THE RELATIONSHIP BETWEEN TEACHING METHODS AND ACHIEVEMENT IN MATHEMATICS

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DEDICATION

This mini-dissertation is dedicated to:

- My wife, Thokozani and our children: Mziwandile, Zamazulu, Mbulelo, Mongi, Mondli, Lwazi, and Zola for their support throughout the study.

- . My father, Solomon, and my elder brother, Siyabonga who were the source of inspiration in my studies

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SINOPSIS

Wiskunde is nog altyd as 'n moeilike vak beskou. Dit is nie noodwendig waar nie. Dit is eerder waar dat Wiskunde heelwat verskil van die meeste ander vakke. Daarom word begrip in Wiskunde op 'n ander manier teweeggebring as in baie ander vakke; en die onderrig moet op 'n ander manier geskied as in die ander vakke.

Hierdie studie is 'n navorsing van die Wiskunde-onderrigmetodes wat gebruik word deur onderwysers in die voormalige swart skole van KwaZulu Natal. Die doel is om uit te vind of 'n verband is tussen die metodes wat die onderwysers meestal gebruik en die swak resultate in Wiskunde in hierdie skole.

Uit die literatuur blyk dit dat die lesingmetode en die handboekmetode in Wiskunde nie begryp by leerlinge bevorder nie. Dit is een faktor wat lei tot 'n hoë druipsyfer.

Volgens die literatuur is die mees geskikte en doeltreffende metode om Wiskunde te onderrig die probleemoplossing-metode. Om die beste begrip by die studente te kry, moet hierdie metode tesame met ander onderrigmetodes gebruik word. Die probleemoplossing-metode kan gebruik word tesame met self-aktiwiteitsmetodes; asook vraag-en-antwoord, bespreking, ensovoorts. Dit sluit nie noodwendig die handboek en lesingmetodes uit nie.

Bogenoemde bewering is gebaseer op die feit dat Wiskunde 'n vak is waarin die studente probleme moet oplos en die doel van die probleemoplossings-metode is om hulle leer om dit te doen. .

Die navorsing is gedoen deur video-opnames te maak van Wiskundelesse. Die kassette wat so gekry is, is dan bestudeer en geanaliseer. Die doel was om uit te vind watter metode of metodes die meeste deur onderwysers in die streek gebruik word. Daarna is elke metode verder geanaliseer in terme van geskikthied vir Wiskunde-onderrig.

Uit die analise van die lesse, het dit duidelik geword dat die onderwysers meer as een metode per les gebruik. Daar is ook gevind dat die meeste onderwysers vir 'n groter gedeelte van die tyd die lesingmetode gebruik.

Volgens statistiek dra die lesingmetode by tot 'n hoë druipsyfer. In teenstelling hiermee, bring die toepassing van die vraag-en-antwoord-en probleemoplossings-metodes, volgens statistiek, 'n verbetering in Wiskunde-prestasie.

Uit die literatuur en data vekry met die emperiese ondersoek, is die volgende gevolgtrekkings gemaak:

- daar 'n sterk verband is tussen onderrigmetodes en studente se prestasie in Wiskunde.
- die oormagtige gebruik van die lesingmetode dra by tot die hoe druipsyfer in Wiskunde in die streek.
- afgesien van die lesing-en-handboekmetodes, kan die gebruik van ander onderrigmetodes die slaagsyfer in Wiskunde verhoog.
- die probeemlossings-metode, tesame met metodes soos vraag-en-antwoord, bespreking en baie ander, veral die met hoe leerlingbetrokkenheid, kan daartoe lei dat studente beter in Wiskunde presteer.

- sommige onderwysers gebruik die vraag-en-antwoord-metode nie korrek nie. Hulle dink dat hulle die vraag-en-antwoord-metode gebruik, terwyl hulle eintlik net vrae vra.

4.3 AANBEVELINGS

die volgende aanbevelings vloei uit hierdie studie:

- onderwysers moet slegs Wiskunde onderrig indien hulle daarvoor gekwalifiseerd is.
- die lesingmetode moet nie as die enigste metode gebruik word nie.
- die lesingmetode mag wel gebruik word, maar dan saam met ander metodes wat geskik is vir wiskunde-onderrig. Indien die onderwyser byvoorbeeld die besprekingsmetode wil gebruik, kan hy dit inlei deur middel van die lesingmetode.
- die lesingmetode kan ook gebruik word om wanbegrippe te korrigeer, hoewel dit ook gedoen kan word deur die vraag-en-antwoord-en probleemoplossing-metodes.
- die probleemoplossing-metode behoort meer gebruik te word.
- die probleemoplossing-metode kan saam met ander geskikte metodes,soos vraag-en-antwoord,bespreking,ensovoorts gebruik word.

- al die opdragte moet omskep word in probleme waarop die studente self die antwoorde moet vind.Die antwoorde moet nie sommer gegee word nie.
- wanneer studente in die wiskundeklas ingaan,moet dit wees om probleme te gaan oplos en nie om te gaan kyk en luister hoë die onderwyser sy kennis van wiskunde vir die studente demonstreer nie.
- die onderwyser se taak is om `n fasiliteerder te wees. Hy moet vooraf beplan watter probleme hy vir die studente gaan gee. Die probleme moet versigtig gegradeer wees sodat dit vir studente verstaanbaar en sinvol kan wees.

CONTENTS

CHAPTER 1 : GENERAL ORIENTATION

1.1 INTRODUCTION

The rate at which a country develops, is influenced to a large extent by the education in that country. This means that development is mostly dependent on education. This view is shared by Thompson (1981:87) who asserts that education is a catalyst to development.

On the basis of the above view, an education system should be planned and geared towards a development which coincides with the needs, goals and values of a society in which the school operates. For instance, if a country is to participate effectively in the modern world technology, the schools have to teach technological skills, mathematics and science (Ezewu, 1989:141).

According to Brissenden (1979:65) a country cannot survive without the wide spread of technology. The implication here is that all the countries must struggle to develop technology. But, technology is dependent upon science, and there can be no other science without mathematics. Hence, countries should develop mathematics and science and then technology.

South Africa, like all other countries, needs to develop technology. Hence, more students who pass standard 10 mathematics are needed. The problem that she faces is the high failure rate in mathematics, in the previously black schools.
The following statistics indicate that the mathematics failure rate is high: in 1992, only 26.54 % of the students who wrote standard 10 mathematics, passed it and only 49.24 % passed physical science in standard 10 under the Department of

Education and Training. Of the total number of standard 10 candidates, only 17.61 % , passed mathematics (Le Roux,1995:2).

This high failure rate challenges the researchers and educationists. They must devise some strategies to enable more students to pass mathematics. But, research must start by finding the cause for such high failure rate. That is probably why Greene (1993:53) argues that there is a great need for more and better education in science and technology. This may decrease the failure rate.

There is a perspective that, to increase the pass rate in mathematics, it is important for the department of education to try and increase the number of students who do mathematics by actually making it compulsory up to standard 10. According to Taylor and Richard (1987:2) the need for advancement in science and technology has led to a proposal that science and mathematics should be as important as reading and writing.

This view is shared by Le Roux (1995:19) who proposes that to promote mathematics and science, these subjects must be the compulsory components in every teacher's diploma. This proposal would be effective since it has the potential to increase the number of qualified mathematics teacher who would be able to teach mathematics successfully. This may help to improve the students' achievement in mathematics.

However, Le Roux's proposals can only be relevant if the mathematics pass rate also increases. The high failure rate depends upon quite a number of factors.

But this investigation is only concerned with the relationship between the teaching methods and the students' achievement in mathematics.

Since mathematics is used to solve problems, the teachers should focus on developing problem solving skills. This implies that the teaching must enable the students to solve problems and think critically. Their teaching must be focused on enabling the students to solve problems and think. If problem solving and the thinking processes are neglected, the chances are very high that the failure rate will be high. That is why the researcher is investigating the teaching strategies as a possible cause of high failure rate in mathematics in this region.

1.2 STATEMENT OF THE PROBLEM

Parents and students seem to have a positive attitude towards mathematics in the Kwa-Zulu/Natal region. This is witnessed by the fact that even though there is such a high failure rate, the number of students who still do mathematics at standard 10 is still very high. For instance, according to the records from the education department of the region, more than 27 000 students in the Kwa-Zulu Natal formerly black schools wrote standard ten examination in mathematics at the end of 1995. The problem is that on the majority, they fail the subject.

According to Greene (1993:47) a teacher may be seen as a dispenser of knowledge and there is minimal regard for active and creative abilities of the learners. The pupils therefore do not develop skills to solve problems. There is scant opportunity for acknowledgement of alternative methods and encouragement of creativity involved in the devising of such methods. They have to learn the solutions that have been produced by the teacher and nothing more.

However, it is difficult to learn and remember solutions that have been prepared by someone else. This usually lead to rote learning. Furthermore, it is not necessarily the case that the problems that were solved in class would be part of the examination. In many cases, very few or none of these problems that were solved in class are included in the examination paper. This may be the reason for the high failure rate.

1.3 AIM OF THE STUDY

The aim of the study is to expose the causes of the high failure rate of mathematics in the formerly black Kwa-Zulu/Natal schools. It is felt that the reason for such a high failure rate is not that the students cannot understand or do mathematics. It is because the teachers do not present the subject matter in a manner that is understandable to the students and enables them to solve mathematics problems on their own.

The study will, therefore, examine the teaching methods that are mostly applied by the teachers in the region. Such methods will be scrutinised, in terms of efficiency and effectiveness in enabling the students to solve mathematics problems on their own. The study will also expose those methods that encourage effective teaching of mathematics.

1.4 DELIMITATION OF THE STUDY

As it has been mentioned earlier that the aim of the study is to examine the teaching methods that are applied by most of the mathematics teachers, the field is very broad. Hence, the study will be limited to the classroom interaction.

1.5 RESEARCH METHODS

1.5.1. LITERATURE REVIEW

This study has been undertaken in mathematics education, and attention will be paid only to the teaching methods and strategies as observed in the classroom situation. The following teaching methods will be discussed: Lecture method, the text book method, the problem solving or heuristic method, self-activity, project method, learning cycle, investigative approach, constructivist point of view, question and answer method, discussion method and the summary.

1.5.2 VIDEO TAPES

At least ten lessons, by ten different teachers will be video-taped. The videos will then be scrutinised and the teaching methods, approaches and strategies will be critically observed. The main concern here is: which method is used ? does it enable the child to think critically and solve problems ? In any lesson, is there any thinking involved ?

Preference will be given to those teachers who also teach standard 10 mathematics. The intention is to compare the teacher's methods of teaching to the standard 10 mathematics pass percentage in the previous year.

1.6 PROGRAMME

Chapter 1

This introductory chapter explains the statement of the problem, delimitation of the study, the significance of the study and the research methods. This chapter

also provides a frame of reference which will allow the study to be taken with a focal point of reference.

Chapter 2

This chapter presents a literature study that has a bearing on the mathematics education, methods and strategies for teaching mathematics.

Chapter 3

This chapter deals with research design, methodology and procedures which include sampling and description of instrument

It also deals with the data collection using the tapes that were made. Recording and classification of the observation are presented in this chapter. For interpretation, analysis, and for discussion, each teacher's lesson is categorised according to the methods applied in that lesson. The results are then tabulated according to the percentage of each method that is applied by each teacher and the corresponding standard ten percentage pass at that school.

Chapter 4

This chapter gives a summary, conclusion and recommendations based on the findings of the study.

CHAPTER 2 : TEACHING METHODS IN MATHEMATICS EDUCATION

2.1 INTRODUCTION

The objective of this chapter is to present an overview of the literature that has already been written on various teaching methods and some aspects of Mathematics Education. The first part of the chapter will briefly deal with Didactics and subject Didactics.

The rest of the chapter will be devoted to the teaching methods, strategies and approaches which will consist of: the problem solving method, self-activities like the learning cycle, project method, investigative approach, constructivist approach, question and answer method, discussion method, lecture method; text book method;

There are others that have not been included.

2.2 DIDACTICS AND MATHEMATICS DIDACTICS.

According to Klafki (Duminy and Sohnge, 1980:1) "didactics" means to instruct, to teach and to learn. This implies that didactics has to do with the science of educating, teaching and learning. Fraser, Loubser and Van Rooy (1990:3) see didactics as a science which studies teaching and learning as interrelated aspects of reality which forms an essential part of man's life world. This means that if no learning is taking place, teaching is irrelevant and should not be continued, as the goal of teaching is to ensure that learning takes place. This is because teaching and learning are interrelated and inseparable. That is why in talking about the methods of teaching, it is essential to also talk about the extent to which those methods lead to learning.

According to Van der Stoep and Louw (1984:28) "didactics" is the theory of teaching. It examines the conditions that are basic and conducive to effective teaching and learning. This point of view implies that "didactics" embraces teaching in it's entirety. Hence, it is the foundation for comparing the suitability of the individual teaching methods. This leads to the exploration of the term 'Subject Didactics'. Duminy and Sohnge (1980:10) refers to subject didactics as didactics that deals with the specific school subject . In this regard, it will focus on the distinctive manifestation of mathematics.

It is in this regard that Griessel, Du Plooy and Oberholzer (1976:344) specify that subject didactics is concerned with all the aspects of teaching the particular subject. In shorts, subject didactics is concerned with, among other things, the methods of teaching the particular subject. This study will concentrate on the methods of teaching mathematics. It is the knowledge of mathematics didactics that makes the selection of the suitable teaching method(s) possible. These methods will enable the students to solve problems and use their mathematics knowledge to understand and interpret unfamiliar situations and different theories in mathematics.

There is a general view that there is a link between pass rate and the quality of teaching. Fraser, Loubser and Van Rooy (1990:53) assert that instructions and learning will be effective only when teachers succeed in exposing the selected subject content through their proficiency and the use of teaching strategies. This assertion coincides with the intention of this investigation which is investigating the effect of the teaching strategies on the students' achievement in mathematics. To do that the teaching methods will be studied with the intention

of identifying those teaching methods that are not very suitable for teaching mathematics and those that are quite suitable.

2.3 TEACHING METHODS

According to van der Stoep and Louw (1984:48) the purpose of teaching is to unlock reality and this is not an easy task. Not every person can just teach if he/she knows the subject matter. People teach, only if they are properly prepared for it in a sense of being thoroughly trained to teach using certain methods. This is why educators and researchers have developed quite a number of very useful methods of teaching. This is also why prospective teachers have to spend as long as even four years learning and getting used to the teaching methods (Duminy & Steyn, 1987:82).

Different teaching methods are used by different teachers according to the needs of the subjects they teach and according to the teacher's knowledge , personality, interests and wants. The aim of the application of these teaching methods is to make the subject matter suitable and understandable to the students. For the subject matter to be well understood, the instructions to the students in the classroom should rest upon the same basic life forms. This means that the students should receive the subject matter in a manner that is related to how they 'receive' and learn things in their out-of-school environment (Duminy & Steyn, 1987: 82).

2.3.1. PROBLEM SOLVING METHOD

The problem solving method of teaching is sometimes referred to as the HEURISTIC method. According to George and Jeremy (Randall & Edward,1990 :14) heuristic means the art of discovery. The implication here is that the

problem solving method is meant to enable the students to discover or invent new knowledge on the bases of their experiences. They assert that problems are a vehicle through which new concepts or skills might be learned.

Naidoo, Smit and van Heerden (1995:16) share the same view when they define problem solving as a process of applying mathematical knowledge and skills to new and unfamiliar situations. The implication of this definition is that problem solving is involved whenever the knowledge of mathematics is applied to solve a problem or to understand a situation or a theory. This definition, further, implies that mathematics learning occurs and problem solving becomes successful only if the new mathematics situation is related to the already available mathematics knowledge in the child's mind.

Vrey (1990:278) shares the same view when he emphasises that the students are ready to learn something new only when they have mastered the prerequisites. This means that any new mathematics knowledge can only be acquired if it links with the already available knowledge. Mathematics knowledge does not exist in isolation. This also means that a teacher must ensure that there are no gaps of knowledge before he gives the problem to the students. Then the students are very likely to learn on their own.

In support of the above views Dewey (Randall & Edward, 1995:17) argues that the same experience that lead to the development of problem solving ability, also lead to learning important subject matter. That is, applying the mathematics knowledge to make sense of any situation including what is in the syllabi and is supposed to be learned, is also problem solving.

These definitions are further simplified and clarified by Duminy and Steyn, (1987: 112) who assert that problem solving is a teaching method whereby a teacher guides the students to use their previous knowledge together with their thinking ability to gain or discover more knowledge and solve problems. This entails the pupils' ability to relate the known to the unknown and make sense of any situation and eventually make valid and logical conclusions.

From the definitions above, it is felt that problem solving is a way in which mathematicians make sense of any unfamiliar situation they encounter. In other words, it is a natural way of understanding things, even outside the school situation. It is a continuation of how the child experiences life out of school. There is therefore, according to this method, a relation between mathematical thinking and the thinking in which people generally make sense of situations. If the students can understand mathematics according to these definitions, they should be motivated and develop more love for the subject and, hence, pass it.

Hence, problem solving is not a method that can easily be compared with other teaching methods. It will always be the best. It enables the students to learn and do mathematics on their own. This idea is shared by Naidoo et al (1995:20) when they assert that student should be equipped with the ability to learn things that are not yet known. They must be able to analyse a problem and find a way of solving it.

When the students are able to solve problems, it can be said that they know mathematics. Students need to get some taste of mathematical discovery themselves in order to understand mathematics very well. 'Finished face' of mathematics that is presented deductively in text books does not do justice to

the students. The students need to discover mathematics in the making so that they can apply their plausible reasoning.

In view of the usefulness of the problem solving method of teaching and learning, it is necessary to convert all teaching and learning to problem solving situations. In this case learning becomes meaningful and useful to the child because it coincides with how the child has been acquiring experiences outside the school situation. There are no teachers outside the school and children have to acquire experiences on their own and make sense of unfamiliar situations. This view is shared by George and Jeremy (Randall & Edward,1990: 19) when they say:

"Instruction in subject matter that does not fit into any problem already stirring in the student's own experience or that is not presented in such a way as to arouse problem is worse than useless for intellectual purposes".

In the light of the above exposition, it is clear that any mathematics classroom is a place for solving problem. It is not a place where a teacher talks and demonstrates his/her fluency , in presenting his lesson, at the expense of the students' thinking time. This idea is shared by Lumb (Naidoo et al, 1995:20) who asserts that the teacher in problem solving does not provide information, but provides resources and ask leading questions. If the teacher keeps on providing information to the students, they will not learn to solve problems on their own. Polya (Randall & Edward,1990:16) emphasises that the students should know how to do mathematics and says that to know mathematics is to be able to solve problems. This requires practice.

George and Jeremy (Randall & Edward,1990:17) emphasise that problem solving, among other things, is an art and the only difficulty is in operationalizing it in the classroom. They say the difficulty is in developing the artistic ability in the student. This requires well planned practice, with well graded sums. In explaining this, Polya (Randall & Edward 1990:18) argues that problem solving is a practical art one learns by imitation and practice. He says only through judicious use of non-routine problems can students develop their problem solving abilities. The teacher needs to set the right kinds of problems for a given class and provide only the appropriate amount of guidance. He, further, asserts that a major aim of education is the development of intelligence and to teach young people to think. This means that children should be taught how to do mathematics insightfully rather than mechanically. Insightful performance leads to success.

Naidoo et al (1995:24) discuss teaching via problem solving. They say the teacher teaches a topic of the syllabus by starting with a problem situation. Methods are developed by the pupils during the lesson in this approach. Non-routine problems are transformed into routine ones.

- Citing the Yearbook of the NCTM(1989), Naidoo et al (1995:24/25) maintain that teaching via problem solving is preferred. They say that it is in keeping with the recommendation of the NCTM standard commission of 1987 that:
- mathematics concepts can be learned in the context of problem solving.
- the development of high level-thinking process can be fostered through problem solving experiences.

- mathematics instruction should take place in an inquiry- oriented, problem-solving atmosphere.

Duminy and Steyn (1987:112) assert that knowledge which is gained through the pupils' thinking and effort has more didactic value than the same knowledge when it is assimilated by listening to the teacher talks. This is because, apart from gaining the knowledge, the student has also gained a way of thinking and a method of obtaining information on his/her own. He has also learned a way of living for he is no more as dependent upon a teacher as he was before. Further, there is great hope that he will be able to solve many other problems, especially of the related kind. Problem-solving goes hand in hand with critical thinking and this is one of the aims of educating. However, it is unfortunate that, according to Duminy and Steyn (1987;112), genuine problem-solving is often neglected in the schools and this is very likely to contribute towards the high failure rate in mathematics, for instance.

Mathematics is a subject that educates and enables the child to solve problems of all kinds. This means that the child has to learn and practise how to solve problems. He does this by actually being exposed to problems most of the time. This can only be achieved by incorporating the problem solving method in one's teaching. From the discussion above, it is clear that the problem solving method alone may solve the problem of the mathematics high failure rate in the Kwa-Zulu/Natal region. The problem is that it may not , at first, be easily understood by the students. Then, the problem solving method should be supplemented by other teaching methods which should be used concurrently with it.

There are many methods that are useful in the teaching of mathematics, but they become complete if they are applied concurrently with the problem solving method. All the teaching methods are useful if and only if they are used to complete the problem solving method. If that collaborative application of teaching methods with the problem solving method, is done in such a way that the problem solving method dominates in each lesson, then the students will understand mathematics in general and will be able to solve problems. Furthermore, they will pass mathematics in all standards. In other words, the main method of teaching mathematics is the problem solving method. All other methods can be applied only to assist or complement the problem solving method.

While applying problem solving method in all mathematics teaching, other methods may be used to complement it. The teaching methods that will be discussed below, are the ones that may be applied to supplement the problem solving method. They should be applied within the problem solving methods.

2.3.2. SELF-ACTIVITY

This is a teaching method where a teacher gives a chance to, and skilfully assists, the students to become seekers of knowledge themselves. It is based on the child's own force or momentum and comes from his own interest. In this didactic situation, the child is active mainly through imitation and reproduction. His activity has a mechanical, and automatic character (Duminy & Steyn,1987: 96)

They assert that self-activity is found in a didactic situation where a child is thrown on his own resources where he becomes the seeker, the discoverer, the

inventor, the creator and so on. This approach to teaching and learning is related to the problem solving method that has just been discussed. Self-activity actually allows the child to be more exposed to problems.

The work that the child does in this situation is comparatively hard. But, he/she does not feel the strain since he is motivated. The information that is obtained in this way usually stays very long in the mind. This approach to teaching resembles the real life situation where an individual encounters a problem. He then decides to solve it without being asked or forced (Duminy & Steyn,1987 : 97)

Duminy and Steyn (1987:97) assert that, apart from being a teaching method, self-activity gives a chance to the students to practise thinking. The teacher who uses this method concurrently with problem solving method, will produce effective thinkers because he gives the pupils a chance to practise thinking. This is based on the argument that if a child is to become somebody who can reason, he must be given a chance to practise it. He must be given exercises in reasoning. This method of teaching is likely to offer this opportunity. They will easily develop problem solving abilities and love for solving problems, through this kind of exposure and practice.

Self-activity is one of the basic methods of teaching and learning. It should be used to the full. It is quit suitable for teaching mathematics where problem solving is the main goal. In this self-activity method, the pupils act spontaneously. They will express their thoughts in their own words, drawings, calculations. They will cut, paste, fold, write and model in clay. Using this method

will actually reduce the high failure rate in mathematics in our country. It only needs to be applied correctly and properly.

When they find it difficult to express themselves, they look for meanings in the dictionaries and use the words to express themselves and explain their points of view. While they are looking for words and their meanings and how to use them, the subject matter is still and always in their minds. In other words, the subject matter stays long enough in their minds. Hence, it actually become part of them, in a sense that they understand it more and cannot easily forgot it (Duminy & Steyn, 1987:98).

They will make some guesses . The teacher must just follow them up. They make drawings, improve on them or do away with them and start again. This method of teaching, will help our pupils to solve problems and to think critically and creatively. The guessing part of it, for instance, is a starting point for a proof by contradiction in mathematics. If they start it on their own, it will not be as difficult as it usually is to most students. For instance, mathematical induction has some element of proof by contradiction which has some guessing in it.

Children are naturally inquisitive, curious and enthusiastic. They question most of the things they encounter. They are therefore natural problem raisers and problem solvers. Therefore, applying the self-activity method coincide with the nature of the children and at the same time it coincide with the nature of learning, especially, of learning mathematics. If this method is correctly applied, the students will be helped to learn the approaches and the strategies used by scientists and mathematicians to solve problems. The students will then develop

the ability to think abstractly, more critically and more creatively. It is essential that teachers of mathematics should be familiar with this method also.

What is also very important about this method is that the students make mistakes which they also correct. In correcting those mistake they learn more. Children can and do learn from their mistakes and they sometimes even devise surprisingly interesting and satisfactory solutions.

This method should take advantage of the fact that children have inquiring minds. This method will then try to satisfy the children's' needs of wanting to inquire all the time. They will be encouraged to look for cause and effect of what they see and experience. This will encourage real learning and not memorisation to take place. It will also enhance the children's' natural curiosity and enthusiasm which are so essential in every learning, especially in mathematics.

Self-activity is an element of problem solving. While in problem solving the teacher starts a lesson by imposing a problem, in self-activity, the students find the problems themselves and solve them. Self-activity is incomplete and is useless, in mathematics if it excludes the problem solving part of it.

2.3.3 LEARNING CYCLE.

The learning cycle is also a self-activity in which the students are exposed to the subject matter. They are asked to perform a certain task on their own, using the information that is available. During its application, the teacher guides the students so that they can follow certain steps which are: exploration; introduction of terms and concept application.

2.3.3.1. EXPLORATION

Here the students learn through their own action and reaction in the new situation. In this phase they explore new material and new ideas with minimal guidance and the role of the teacher in this case is to arrange the subject matter so that:

- the new experience should raise questions or complexities that they cannot answer or understand with their accustomed ways of thinking, and

- it should also lead to the identification of the pattern of regularity in the phenomenon.

2.3.3.2 TERM INTRODUCTION

This phase starts with the introduction of the new terms that refer to the patterns which were encountered during the exploration activity. At this stage the students should be encouraged to identify as much of the new patterns as possible before it is revealed in the class.

2.3.3.3 CONCEPT APPLICATION

Here the students apply the new term and the thinking patterns to additional examples.

(a) The concept application phase is necessary for the students to extend the range of applicability of the new concept. Without a variety of applications, the concept application and meaning may remain restricted to the examples that were used at the time when it was defined and discussed.

In support of this statement, Randall and Edward (1990:14) refer to problem solving and concept application as a practice to reinforce the skills and concepts taught directly. The implication here is that students get more used to theories if they keep on applying them. By applying the new concepts, they learn to use it. This also helps them to remember and understand it more.

(b) Reference is made to a concept as a mental pattern that is referred to by verbal label. This means a pattern that is in one's mind

(c) Thus a concept is a pattern plus the term. Teachers can introduce the terms but students must perceive the patterns themselves.

(d) Exploration provides the opportunity for the students to discover the patterns.

(e) Term Introduction provides teachers with an opportunity to introduce the terms and provides the students with an opportunity to link the pattern with the term. This means that, at this stage, they acquire the concept.

Learning cycle is a teaching method that purports to be consistent with the way people spontaneously construct knowledge. For excellent mathematics learning, learning cycle should be used collaboratively with the problem solving method.

From the above discussion it is clear that the learning cycle is a controlled self-activity. It is controlled in a sense that the starting point is defined. Students are given a problem and are told how to start investigating. It is also a problem solving approach in a sense that they must be able to understand the unfamiliar situation on their own. Hence, the method is very useful in the teaching of mathematics.

2.3.4 PROJECT METHOD

Duminy and Steyn (1987: 98) define a project, generally, as a problem taken from the real life and studied in details from all possible angles. This obviously means that the project teaching method is the one in which the teacher organises and gives an opportunity to the pupils to be involved in the solution of a real life problem.

For instance, a mathematics class which is doing mensuration, can be given a chance to observe or work with carpet layers. They may even be given a chance to measure the carpet that has to be fitted. Depending upon their age-group, this project will be interesting and useful to mathematics pupils. Apart from the fact that they will learn how to measure, they will also develop the love for mathematics when they notice its applicability and usefulness.

According to Cawood and Gibbon (1981:215) the project work is a method of teaching in which the teacher enables the pupils to plan and carry out an extensive task that is meaningful and practical. They also assert that this approach prepares the pupils for later scientific investigation and research. In their explanation, they emphasise that the project must emanate from the children's' real-life situation. This implies that the children's' immediate needs and interests are significant in choosing the project.

For a project method to be successful, the problem must be taken from where the pupils can reach. It must be something the students have seen. This is because one can solve a problem if there is a reasonable amount of the known information. If that is not the case, the solution of that problem becomes difficult if not impossible. According to Duminy and Steyn (1987:89) the project method

offers excellent opportunity for problem solving and self-activity. Hence, this is an attempt to bring into practice most all the didactic principles.

Duminy and Steyn (1987:99) argue that the project method is an attempt to base the learning on real and actual problem situations. If this was always easy to do most teachers would be using the project method since it is more or less the real application of the principle that school education is the continuation of the education that was initiated at home. This is the education that is based on out-of-school-experiences. For better understanding, mathematics should also be taught relative to out-of-school experiences.

It is not possible to always apply the project teaching , since there are many subjects that are based on different experiences. The project method can only be applied occasionally. That is why then Duminy and Steyn (1987: 99) refer to the concept of occasional project teaching. This means that all the subjects keep their normal school programme. They are only occasionally interrupted by the undertaking of a project which involves as many of the different subjects as possible. The involvement of many subject areas in a particular project teaching is not very easy. It depends on the subjects themselves. For instance, it is not very difficult to have a project in which Mathematics, Physical Science, Biology, and Environmental studies are involved.

Many of these projects will start with an excursion and end up with group work. In the excursion, the pupils observe certain occurrences which pose questions to them and cause them to wonder. Then the discussions are there so as to sort of elucidate and try to provide answers. The activities involve oral and written contributions, making of calculations and so on.

According to Cawood and Gibbon (1981:219), the project method, among other things, has the following advantages:

- it is a meaningful learning activity for the child.
- it creates responsibility, critical judgement, initiative, co-operation, and so on.
- it allows for the inquiring and inquisitive nature of the child.

They maintain that if this method is carried to completion, the pupils gain confidence and self-assurance and are encouraged to make further use of this self-activity method which is so valuable in learning mathematics. They will eventually be able to do mathematics on their own without the assistance of the teacher and can eventually become mathematicians, which is the desire of mathematics educators.

From the above mentioned objectives, it is clear that the project method is convenient for teaching mathematics. It provides, according to the objectives, critical and creative thinking, initiative, co-operation which are essential in learning mathematics. This is one of the methods of teaching that would solve the problem of high failure rate in mathematics in the KwaZulu-Natal schools, provided it is used collaboratively with the problem solving method. This is because any learning, in mathematics, that does not enable the students to solve problems, is not helpful. Without the simultaneous application of the problem solving method with the project method, such a project is irrelevant.

This method demonstrates, clearly, the applicability of the particular subject and thus motivates the pupils. It further gives more information about the

subject. It is, therefore, advisable to apply it in teaching mathematics together with other methods, in a problem solving approach.

From the above explanation, it is clear that the project method is a self-activity of some kind and that it cannot be successful if it is not used collaboratively with the problem solving method. Actually, problem solving is the aim of the project in mathematics. So , any project which does not incorporate the problem solving approach is irrelevant.

2.3.5. INVESTIGATIVE APPROACH

Investigative teaching is a teaching strategy in which the teacher systematically exposes the students to the subject matter. He does not teach but urges the students to observe the occurrences and procedures. The students are then required to generalise and interpret their observations. In this approach, the students learn by interpreting their environment. The following example may help to explain this approach:

(a) $(x + 1)^2 = x^2 + 2x + 1$

(b) $(x + 2)^2 = x^2 + 4x + 4$

(c) $(x + 3)^2 = x^2 + 6x + 9$

The students now start to relate the left hand side to the right hand side. They notice where there is a square and so on. They next compare only the right hand sides. If they are able , on their own , to say that they expect $(x + 4)^2$ to be equal to $x^2 + 8x + 16$, then they have learned by the investigation method.

The next step for the students will now be to explain and convince the teacher and the class that this always works (Moodley, Njisane & Presmeg , 1992: 157).

To encourage the students to accept, adopt and participate freely, in this approach, the teacher should create a particular classroom situation. That is, the one in which the rightness or wrongness of the answer is not the issue. In such a classroom, the pupils are encouraged to make conjectures as to the similarities and the sameness they see. They must freely discuss this with others without the fear of being judged wrong or stupid. They must also listen to other pupils' ideas so that they may modify their own conjectures (Moodley et al, 1992:161).

Moodley et al (1992:161) argue that during the investigation the pupils spend time to study the underlying process. They acquire the necessary familiarity with the subject matter and accumulate enough knowledge about the subject matter. They then become confident about what they know. They are also, able to explain it confidently to the class and to the teacher. Moodley and his colleagues further assert that the generalisation about patterns they have discovered, motivates the pupils as they feel that they are successful in doing mathematics. They begin to enjoy doing mathematics and develop a special positive attitude towards mathematics. This attitude is essential in developing mathematics ability.

Moodley et al (1992;162) emphasise that, in investigative teaching, the teacher's task is to lead and help the pupils to become aware of the patterns involved (the underlying sameness). They must discover it themselves. It goes without saying

that the investigative teaching method resembles the processes that are followed by the mathematicians and scientists in their problem solving activities.

Because the pupils discover the information themselves, their levels of understanding, knowledge and skills are very high. This is in agreement with Moodley et al (1992:165), who argue that some of the students do not understand well if they are told. They learn better if they are allowed and enabled to investigate. Some of these students get very much bored if they have to sit and listen. They may fail and may even leave school, if they are not given a chance to find information themselves.

James (Moodley, et al,1992:167) argues that students who have learned in an investigative approach retain the subject matter for a long time and understand it very well. The subject matter obtained in this way become the child's own. He/she can always explain it to the class and to the teacher confidently. He further asserts that even students who appeared dull improves considerably with the application of the investigative method. He maintains that students who are taught to work investigatively, actually develop a strategy for learning or doing mathematics and for thinking in general. He/she is then able to use these thinking strategies in the formation of concepts and probably of mathematics learning.

Breen (Moodley, 1992:169) claims that for successful teaching and learning to occur, the classroom situation should be adjusted or modelled to more or less resemble outside experiences of the children. This encourages free and more or less natural interaction among the students. This means that they learn in a manner that is not very remote from the one in which they have always been

investigating things, even before they started with mathematics. So, there is just that continuity which makes the subject matter and the subject as a whole more interesting and enjoyable.

Mary (Moodley, et al, 1992:170) emphasises that teaching will be educative if the teacher, among other things, learns new sets of skills and suppresses what she terms 'teacher lust'. She explains that as meaning the teacher's desire to intrude and show off his knowledge. The implication here is that the teacher must give a chance to the students to observe, investigate, think and find the solutions and answers. He must not disturb them by giving those solutions or answers.

The above idea is further supported by Wheeler (Moodley, et al, 1992:170), who describes some of the characteristics of the role of the teacher as follows:

- the teacher must withdraw as much of himself as possible in the teaching situation.
- he must use every means to focus the students on the problem
- he must efface himself from their attention

From the above discussion it is clear that the investigative approach places an emphasis on of the process of mathematics rather than the product. This will aim at encouraging argument and original thought as well as personal qualities such as persistence, co-operation and curiosity. This also promotes independent thinking and self-reliance as well as willingness to tackle novel situations.

Breen (Moodley, et al, 1992:169) emphasises that, investigational work will start with the premise that unless the students have an opportunity to

experience for themselves, the feeling of owning his/her own mathematics and making his/her own mathematical decision, he/she will have gained very little that is of lasting value mathematically, and which can be transferred to general life. The implication here is that the students will have made minimum use of the investigative approach if after being exposed to it, he/she is still not confident to use mathematics and make mathematical decisions.

It can be noticed that the investigative approach to teaching is part of the problem solving method. In the same way as teaching is done in problem solving, the students are supposed to interpret the situation on the bases of their previous knowledge. That is how students can learned mathematics effectively. Furthermore, this approach can be applied within the problem solving method and collaboratively with the learning cycle.

2.3.6 . CONSTRUCTIVISTS' POINT OF VIEW

According to Schoenfeld (1985:20) constructivism is a perspective that has come to play an increasing role in cognitive enquiries. These inquiries will help the teacher to teach accordingly. It promises to reshape many of our ideas about teaching and learning. It is not part of cognitive science.

Bodner (Moodley et al, 1992:28) analyses the constructive view of learning when he says:

"Construction is a process in which learning is both built and continually tested. Individuals are not free to construct any knowledge. Their knowledge must be viable and it must work". The implication of this emphasis is that knowledge is constructed by the particular individual. It is not received from someone else. Once it has been constructed, it is tested to see if it is in agreement with the

already known ideas. This refers to concepts, ideas, theories , models and so on. Then, obviously, constructivism refers to the teaching approach which is based on the fact that knowledge is constructed. Such teaching allows the students to think and understand according to their levels of abilities and thinking approaches.

To elucidate further, Labanowicz (Moodley, et al, 1992:28) says: "We see what we understand rather than understand what we see. Man's drawings of reality and interpretation of situations reflect the internal organisation of his network of ideas". This explains that learners construct understanding. They do not learn exactly what they are told. According to this, the teacher must not talk too much. He must give the students a chance to think and construct the new knowledge. According to the foregoing explanation emphasis has shifted from teaching to facilitating. The teacher role in this case is to facilitate the learning process.

Schoenfeld (1985:20) asserts that the interpretation of phenomena for children is not necessarily the same as that for adults. They do not see the world as we see it. This depends upon differences in experiences. Children have less experience than adults. This also applies to different adults, for they do not possess the same experiences. Hence, they all build their own interpretative framework according to what is already known. This, further, means that the students will learn the theory according to, among other things, their background, and their particular way of interpreting and constructing things.

According to Carey (Schoenfeld,1985) human beings have always been constructing explanatory structures. He emphasises that this construction of reality by human beings is life long. From youth to death, there is no time when

human beings do not construct knowledge. The implication is that learning by constructing is natural and all the teachers should understand, accept and apply this information to try and better the difficulties involved in making their teaching effective.

Moodley et al (1992:36) maintain that there should be a dialogue between the teacher and the students. This, he hopes, will provide an opportunity for the students to construct their knowledge on the basis of the interaction. This is based on the fact that the knowledge that is constructed depends on the previous knowledge and the teacher's explanation. Therefore during the dialogue, the child uses the teacher's knowledge to construct his own.

Romberg and Carpenter (Schoenfeld, 1985:24) support the above view when they assert that the teachers' weaknesses are to teach under the assumption that the pupils absorb what they have been taught. They maintain that this assumption is wrong. In their view, the pupils construct knowledge and the instruction only assist the construction of such knowledge. So, the teaching of mathematics should be based on this premise as well as the understanding that the way we learn is determined by the kind of knowledge we already have, as the foundation for constructing more knowledge.

It may be observed that in the constructivist approach, the pupils are exposed to knowledge in order to construct their own on the bases of their previous knowledge. This coincides with the problem solving approach, where a student is expected to make sense of what he encounters, on the bases of his previous mathematics knowledge. Hence, constructivism will be much useful if it is applied within the problem solving method. The students have to make sense of

the unfamiliar situation or new knowledge. This is done in more or less the same way as students try to find the solution to a problem. So, this is a problem solving approach of some kind (Naidoo et al, 1996:25).

2.3.7 QUESTION AND ANSWER METHOD

According to Dumny and Steyn (1987:111) question and answer method is a method of teaching in which a teacher arranges questions in a logical sequence and around a definite core. Such questions are arranged so that they actually remind the pupils about what is already in their minds. The knowledge that is in the pupils' minds is essential as a starting point for the new knowledge. The pupils themselves also realise the importance of what they know regarding the subject matter at hand. During the application of this method, the teacher tacitly enables the pupils to used the knowledge they already have in solving problems.

It is true that questions are important in any lesson, but such questions are occasional and more detached. In the case of question and answer method the questions are the main means of conveying the information to the pupils or of enabling the pupils to solve problems. They may be so carefully chosen and planned that they may be very useful in enabling the pupils to solve problems which might have been otherwise difficult to them. That is why then Duminy et al (1987: 112) maintain that in this method, teaching does not necessarily mean the pouring-out of knowledge, but the drawing out and systematising of knowledge and truth already in the pupils' minds.

From experience it can be noticed that there are some students who have a very good knowledge of mathematics but are unable to apply it in assimilating more

information or in solving problems. When the students are answering the questions during a question and answer lesson , they are already solving problems. This is very much helpful to the students. It gives them a background, practice, insight and the reasoning involved in the solution of problems.

The question and answer method will be more useful in the teaching of mathematics if it is applied collaboratively with the problem solving method of teaching. This means that, the questions that are asked , are asked so as to guide the child in trying to make sense of the mathematics problem or a theorem.

2.3.8 DISCUSSION METHOD

This is a teaching method whereby, a teacher arranges his/her pupils in groups and then enable them to learn by discussing the subject matter. The subject matter may be a solution of a problem or trying to understand a particular theory. According to Duminy and Sohnge (1980:68) discussion is a discourse among members of a class with a definite objective in view. This emphasises the presence of an objective in any discussion lesson. Cawood and Gibbon (1981: 205) feel that the groups must normally consist of five to seven members.

Rivlin (Duminy & Sohnge, 1980:68) asserts that, in the discussion method of teaching and learning, the pupils actually share in the process of learning by evaluating their points of view and respecting each other's points of view, while seeking solutions. Duminy and Sohnge (1980:68) further maintain that it is through reflective thinking and exchange of ideas that this method is so useful and that available evidence relevant to a certain problem is analysed and evaluated. The group, with the systematic assistance of the teacher, is able to

even reach some generalisation and conclusion. They also maintain that the students gain more insight into the subject if they are able to discover the information themselves.

According to Duminy and Sohnge (1980: 68), the value of the class discussion, lies mainly at two levels:

- Socio-pedagogical

According to this sphere, all the pupils must be willing to share their ideas. If that is not the case, then the method is not applicable. The teacher must motivate the pupils so that they may share their ideas, as that is the major reason for discussion. The students must also be willing to expose their ideas to criticism and even rejection. They must also develop some love for other pupils' ideas, in a sense of willingness to listen to and consider those ideas.

- Didactic value.

There are ideas and experiences which people hold for quit some time. The person concerned is not necessarily aware that what he knows is wrong. He is able to discover that by being exposed to the group discussion. This is just a general comment. It actually receive application in the classroom situation in which discussion method is applied. Here, views and experiences are being augmented and corrected by other pupils and the teacher. Hence, new knowledge is gained and new insight is acquired. What was accepted as self-evident may not be regarded as such by the class and the teacher (Duminy & Sohnge, 1980: 69).

This method opens up the pupils' minds and suggests that, they may not be sure about the correctness their ideas. Ideas should be weighed and compared

with those of other people. Duminy at al (1980:69) assert that this method may serve as a starting point for healthy academic doubt, leading to the necessary discipline of thought and the consequent fresh questioning and more profound reflection. This leads to the gaining of new insights and the establishment of more extensive, integrated knowledge of higher level, at the child's level. This is because they themselves discover or construct this knowledge, on the bases of their specific age level's reasoning. In this method, the teacher does not just pump-in the knowledge which is above the pupils' level.

The topic for discussion must be interesting and within the pupils' level of development. When the teacher is applying this method, he must give the pupils the problem that they themselves would also like to solve. Alternatively, the teacher must make a motivating introduction and the topic must be the one that grips the interest and imagination of the pupils.

In addition to these spheres, the role of a teacher is also crucial. Teachers must be well prepared for and sufficiently knowledgeable about the subject matter. If they are not , they will not be able to achieve their objective and it would be a waste of time. He will, for instance, not be able to formulate the right questions and comments that are essential for the pupils to reach their solution. He must lead irrespective of the direction of the students' discussion (Duminy & Sohnge, 1980:71)

Apart from leading the lesson, the teacher must be able to expose the misconceptions and fallacies arrived at by the group. He must also be able to explain the possible reason for the pupils to arrive at such a misconception and fallacy so that the pupils may not repeat the same mistake. It is the teacher who

must provide a stimulus that may enable the pupils to advance to higher levels of thought. Leading questions are useful in this regard. This view is shared by Brissenden (1989:60), when he emphasises that the teacher must diagnose misunderstandings by listening and observing. According to him, the teacher must file children's' misconceptions mentally for some individual attention.

There are some teachers who feel that they have not taught if they did not explain anything. While the students are still busy trying to get a solution the teacher starts giving an answer. This disturbs the pupils and they will never try their best because they know the teacher is going to do it for them. Such teachers start giving additional information about the problem instead of systematically leading the pupils towards discovering that information. However, Duminy and Sohnge (1980:71) emphasise that the teachers must stop monopolising the discussion by intervening too soon. This intervention actually undermines the main objective of the discussion lesson which shows that the teacher is more subject matter centred than pupil centred. The main purpose of the group method of teaching is to give a chance to the pupils to sharpen their thoughts and power of expression. They must practise to think and solve problems.

According to Cawood and Gibbon (1981: 205) group work is very effective as an educate mathematics teaching method for it is pupil centred. They further assert that, in group work, the teacher operates more in the background and fulfils the role of a quiet leader who is only available for assistance. His main duty is to plan the learning situation, select the learning aids, motivate the pupils and only facilitate the learning. This claim is shared by Brissenden (1989:60),

who maintains that the teacher must not think it is his job to comment on everything in class.

Cawood and Gibbon (1981: 205), in supporting the advantages of using the group method of teaching, list the following objectives:

- gives maximum opportunity for the discussion of a lesson material.
- provides insight and understanding and promotes critical thinking.
- achieves maximum learner-learner interaction and learner-teacher interaction.
- creates a supportive function for the group with respect to each other.

From the above mentioned objectives, it is clear that the discussion method is convenient for teaching mathematics. It provides, according to the objectives, critical and creative thinking which is essential in learning mathematics. This is one of the methods of teaching that would solve the problem of high failure rate in mathematics.

The teacher can guide the pupils efficiently if he understands them well. It is in these discussions that the teacher obtains some valuable information about his/her pupils, as he sees and hears them in action. He then has an opportunity to follow the thinking patterns of his pupils and their abilities to think in the abstraction.

According to Cawood and Gibbon (1981:219) the discussion method, among other things, has the following advantages:

- it is a meaningful learning activity for the child.
- it creates responsibility, critical judgement, initiative, co-operation, and so on.

- it allows for the inquiring and inquisitive nature of the child.
- they will gain new insights and establish more extensive , integrated knowledge of higher level.

This is a good teaching method but its impact in the teaching of mathematics can only be realised if it is applied collaboratively with the problem solving method of teaching. This means that the discussion should be focused on enabling the students to apply their mathematics knowledge to understand mathematics theories, theorems and to solve problems.

2.3.9 LECTURE METHOD

In this method, the teacher actually tells the pupils the subject matter. He tells the pupils, point by point, from the beginning to the end of the lesson. The pupils sit quietly and listen. They are expected to grasp the subject matter by actually listening attentively. In this method, it is assumed that the child learns what he/she is told. He is seen as an empty vessel which is ready to receive whatever information the adult/teacher pours into him. The result is a passive idea of learning in which school education is centred round the teacher and the subject matter.(Duminy & steyn,1987:82).

The above description of the lecture method is shared by Cawood and Gibbon (1981:202) who defines the lecture method as the uninterrupted and one-directional presentation in a teaching situation. According to them, time for questions is not provided for when the lecturing is in progress. The teacher may not be disturbed. What is important is the subject matter and not the pupils. The teacher lectures in the same way he would, even if he was just alone in the classroom.

The above observation is, further, echoed by Abuse and Robins (1972:462) who emphasise that in a lecture method, the teacher offers an adequate exposition of the subject without recourse to feedback about the understanding of the students.

According to the views mentioned above, the lecture method cannot be used successfully in teaching mathematics. In learning mathematics, the students have to be given time to think on their own. They must work out something, and time gets wasted if the mathematics students sit and listen. In every lesson, they must be thinking, trying to accommodate new theories and solving problems.

However, the lecture method can be applied collaboratively with other methods like Question and answer, Discussion, Problem-solving, and so on. Even then , the percentage of the lecture method that is applied in any lesson should be minimal, (say 5%). The excessive application of this method is very likely to contribute to the high failure rate in mathematics in the Kwa-Zulu Natal formerly black schools. It does not give insight, but it leads to memorisation.

For understanding and insight, the pupils must be given a chance to construct their own knowledge based on the subject matter. Knowledge must not just be pumped-in. Knowledge must be used to gain more knowledge. Knowledge gained in this manner is easily applicable and generally useful.

The above view is shared by Capenter (1984;11/12) who asserts that pupils do not necessarily learn what they are taught. They actually construct their own knowledge, relative to the instruction they receive. According to this theory, the

lecture method alone is not enough to enable the students to construct their knowledge. It probably needs to be applied concurrently with other methods. For instance, it can be applied together with self-activities like problem-solving method, discussion method, question and answer method, discovery method and so on. Further more, the lecture method should be applied during the introduction part , when the pupils are being instructed what to do.

However, Duminy and Steyn (1987 : 83/84) emphasise that the lecture method becomes useful when the teacher wants to correct certain mistakes done by the students in the subject matter. The teacher has to tell them. They maintain that, when applying any method in a didactic situation, telling method is the starting point and cannot be avoided. The students need to be told what is expected of them and how they are supposed to attend to it.

If teachers have intentions to use the lecture method, it is important that they introduce their lesson by posing a problem. This motivates the students and they start to think about the problem and analyse it. They are ready to receive the information which is related to the solution of the problem. The students become interested in this classroom activity. They construct, within themselves, a need to listen and learn (Duminy & Steyn,1987:85).

This does not necessarily apply in mathematics. Once a problem is given in mathematics, it must be solved by the students. The teacher cannot start lecturing about the solution of the problem. In mathematics, the teacher can use the lecture method, just to pose the problem. Thereafter, the students must start solving the problem. In this case the lecture method is being used concurrently with the problem solving method.

Duminy and Steyn (1987:88) present the following disadvantages of the lecture method:

- it often becomes the pumping-in of knowledge.
- the need for self activity, initiative, creativity, and problem-solving approach is ignored.
- not enough attention is given to individual differences
- pupils usually accept without questioning.

All these disadvantages indicate that this method is not very suitable for being used as the only method in any mathematics lesson. In mathematics, for instance, the students must be free to ask questions at any time. They must be encouraged to be creative, initiative and confident. That is not accommodated in the lecture method. The lecture method may only be applied to complement the problem solving method, otherwise, it may lead to the students getting confused and the failure rate increasing.

2.3.2 TEXTBOOK METHOD

Taute (Duminy & Sohnge, 1980:78) describes the text book method as a method in which the teacher strictly depends upon a text book in his teaching. Here the pupils are required to have their books open. The book is then read in the classroom. The teacher only explains where it is necessary. For instance, where there is an unfamiliar word, the teacher gets a chance to explain. He then ask the pupils to underline a sentence or a paragraph.

The teacher summarises his lesson by stressing the most important points that have been underlined. He, further, tells the pupils what to write in case they are

supposed to write about that particular section of the work. In particular, he tells the pupils exactly which paragraph to start with and exactly where to stop, in case the pupils are supposed to write about the particular topic. This does not necessarily stress understanding of the subject matter. As long as the pupils can write what is there in the text-book, the teacher is satisfied.

It goes without saying that this method encourages memorisation and recitation and is not suitable for mathematics teaching. In support of the above, Duminy and Sohnge (1980:78) argue that this method does not stimulate self-activity and independence among the pupils. The pupils keep on depending upon the text-book and the teacher's interpretation of the text-book. It is one of the most passive teaching methods. It does not encourage the pupils to read extensively, to think for themselves and to formulate their thoughts well and express these thoughts properly in oral form or in written language.

According to Duminy and Sohnge (1980: 78/79) the text book method has certain shortcomings which are briefly discussed below:

Teachers in this method are guided by the text book. They do not consider the pupils' interest, their needs, their abilities and their individual differences. The method itself does not have provision for that. As far as the method is concerned, it is the students who must try to meet the demands of the method.

Duminy, et al. (1980: 78/79) emphasise that according to this method, the teacher's task becomes subject-matter-bound, and progress through the text book becomes the most important aim.

- The teacher and the pupils accept the information given in the text-book as the final authority in the subject in question. The pupils may even fail to understand the same information if it is written in another text-book using different words. This shows the greatness of the degree of lack of understanding when the students are taught using this method.

- The teacher and the students who are using this method of teaching and learning, do not see the need to use other text book. They feel that all the information they need is in that particular text-book. This is not a very good approach to the teaching and learning situation because there is, according to Duminy and Sohnge (1980: 78-79) no text book which is complete. Different text-books work hand-in-hand to bring about solid; complete and valuable information.

From the above disadvantages, it is clear that the text-book method, in mathematics, can only be useful if it is used collaboratively with other methods. When it is applied alone, it is not likely to promote problem solving, self-activities and learning approaches like investigating and constructing knowledge which are so vital in the learning of mathematics. The teacher may use this method alone if he is giving homework or class work.

2.4 SUMMARY

A study of literature on the teaching methods has revealed a number of methods that are applied in the teaching of mathematics. Most of these methods are suitable and convenient for teaching mathematics. If they are applied correctly, they may enable the students to solve problems and to make sense of unfamiliar situations. In other words, some of these teaching methods may

enable the students to construct their own knowledge on the bases of the instructions and their previous experiences.

The methods that are mathematically educative are those that enable the child to think and apply his previous mathematics knowledge to discover, invent and to make sense of the mathematical situations he encounters. The child then develops problem solving abilities and, hence, does not always depend upon the teacher for the solution of problems. In this case the students are likely to pass their mathematics examinations, since the mathematics examination paper contains mostly problems.

There are some teaching methods that are not very effective in the teaching and learning of mathematics. Such methods do not necessarily enable the students to solve problems. Hence, they are irrelevant and not useful in so far as mathematics teaching is concerned. Mathematics is done at school, only to enable the students to solve real life problems. This view is supported by Randall and Edward (1990:13) when they argue that problem solving is the reason for doing mathematics at all.

These ineffective methods are lecture method and the text book methods. They concentrate on giving the information rather than enabling the students to discover the information themselves. Such teaching methods may not enable the students to solve problems, but show them solutions of particular sums. In this way the students must remember the solutions that were done by the teacher or are given in the text book as examples. Good result cannot be obtained in mathematics when teachers still believe in telling the students rather than giving them a chance to think, understand, and construct their own knowledge.

Among good mathematics teaching methods, the problem solving approach is the main method for effective, efficient and successful teaching of mathematics. This is because the problem solving method enables the students to use their previous knowledge to understand new theories and solve problems. In fact, the main goal of the problem solving method is to teach problem solving and enable the students to discover theories and procedures. Discovering solutions to problems and making sense of unfamiliar situations is what mathematics entails. This method is very likely to improve mathematics pass rate in this region.

Apart from the lecture method and the text book methods, most of the teaching methods can be used collaboratively with the problem solving method. Such methods are used to supplement the problem solving method. For instance, the question and answer method is applied to assist the problem solving method where the students find it difficult to proceed on their own in solving a particular problem or making sense of an unfamiliar situation. In this regard, the discussion method may be applied concurrently with the problem solving method, to produce or gather more information that forms the foundation of the problem at hand and to generate more ideas about the subject matter.

According to Naidoo et al (1996:24) problem solving strengthens the students in making sense of the unfamiliar situation. This implies that students learn better if the subject matter is presented in the form of a problem. Dewey (Randall et al, 1990:199) stresses that instructions in subject matter that does not fit into any problem already stirring in the students' own experiences or that is not presented in such a way as to arouse a problem is worse than useless for intellectual purposes. He argues that it is useless in a sense that it remains in as so much

lumber and debris. He further asserts that it is a barrier, an obstruction in the way of effective thinking when a problem arises.

The above argument is in agreement with the constructivist view where students must be given a chance to construct their own knowledge. So, the constructivist view can be applied conveniently within the problem solving method. Almost all the teaching methods can be used collaboratively with the problem solving method.

So, the method that is most convenient in the teaching of mathematics is the problem solving method. However, there are some other methods that are also good. But, such methods are efficient if they are used to help the child in understanding the problem solving approach to learning. In other words, all other methods may be applied only to supplement the problem solving method.

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

3.1 INTRODUCTION

This chapter is concerned with procedures that constitute what is called research design and methodology. Hence, it focuses on the collection, recording, classification, analysis, discussion, and interpretation of the data based on the video tapes.

According to resent literature on research, educationists and researchers have turned to direct observation in the classroom as a method of collecting data. In this study, video tapes are used to collect and record data on the methods of teaching and learning mathematics.

3.2 RESEARCH METHOD

Video tapes for different lessons that were presented by different mathematics teachers were taken. The video tapes show exactly the methods which the teachers apply in the teaching of mathematics.

These videos are then recorded, classified, analysed, discussed and interpreted in terms of the teaching method(s) the teacher employs in his teaching. The methods were then viewed against the standard ten pass percentage.

3.3 VIDEO TAPING

The college educational technology lecturer took the video tapes of the lessons that were presented by the mathematics teachers, at their schools.

This process was completed in two weeks' time. The reason for such a long time, is that the selected schools are far apart.

3.4 DEFINITION OF POPULATION

In this study the population consisted of mathematics teachers of Madadeni circuit. 10 teachers were selected from the 30 high schools in the circuit for the study.

- Two schools with the best standard 10 mathematics results in the circuit. These are the schools whose mathematics percentage pass in 1995 is, at least, 60%.

- Four schools with average standard 10 mathematics pass percentages in the circuit. These are the schools with a percentage pass, for 1995, which lies between 40 % and 60 %.

- Two Schools with low standard 10 mathematics pass percentages. These are the schools whose percentage pass is at most 40 %.

- The teachers who were selected are those who have taught standard ten mathematics in 1995. This is because it is desired to relate the teaching methods used by the particular teacher to the standard ten percentage pass, he/she obtained in 1995.

3.5 PRELIMINARY ARRANGEMENTS

Permission to use the high schools for the investigation was obtained from the circuit inspector. Then, letters were written to the high school principals

asking for permission to involve their schools, mathematics teachers and students in the investigation.

3.6 OBSERVATIONS

It was observed that in any lesson, teachers employ more than just one teaching method. Some use the lecture method and the question and answer method in one and the same lesson. Others use the lecture method and the text book method. There are many other such combinations. However, it is observed that the lecture method dominates any other method. The implication here is that most of the teachers use it and any other method that is used concurrently with the lecture method is, comparatively, used for a very short time. For instance, the question and answer method usually consists of unrelated questions, mostly for recall purposes. According to Duminy and Steyn (1978:111) this does not constitute what is called question and answer method.

3.7 DATA OBTAINED THROUGH THE VIDEO TAPES

In the light of the observations and the finding elaborated above, the data consist of the percentage of each method that was applied by each teacher and the standard ten percentage pass. The names of the teachers will not be stated in this study. Symbols will be used to denote the teachers.

3.7.1

TEACHER: A

CLASS: Std 6

TOPIC: Measurements of the angles and sides of triangles

3.7.1.1 This was self-activity in which the students had to measure the lengths and magnitudes of angles. The activity itself was mathematically educative. But, it was not used to reach any conclusion. So, this self-activity was incomplete. It did not help the students to discover some mathematics knowledge or enable them to solve problems.

Instead of giving a chance to the students to make some conclusions or to think, the teacher started telling the students the relationships. In this lesson, the some students could construct some knowledge. But, the thinking process was excluded. His teaching can be tabulated as follows:

3.7.1.2

TEACHER	Que. &ans	Lecture	Discussion	Prob. Solv.	Discovery	1995 std 10 %pass
A	30%	60%	0%	10%	0%	30%

3.7.1.3 SUGGESTIONS FOR IMPROVEMENT

After the students learn how to measure the angles, the teacher should immediately ask them to find the sum of the angles of triangles. In this case they will have used their thought. They will have made decisions. In the above-mentioned case the students just measure. They have no chance to think and make decisions that if they need to find the sum of the angles of a triangle, they must start by measuring each angle. Then they must add the angles they have measured. Such thinking is necessary in mathematics learning. But, here the teacher does all the thinking and the students only have to sit, listen and accept the teacher's thought and conclusions.

3.7.2. TEACHER-B

CLASS: Std 9

TOPIC: Solution of simple trigonometric equations

3.7.2.1 Here the teacher knows his mathematics but has a problem of always wanting to tell the students. He just gives no chance to the students to think. Immediately after giving them some work to do or just before he start the lesson, he tells them about the reduction formula, instead of observing and helping them, if they cannot find a suitable method for solving the problems. He can even tell them about the reduction formula if they cannot think about it themselves.

He continues like that throughout the lesson. There is just no time for the child to think. According to this lesson the child only has to remember the procedure as it was done by the teacher and nothing else. No reasoning, thinking, and so on, is involved. The teacher thinks for the students and the percentage of his teaching can be tabulated as follows:

3.7.2.2

TEACHER	Que. & ans	Lecture	Discussion	Prob. Solv.	1995-Std 10 % Pass
B	40%	50%	0%	10%	35%

3.7.2.3 SUGGESTIONS FOR IMPROVEMENT

The teacher talk should not dominate the scene. Pupils should be encouraged to participate in the development of the lesson. If they solve problems in almost all the lessons they will improve their problem solving abilities and hence, they will know more mathematics.

3.7.3 TEACHER-C

CLASS: Std 10

TOPIC: Introducing Trigonometric ratios

3.7.3.1 DISCUSSION

The teacher had a good introduction. She drew a right-angled triangle, labelled the sides in terms of opposite side, adjacent side and hypotenuse, and wrote the ratio: $\frac{\text{opposite side}}{\text{hypotenuse}}$

Then she allowed the students to mention the rest of the ratios. In this case it is possible that there was some thought involved. [However, it seams there was some confusion. The students were both learning the theorem of Pythagoras and applying it. The theorem of Pythagoras should have appeared in the introduction, so that it could be applied in the subject matter].

Thereafter, the teaching method became the telling method. There were questions that were asked, but could not constitute what is called the question and answer method. There was very little time allowed for thinking

by the students. They could not even get a chance to see the problem as a whole. They are bombarded with short questions involving only part of the whole problem.

They will only be able to follow what they have been told rather than be able to think, plan and make decisions about the sum. They will not necessarily know or pass mathematics. Problem-solving is not included in the teaching and learning. It may not be so easy for them to construct their own knowledge. A chance like that does not arise. They must take the teacher's knowledge. The percentage of the teaching methods she applied can be tabulated as follows:

3.7.3.2

TEACHER	Ques.&ans	Lecture	Discussion	Prob. Solv.	Discovery	1996-Std 10 % Pass
C	30%	60%	0%	10%	0%	30

3.7.3.3 SUGGESTIONS FOR IMPROVEMENT

In all her teaching, the starting point must be the consideration of the thinking processes that can be engaged in the learning, for it is only then that the learning of mathematics may occur.

After introducing the subject matter, she should have left most of the thinking to be done by the students. In so doing they are practising mathematics and problem-solving.

3.7.4 TEACHER-D

CLASS: Std 8

TOPIC : Calculations based on the exterior angles theorem.

3.7.4.1 DISCUSSION

It was clear in this lesson that the students were not familiar with the statement of the theorem that was to be applied. The students, therefore, could not be involved in the thinking process. They could only listen. As a result then, the teaching method that could be applied was the telling method. The teacher thinks that he is using the question and answer method while it is the lecture method. He asks questions and answers them himself.

There is just no mathematical thinking involved in this lesson and the percentage of the teaching methods he uses can be summarised as follows:

3.7.4.2

TEACHER	Que & ans	Lecture	Discussion	Prob. Solv.	Discovery	1995- Std 10 % Pass
D	30%	70%	0%	0%	0%	25%

3.7.4.3 SUGGESTIONS FOR IMPROVEMENT

The teacher should first establish that the students have the prerequisite knowledge before he facilitates the learning of a particular subject matter. Further, he should not talk too much. He should give a chance to the students to find information for themselves.

3.7.5 TEACHER-E

CLASS: Std 8

TOPIC: Straight line graph

3.7.5.1 DISCUSSION

Even though the students had to do something on the board, they were repeating what the teacher had already done. They were not thinking. They only had to follow the procedure as explained by the teacher.

The teacher does ask questions, but he soon answers such questions himself. When he says "what is the next step", he wants them to repeat what he had told them. He does not expect them to think at all. He feels that they cannot think. He says they must anticipate the shape of the graph without giving them any chance to do so. The percentage of his teaching methods can be summarised as follows:

3.7.5.2

TEACHER	Que. & ans	Lecture	Discusion	Prob. Solv.	Discovery	1995- Std 10 % Pass
E	40%	50%	0%	10%	0%	40%

3.7.5.3 SUGGESTIONS FOR IMPROVEMENT

The teacher must stop talking too much and must allow the students to think. For instance, he must have drawn the axes and asked the students to label it. In so doing he wants to find out where the pupils are. He is trying to get the starting point. Then, the students will have to draw the straight line graph themselves. If they are able, then they may immediately try to draw some other graphs using the same principle.

3.7.6 TEACHER-F

CLASS: Std 9

TOPIC: Trigonometric ratios of angle: 0^{o}, 90^{o}, 180^{o}, 270^{o}, 360^{o}

3.7.6.1 DISCUSSION

He is a very good teacher. He uses the lecture method collaboratively with the question and answer method. Unlike the previous teachers, he uses more of the question and answer method than the lecture method. He also applies the problem-solving approach in his teaching. For instance, when he was introducing the co-ordinates of (1;0), he noticed that the pupils are not familiar with the diagram. Then, he used a simplier diagram to let the students understand the diagram under discussion. He does not tell but helps them to find out or construct the meaning themselves. That is part of problem solving approach to teaching. This makes his teaching quite effective and efficient.

It is unfortunate that he very quickly starts to explain while the students are still thinking and trying to find out. Then, he starts using the lecture method.

When he gives them homework, he does not forget to tell the " please do the same thing that I have done" Just when will they ever get a chance to think for themselves without being restricted ? The observations can be tabulated as follows:

3.7.6.2

TEACHER	Que.& ans	Lecture	Discussion	Prob. Solv.	Discovery	1996-Std 10 % Pass
F	50%	10%	0%	30%	10%	70%

3.7.6.3 SUGGESTION FOR IMPROVEMENT

The teacher must just relax and learn to facilitate rather than to teach. He has the ability. But, he also has the desire to explain. He must stop talking and give the students time to solve problems on their own.

3.7.7 TEACHER-G

CLASS: Std 6

TOPIC: The sum of the angles of a triangle.

3.7.7.1 DISCUSSION

The lesson was conducted using the lecture method. There were questions that were asked. But almost all were for recall. There were no higher order

questions. At no stage were the students required to think. Though the teacher used the paper cuttings to demonstrate the theorem, he did not relate or allow the students to relate the demonstration to the angles of a triangle. He quickly applied the results of the demonstration.

The students should have been given enough time to think about the demonstration, to make conclusions and try to apply the results of the demonstration.

Even when the students were already doing the classwork, the teacher was going around, telling them the procedures rather than allowing them to think about solving in their own ways. The observations can be tabulated as follows:

3.7.7.2

TEACHER	Ques. & an	Lecture	Discussion	Prob. Solv.	Discovery	1995-Std 10 % Pass
G	30%	60%	10%	0%	0%	40%

3.7.7.3 SUGGESTIONS FOR THE IMPROVEMENT

The teacher must give the students some problems to solve. He must stop talking too much.

3.7.8 TEACHER-H

CLASS: Std 10

TOPIC: Linear programming

3.7.8.1 DISCUSSION

The students were arranged for class discussion, but the lesson was conducted using the lecture method and the question and answer method. There was also some problem solving method based on some minor investigation.

The observation was as follows:

3.7.8.2

Teacher	Ques. & ans	Lecture	Prob. Solv.	1996-Std 10 % pass
H	50%	40%	10%	65%

3.7.9 TEACHER-I

CLASS: Std 10

TOPIC: Ratios of compound angles

3.7.9.1 DISCUSSION

The main teaching method was the lecture method. It is used concurrently with the question and answer method and very little problem solving method according to the following tabulation:

3.7.9.2

Teacher	Ques. & ans.	Lecture	Prob. solv.	1995- Std 10 %pass
I	40%	50%	10%	50%

3.7.10 TEACHER-J

CLASS: Std 10

TOPIC: Proof of Geometric riders

3.7.10.1 DISCUSSION

The teacher's intention is to use the problem solving method concurrently with the question and answer method, but he seem to be using more of the lecture method than any of the two methods. He asks questions and answers them himself. The observation of his lesson was as follows:

3.7.10.2

	Ques &ans	lecture	prob. solv.	Discussion	1995- Std 10 %Pass
Teacher					
J	40%	40%	20%	0%	55%

3.8 THE SUMMARY OF THE OBSERVATION WAS AS FOLLOWS:

3.8.1 OBSERVATIONS

Teacher	Que. &ans	Lecture	Discussion	Prob. solvi	Discovery	1995-Std 10
	0%	0%	0%	0%	0%	% pass
A	30%	60%	0%	10%	0%	30%
B	40%	50%	0%	10%	0%	35%
C	30%	60%	0%	10%	0%	30%
D	30%	70%	0%	0%	0%	25%
E	40%	50%	0%	10%	0%	40%
F	50%	10%	0%	30%	10%	70%
G	30%	60%	10%	0%	0%	40%
H	50%	40%	0%	10%	0%	65%
I	40%	50%	0%	10%	0%	45%
X J	40%	40%	0%	20%	0%	55%
Mean	38	49	1	11	1	44

3.8.2 STANDARD DEVIATION

3.8.2.1 THE SCORES CAN BE TABULATED AS FOLLOWS:

Quest. & answer	Lecture	Problem solving	STD 10 result (%)

x	x^2	y	Y^2	z	Z^2	k	K^2
30	900	60	3600	10	100	30	900
40	1600	50	2500	10	100	35	1225
30	900	60	3600	10	100	30	900
30	900	70	4900	0	0	25	625
40	1600	50	2500	10	100	40	1600
50	2500	10	100	30	90	70	4900
30	900	60	3600	0	0	40	1600
50	2500	40	1600	10	100	65	4225
40	1600	50	2500	10	100	45	2025
40	1600	40	1600	20	400	55	3025
380	15000	490	26500	110	1090	435	21025

3.8.2.2 CALCULATION OF THE STANDARD DEVIATIONS

According to Mulder (1982:28) the standard deviation is given by the

following formula:

$$S = \frac{1}{N}[N\ x^2 - (\ x)^2]^{0,5}$$

Where S = Standard deviation

N = The number of scores

x = The percentage of the question and answer method

y = The percentage of the lecture method

z = The percentage of the problem solving method

k = The percentage of the 1995 standard 10 pass

According to Mulder (1982:28) the formula for the standard deviation is:

QUESTION AND ANSWER METHOD

$$s = \frac{1}{N}\sqrt{N \quad x - (\quad x)}$$

$$= \frac{1}{10}\sqrt{10 * 15000 - (380)}$$

$$= \frac{1}{10}\sqrt{150000 - 144400}$$

$$= \frac{\sqrt{5600}}{10}$$

$$= \frac{74,833}{10}$$

$$S = 7,5$$

LECTURE METHOD

$$S = \frac{1}{10}\sqrt{N \quad y - (\quad y)}$$

$$= \frac{1}{10}\sqrt{10 \quad 26500 - (490)}$$

$$= \frac{\sqrt{265000 - 240100}}{10}$$

$$= \frac{157,7973}{10}$$

$$S = 15,8$$

Problem solving method

$$S = \frac{1}{N}\sqrt{N \quad z \quad - \quad (\ Z)}$$

$$S = \frac{1}{10}\sqrt{10 * 1900 \_\_ (110)}$$

$$S = \frac{1}{10}\sqrt{19000 - 12100}$$

$$S = \frac{83.0662}{10} = 8,3$$

STD 10 results

$$S = \frac{1}{N}\sqrt{N \quad k - (\quad k)}$$

$$S = \frac{1}{10}\sqrt{10 * 21025 - 189\,225}$$

$$S = \frac{1}{10}\sqrt{210250 - 189225}$$

$$S = \frac{\sqrt{21025}}{10}$$

$$= \frac{145}{10} = 14,5$$

3.9 PEASON'S CORRELATION COEFFICIENT.

3.9.1 THE QUESTION AND ANSWER METHOD

3.9.1.1 SCORES

	Ques. & ans. Method		1995 STD 10 Results		Product
TEACHER	x	X^2	k	K^2	xk
A	30	900	30	900	900
B	40	1600	35	1225	1400
C	30	900	30	900	900
D	30	900	25	625	750
E	40	1600	40	1600	1600
F	50	2500	70	4900	3500
G	30	900	40	1600	1200
H	50	2500	65	4225	3250
I	40	1600	45	2025	1800
J	40	1600	55	3025	2200
TOTAL	380	15000	435	21025	17500

3.9.1.2 CALCULATION OF PEARSON'S CORRELATION COEFFICIENT

$$r = \frac{N\,xk - x\,k}{\sqrt{[N\,k^2 - (x)^2][N\,k^2 - (k)^2]}}$$

$$= \frac{10 * 17500 - 380 * 435}{\sqrt{[10*15000 - (380)^2][10 * 21025 - (435)^2}}$$

$$= \frac{175000 - 165300}{\sqrt{(150000 - 144400)(210250 - 189225)}}$$

$$= \frac{9700}{\sqrt{(5600)\,(21025)}}$$

$r = 0.894$

3.9.1.3 DISCUSSION OF THE CORRELATION COEFFICIENT

Hence there is a very high positive correlation between the standard ten percentage pass and the question and answer methods. Since the correlation is positive, then the more the question and answer method is used by the teachers, the better are the standard ten results. This can be ascribed to the fact that the question and answer method is mostly used concurrently with the problem solving method.

3.9.2. THE LECTURE METHOD

3.9.2.1 SCORES

Teacher	Lecture	lecture	1995-Std 10	% Pass	Product	
	y	Y^2	k	K^2	yk	
A	60	3600	30	900	1800	
B	50	2500	35	1225	1750	
C	70	4900	30	900	2100	
D	70	4900	25	625	1750	
E	50	2500	40	1600	2000	
F	10	100	70	4900	700	
G	60	3600	40	1600	2400	
H	40	1600	65	4225	2600	
I	50	2500	45	2025	2250	
J	40	1600	55	3025	2200	
TOTAL	**500**	**27800**	**435**	**21025**	**19550**	

3.9.2.2 CALCULATIONS OF CORRELATION COEFFICIENT

$$r = \frac{N \sum yk - \sum y \sum k}{\sqrt{[N \sum y^2 - (\sum y)^2][N \sum k^2 - (\sum k)^2]}}$$

$$= \frac{10 * 19550 - 500 * 435}{\sqrt{[10 * 27800 - (500)^2][10 * 21025 - (435)^2]}}$$

$$\frac{195500 - 217500}{\sqrt{(278000 - 250000)(210250 - 189225)}}$$

$$= \frac{-22000}{\sqrt{(28000)(21025)}}$$

$$= \frac{-22000}{\sqrt{588700000}}$$

= -0,907

3.9.2.3 DISCUSSION OF THE CORRELATION COEFFICIENT RESULT

There is a very high negative correlation between the standard ten results and the lecture method. This means that if a teacher uses more LECTURE method in his teaching, the number of students who pass mathematics decrease

From observing the videos, it has been noticed that most teachers apply the LECTURE method more than any other method. This means that the reason for such a high failure rate is the excessive use of the lecture method in the teaching of mathematics.

3.9.3 THE PROBLEM SOLVING METHOD

3.9.3.1 SCORES

Teachers	Problem solving	1995 STD 10 % pass	Product	

	z	z^2	k	k^2	
A	10	100	30	900	300
B	10	100	35	1225	350
C	10	100	30	900	300
D	0	0	25	625	0
E	10	100	40	1600	400
F	30	900	70	4900	2100
G	0	0	40	1600	0
H	10	100	65	4225	650
I	10	100	45	2025	450
J	20	400	55	3025	1100
Total	**110**	**1900**	**435**	**21025**	**5650**

3.9.3.2 CALCULATION OF THE PEARSON CORRELATION COEFFICIENT

$$r = \frac{N\,zk - z\,k}{\sqrt{[N\,z^2 - (z)^2]\,[N\,k^2 - (k)^2]}}$$

$$= \frac{10 * 5650 - 110 * 435}{\sqrt{[10 * 1900 - (110)^2]\,[10 * 21025 - (435)^2]}}$$

$$= \frac{56500 - 47850}{\sqrt{[19000 - 12100]\,[210250 - 189225]}}$$

$$= \frac{8650}{(6900 * 21025)^{1/2}}$$

$$= \frac{8650}{(12044.6046)^{1/2}}$$

$$r = 0{,}718$$

3.9. 3.3 DISCUSSION OF THE CORRELATION COEFFICIENT

It is clear that almost all the teachers apply very little of the problem solving method. There are even those who do not apply it at all. But, from the very low percentage usage of the problem solving method, it was possible to calculate the correlation coefficient as shown above. The correlation coefficient is very high and positive. This means that, if more of the problem solving method is applied, the pass rate would improve.

3.10 SUMMARY

It is clear, from the video tapes that the lecture method almost dominates other teaching methods and that the next frequently used method is the question and answer method. There is very little problem solving that can be observed. Even the little percentage of the problem solving method that is applied by some teachers, can be noticed when the question and answer method is being observed very closely. Most of these teachers do not even notice that in their teaching there is some problem solving method that is being applied. Almost all other methods are not used in the teaching of mathematics by these teachers.

It is, however, noticed that, the question and answer method, that is being used, is mostly incomplete. It only becomes questions that are not necessarily related, to constitute what Duminy and Steyn(1978:111) regard as the question and answer method. These are usually questions for recall.

There is very little problem solving approach that is applied and, hence, there is little construction of knowledge by the students.

From the statistics above, it is clear that the lecture method which dominates other methods, has a correlation coefficient of -907. This means that the percentage of the lecture method that is used in the teaching of mathematics, is inversely proportional to the mathematics pass percentage.

On the other hand, the question and answer method has correlation coefficient of 0,894. This is very high and positive. The implication here is that the question and answer method is directly proportional to the mathematics percentage pass. Hence, the teachers should rather use the question and answer teaching method than the lecture method.

The problem solving method has a correlation coefficient of 0,718. This is very high and positive. This also implies that the percentage of the problem solving method that is applied by a teacher in a mathematics lesson, is directly proportional to the mathematics percentage pass. Hence, the teachers may improve their mathematics pass percentage if they use this teaching method as compared to the lecture method.

The above discussion obviously means that the excessive use of the lecture method results in the high failure rate. This means that the teachers must not use the telling method in their mathematics teaching. The question and answer methods and the problem solving methods can be used for, according to the statistics, the application of these methods improve the pass rate.

CHAPTER 4: SUMMARY, CONCLUSION AND RECOMMENDATIONS

4.1 SUMMARY

Mathematics has always been considered a difficult subject. This view is not necessarily true. Rather, mathematics is slightly different from most of the subject. Hence, it must be understood differently and must therefore be taught differently, according to its nature.

This study is an investigation of the teaching methods that are applied by most teachers in the teaching of mathematics in the KwaZulu Natal formerly black schools. The aim is to find out if there is any relationship between the methods that are mostly used by the teachers and the poor achievement in mathematics in these schools.

The study of the literature on the teaching methods, has revealed that the lecture method and the text book methods, when they are used alone, in any lesson, cannot help the students to understand that subject matter. If it is used alone in all the lessons, then most of the students will fail mathematics. This criticism is based on certain disadvantages that have been written on these teaching methods.

According to the literature, the most efficient and effective method of teaching mathematics is the problem solving method. For the best understanding by the students this method should be used collaboratively with other methods of teaching. This means that the problem solving method can efficiently incorporate, and be used collaboratively with, all the self-activity teaching methods, teaching approaches like the investigative and the constructivist

pespectives and methods like the question and answer method, discussion method. This does not necessarily include the text book and the lecture methods.

The above assertion is based on the fact that mathematics is a subject where the students must solve problems and the problem solving method of teaching is for teaching the students how to solve problems. Hence, there is a strong relationship between mathematics and the problem solving method of teaching. Other methods of teaching can also be applied in the teaching of mathematics but, they will produce best achievements if they are applied within the problem solving teaching approach.

The investigation was conducted by producing video tapes of some mathematics lessons in progress. Then, the tapes were studied and analysed. It was desired to find out which method(s) is mostly applied by the mathematics teachers in the region. Then, such a method would be further analysed in terms of suitability for the teaching of mathematics.

When the tapes were analysed, it became clear that teachers apply more than just one method of teaching in any one lesson. It was also discovered that most of the teacher use a higher percentage of the lecture method compared to other teaching methods. In other words, the lecture method dominates the other teaching methods in this region.

However, according to the statistics, the use of the lecture method contributes to the high failure. The application of the question and answer and the problem

solving methods, according to the statistics, does improve achievement in mathematics.

4.2 CONCLUSION

From the study of the literature, the video tapes and the statistics, it can be concluded that:

- there is a strong relationship between the teaching methods and the students' achievement in mathematics.
- the excessive use of the lecture method in the teaching, contributes to the high failure of mathematics in the region.
- apart from the lecture method and the text book method, most of teaching methods have the potential to improve the pass rate of mathematics.
- The problem solving method, when used collaboratively with methods like the question and answer method, discussion method and many other teaching methods, including the self-activities can result into students' high achievement in mathematics.
- most teachers use the lecture method in teaching mathematics.
- some teachers fail to apply the question and answer method correctly. They think they are using the question and answer method when, in fact, they are just asking questions.

4.3 RECOMMENDATIONS

The following recommendations emanate from this study:

- teachers must teach mathematics only if they are qualified to do so, in terms of the knowledge of mathematics and the knowledge of the teaching methods.
- the lecture method should not be used as the only method for teaching any particular lesson.
- if the lecture method is applied, it may only be used concurrently with other suitable methods of teaching mathematics. For instance, when the teacher wants to use the discussion method, he may introduce it using the lecture method.
- the lecture method may next be applied when correcting certain misconceptions, though such misconceptions can suitably be corrected using the problem solving approach, together with the question and answer teaching methods
- in the teaching of mathematics, the text book method should only be used when giving some work to be done for home work or class work. It cannot be applied as a teaching method.
- the problem solving teaching method should be used in almost all the lessons in the teaching of mathematics.
- the problem solving method may be used collaboratively with other suitable mathematics teaching methods such as the question and answer method, the discussion method and so on.
- the methods that are used concurrently with the problem solving method should not necessarily be applied on equal bases with problem solving method. They should be used only to supplement the problem solving method.
- all the instruction should be converted into problems for the students to find out themselves. There must be no telling.

- each time the students enter a mathematics classroom, they should only be going there to solve problems and not to listen to the teacher demonstrating his knowledge of mathematics to them.
- the teacher's duty is to facilitate. He must plan the problems that should be given to the students. The problems must be carefully graded so as to make sense and to be understandable to the students.

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