. Sometimes asking children to give examples also helps. You must not underestimate how much they know.

I: In your introduction of the topic "volume", you used food as an example (rice, potatoes, milk, etc..). Why food?

T: I used food because it is something used most of the time in our lives and it is bought in different containers and quantities. Even the "pds"[he refers to the physically disabled learners] will have an idea of the different containers and quantities that food comes in. I think it will be easy for the learners to understand later that the different quantities could still be there without any specific container. This idea of quantity eeh... being there in different containers could drive the fact that we are more concerned with the space which will be occupied by the object/s, than the container.

I: You talked of conta s, food and container/s. Why the distinction?

T: What do you mean?

I: I mean why did you separate these two?

T: Like I've said, this difference is important in order to separate the issue of space in the container and the food in the container.

I: You talked of rice, potatoes and milk. Why did you talk of the different types of food?

T: How different?

I: I mean rice and potatoes are hard and therefore solids and milk is liquid. Why liquids and solids?

T: Okay, I see. They [he means learners] must realise that everything can occupy space. Solids, liquids and gasses can occupy space. You see *Zet* [he refers to me], if you can mention one thing only, it's easy for them to think that it is only that thing only that can occupy space. So, you must be careful.

I: So, why didn't you mention any gas?

T: *Ja,* you are right. I wanted to talk about the things that they can buy from the supermarket first. Remember though, I talked about gasses when we did volume of gasses today. Eeh...Maria spoke about Easigas.

I: Was that a good answer, especially from Maria?

T: She also impressed me. You see, it's important to ask even general questions. Sometimes they tell you what and how much they know or they don't.

I: Oh… The learners?

T: Ja.

I: Why should it be things that they can buy?

T: *Ja,* you always tell them that science happens around them or they do science all the time they do everything. So is maths.

I: Be serious, Sta. What do you mean?

T: Okay, I mean it is important to talk to them about things they already know or do. It makes them understand very easily. Also, what is learned in class must somehow match with the outside world. It becomes easy for them to learn that way.

I: What would you say about Mateo's answer of the milk and juice in different containers?

T: I think he understands the difference between the space in the container and the liquid in the container.

I: After commenting on Mateo's statement, you asked learners "which things occupy space and which space do they occupy". Why did you ask this question and why then?

T: It was important for me to see during the lesson if they have understood the difference between the space and the things that occupy the space.

I: Do you think the examples they gave were an indication of their understanding of the difference between the space in the container and objects that occupy the space?

T: Ja. Look at the examples they gave me Eeh….mieliemeel, chalk, milk and….

I: Coke and medicine.

T: Ja. They also mentioned the containers.

I: You used those wooden cubes. Why? Couldn't you have used any other blocks?

T: Well, those wooden blocks have a special thing. They are relevant to the teaching of volume.

I: The special thing of the wooden cubes? What is it?

T: Ooh… Each side of the cubes is 1cm. The wooden cubes were meant to drive the issue of 1cm in cubic centimetre (cm^3).

I: What about when the learners used the different boxes and filled them (boxes) with cubes?

T: Earlier I said children need to be referred to other cases that are relevant to other instances. Sometimes learners can think that a law or a principle applies to one case only. So, when they used the different boxes it could be easier for them to be able to understand that the law or principle could be applied to other things. I can also refer to any box when I ask a question or if something has to be explained. So, by using different boxes they can easily understand that the space occupied "is occupied in each box, not one box".

I: You asked the learners to reconstruct their cubes into pairs. Why the idea of pairs?

T: I wanted them to see that the number of cubes does not mean that the volume will change even if the cubes were arranged differently with the same number of cubes.

I: Did the reconstruction of the cubes make them realise that?

T: I think….eeh…..said the shapes are not the same but the number is the same. Percy also said something about it...eeh….

I: Yes, he talked about the equal number of cubes on the left and right.

T: *Ja,* you see, it is very important to be able to compare here.

I: Why is it important to be able compare?

T: I think it is important for them to see the differences or let me say the sameness of quantity but with the sameness of volume.

I: Towards the end of the lesson you asked learners to discuss what they had learnt about volume. Was this not a broad question?

T: I don't think so. I think it gave nearly every learner a chance to think about the things they have learnt about volume.

I: You wrote their summaries on the chalkboard. Why?

T: Writing summaries on the chalkboard gives learners an overview of the important points of the lesson and I like it if they write these as their notes.

I: The lesson on how to measure volume of a rectangular objects: you introduced this lesson by asking the learners to measure each side of the cube. Why was it important for learners to engage in measurement of those cubes?

T: I think children learn with ease or let me say they understand much quicker if they do these things on their own. But you can't just give them jugs or even measuring cylinders and tell them to work own their. You must tell them what to do, when you know exactly what you want them to discover. But for this lesson I wanted them to discover the measurement of each side of the cube.

I: You asked learners to look for the meaning of "cube" in the dictionary. Why did you ask them to use the dictionary in a mathematics lesson?

T: It is easy to let them look for the meaning of words in the dictionary because it will give them the exact meaning of the word, rather than me explaining. On the other hand I think it is important to their reading skills and so on, especially with this OBE thing.

I: You mean…(he interjects).

T: I mean I'm trying to include the other learning areas in teaching maths.

I: When you drew their attention to: Length = 5 cubes

Breadth = 3 rows

Height = 2 layers, do you think their knowledge of what area is, especially of a rectangle, helped them in any way to understand that there is still length and breadth in the rectangular block?

T: Yes, it did. Look when I asked them to look underneath the block and then measure the length and breadth of the flat surface of the block by counting the number of cubes.

I: And the height as indicated or represented by the "layers". Do you think the learners were able to make that connection?

T: To some extent I would say yes. Eeh …when I demonstrated with the hand and explained that the hand is occupying the space which is represented by the height.

I: Why did you let learners work freely by constructing their own rectangular blocks?

T: I wanted each group to come up with different measurements which they would use later.

I: Why was it important for learners to record the dimensions of their blocks?

T: That would help them notice the differences of the different sides.

I: Which sides?

T: Length differs from breadth differs height.

I: Do you think the learners understood that 5 cubes = 5cm; 3 rows = 3 cm and 2 layers = 2cm?

T: I think they did. Remember they had measured each side of the cubes and reported that it is 1 cm?

I: Do you think the dictionary meaning of "cube" enabled the learners to understand "cubic" as in "cubic centimetre" and how?

T: I would say it did. Here it showed that it meant that each block…no, let me say each small block has 6 equal sides that measure 1 cm each.

I: At some stage you asked the learners to look underneath the block and you referred to the area.

What was the idea behind that?

T: I was demonstrating the area of the block, which is important in understanding the formula for calculating the volume of a rectangular block.

I: How important is area in understanding or formulating the formula for volume?

T: $A = L \times B$

$V = (L \times B) \times H$

$\therefore V = Area \times H$; where area is the flat surface ×height.

I: What is the purpose of teaching the formula?

T: It won't always be possible to have the cubes in order to calculate the volume of rectangular. So, if they can use the formula, that's excellent.

I: If they can use the formula correctly, does it mean they understand what volume is?

T: I don't think it means exactly that. One must not be fooled and think that when they use the formula correctly then they understand volume. Volume is more than the formula. We talked mainly about space occupied by potatoes; rice; milk; juice; Easigas and what...before I mentioned the formula. I think the formula is only a shortcut they can use when they understand volume as the space occupied by the object.

I: Let's talk about the lesson of measuring the volume of liquids. You introduced this lesson but stating that doctors, chemists, etc. need to measure volume of certain substances accurately. How appropriate and relevant was this statement?

T: I think it is important to make children aware that what is taught in maths or any subject can be used in other things outside the classroom.

I: You used different measuring cylinders to measure the same quantities. Why did you do that?

T: Firstly, I wanted the children to discover that ml = cm^3. Secondly, I wanted the children to discover that the shape of the container does not cause any change in the volume of water.

I: Did the learners discover all that?

T: I think so. Do you remember that they reported in groups that those quantities were equal?

I: You introduced the lesson on displacement by asking the learners if it possible to measure the length, breadth and height of a stone. Why was this an important question?

T: I think this question would draw the children attention to the important sides of an object if you measured its volume.

I: Now that the stone does not have the sides?

T: Good. The children had to think how they could measure the volume of the stone. It is important to let them come up with ideas. When you ask a question, you also give yourself a chance to see how much they know or they don't. You can be surprised by the answers they come up with. So, their answers give you direction.

I: Do you have to move from group to group when they perform the experiment?

T: Ja, just to make sure that they follow the instructions on the worksheet.

I: Later in the same lesson you explained the concept " displacement". Why did you explain it?

T: Mathematics is a science. So, it has its own language which has to be understood and used correctly. This helps the children to understand what you are teaching.

I: When do you ask the learners to give you examples?

T: Most of the time I do that when I want to see if they have understood what I was teaching. You see, sometimes the children cannot explain what they want to say. So, rather than saying they must explain something, I ask them to give me examples of what they could have explained.

I: Do you find easier to assess if their examples reflect their understanding?

T: Yes.

I: For example?

T: In this lesson [he refers to the lesson on how to measure the volume of irregular solid objects], the children gave examples of "when you cook pap"; "when you get into the bath"; etc.. These examples showed that they understand the idea of displacement.

I: The last lesson was based on the measurement of volume of a gas.

T: Ja, learners had to measure the volume of a gas.

I: Did they manage to do that?

T: I don't think so. I realised later when they were busy with the experiment that they were struggling.

I: What were they struggling with?

T: The plungers were tight. They could not move easily. They are new.

I: Do you think the learners got some idea of what you had hoped to teach?

T: I can't be sure. But later I explained to them what I had hoped to teach them.

I: In your introduction, you asked learners if gasses occupied space. Why did you ask this question?

T: Remember, when I started with the first lesson, I referred to volume as the space occupied by an object. Then, when I asked them if gasses occupied space, I wanted them to refer back to the first lesson.

I: You further asked learners to give you examples of instances of a gas occupying space. The learners' examples of "in a balloon"; "in a tyre"; etc.. Were these examples satisfactory to you?

T: Yes. The examples gave me some idea that the children know that gasses can also occupy space and we can therefore measure its volume.

I: Thank you for your time, Sta.

T: Sharp.

Pre-Test and Post-Test Results Of Individual Physically Disabled and Able-bodied Learners (APPENDIX G)

	Test.1 Number		Test.2 Size		Test.3 Operations on numbers		Test.4 Fractions		Test.5 Problem Solving	
	Pre test (%)	Post test (%)	Pre test (%)	Post test (%)	Pre test (%)	Post test (%)	Pre test (%)	Post test (%)	Pre test (%)	Post test (%)
Learners										
1	83,3	86,6	48,1	62,9	77,5	77,5	48,6	62,1	5,5	33,3
2	63,3	88,0	37,0	48,1	81,6	85,7	51,3	62,1	11,1	22,2
3	80,0	90,0	66,6	70,3	85,7	93,8	43,2	56,7	0	33,3
4	63,3	66,7	29,6	55,5	44,8	55,1	43,2	59,4	0	11,1
5	86,6	90,0	51,8	51,8	67,3	81,6	51,3	54,0	0	33,3
6	86,6	90,0	70,3	81,6	65,3	85,7	72,9	89,1	22,2	100
7	80,0	90,0	51,8	74,0	79,6	89,8	64,8	81,1	83,3	100
8	93,3	96,7	62,9	55,5	55,5	93,8	48,6	62,1	66,6	88,8
9	86,6	90,0	70,3	81,4	97,9	95,9	75,6	91,8	55,5	100
10	93,3	96,7	66,6	77,7	83,6	87,7	64,8	86,4	0	11,1
11	90,0	93,3	74,0	55,5	83,6	93,8	64,8	73,0	11,1	66,6
12	H	76,3	H	33,3	H	73,0	H	35,1	H	0
13	76,6	73,3	48,1	48,1	57,1	59,1	37,8	40,5	0	16,6
14	66,6	88,0	40,7	44,4	69,3	71,3	40,5	43,2	5,5	50,0
15	70,0	70,0	55,5	55,5	71,4	77,5	37,8	54,0	0	16,6
Sum	119,5	1285,6	773,3	895,4	1052,4	1221,3	745,2	950,6	260,8	682,9
No. of Learners	14	14	14	14	14	14	14	14	14	14
Ave %	79,9	85,7	55,2	59,7	75,1	81,4	53,2	63,3	18,6	45,5

Pre-Test and Post-Test Results of Individual Physically Disabled Learners (APPENDIX H)

	Test.1 Number		Test.2 Size		Test.3 Operations on numbers		Test.4 Fractions		Test.5 Problem Solving	
	Pre test (%)	Post test (%)	Pre test (%)	Post test (%)	Pre test (%)	Post test (%)	Pre test (%)	Post test (%)	Pre test (%)	Post test (%)
Learners										
1	83,3	86,6	48,1	62,9	77,5	77,5	48,6	62,1	5,5	33,3
2	63,3	88,0	37,0	48,1	81,6	85,7	51,3	62,1	11,1	22,2
3	80,0	90,0	66,6	70,3	85,7	93,8	43,2	56,7	0	33,3
4	63,3	66,7	29,6	55,5	44,8	55,1	43,2	59,4	0	11,1
5	86,6	90,0	51,8	51,8	67,3	81,6	51,3	54,0	0	33,3
6	86,6	90,0	70,3	81,4	65,3	85,7	72,9	89,1	22,2	100
7	80,0	90,0	51,8	74,0	79,6	89,8	64,8	81,1	83,3	100
8	93,3	96,7	62,9	55,5	87,7	93,8	48,6	62,1	66,6	88,8
9	86,6	90,0	70,3	81,4	97,9	95,9	75,6	91,8	55,5	100
10	93,3	96,7	66,6	77,7	83,6	87,7	64,8	86,4	11,1	11,1
11	90,0	93,3	74,0	55,5	83,6	93,8	64,8	73,0	11,1	66,6
12	H		H		H		H		H	
Sum	906,3	1054,3	629	747,4	854,6	1013,4	629,1	812,9	255,3	599,7
No. of Learners										
Ave %	82,3	87,9	57,1	62,2	77,7	84,4	57,1	67,7	23,2	49,9

Pre-Test and Post-Test Results of Individual Able-Bodied Learners (APPENDIX I)

	Test.1 Number		Test.2 Size		Test.3 Operation on numbers		Test.4 Fractions		Test.5 Problem Solving	
	Pre test (%)	Post test (%)	Pre test (%)	Post test (%)	Pre test (%)	Post test (%)	Pre test (%)	Post test (%)	Pre test (%)	Post test (%)
A	76,6	73,3	48,1	48,1	57,1	59,1	37,8	40,5	0	16,6
B	66,6	88,0	40,7	44,4	69,3	71,3	40,5	43,2	5,5	50,0
C	70,0	70,0	55,5	55,5	71,4	77,5	37,8	54,0	0	16,6
Sum	213,2	213,3	144,3	99,9	197,8	207,9	116,1	137	5,5	83,2
No. of Learners	3	3	3	3	3	3	3	3	3	3
Ave %	71,0	77,1	48,1	33,3	65,9	69,3	38,7	45,9	1,8	27,7