

UNIVERSITY OF BATH

School of Education

**AN INVESTIGATION OF THE POTENTIALITY
OF USING DRAMA IN THE TEACHING
OF MATHEMATICS IN SECONDARY SCHOOL**

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ABSTRACT

The present study investigates the potentiality of using drama as a method of teaching mathematics in secondary school. The research aims, as derived from the analysis of the problem under investigation, are:

1. "To identify the benefits and values of drama as a teaching method of mathematics in the present classroom conditions of secondary schools."

2. "To point out the limitations that teachers either face when attempting to employ drama as a teaching method or which prevent them from using it."

The research methodology constitutes two parts. The first part is a pilot study, which provides assistance to the better planning of the main part of the research and to the objectives' formulation. The second part is the main study which includes interviews with teachers and pupils, as well as observation of three case studies in a secondary comprehensive school in the county of Avon.

The major findings of the present research which seems to provide some resolution to the question under investigation, are as following:

1: The benefits and the values, that drama has as a teaching method of mathematics in present classroom conditions of secondary school level, are identified as:

- * provision of motivation and stimulation, so that children can find an interest for the mathematical activity,
- * encouragement of the active participation, communication and co-operation between the children in mathematics teaching,
- * connection and relation to real life examples and concrete experiences mainly due to the content and the symbolism.

2: The limitations that teachers face when attempting to use drama in mathematics teaching or prevent them from it, are pointed out such as:

- * time,
- * resources,
- * teachers' skills and abilities,
- * children's past experiences and attitudes,
- * teachers' attitudes and personality,
- * co-operation amongst teachers and departments.

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AUTHOR DECLARATION

1. The author is not registered for any other academic award during the period of registration for this study.
2. The material included in this dissertation has not been submitted wholly or in part for any other academic award.
3. The programme of advanced study of which this dissertation is part has consisted of attendance at the following modules:

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[Signature]

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CHAPTER I

INTRODUCTION

Through research studies, it has been revealed that children have difficulties or feel unable to understand mathematics, and apply certain fundamental mathematical skills in real-life problems. At the same time children leave school with negative feelings towards mathematics, failing to appreciate the nature and the value of the subject (see Chapter II, 2.2).

Some of the many causes suggested for these problems, are the lack of appropriate learning environment and unsuitable teaching methods.

Many authors (Dienes 1968, Hughes 1987 and Orton 1987) have advocated that the present learning environment in many classrooms, is unsuitable and does not enhance the process of learning. There is a lot of pressure caused by overloaded syllabuses, as well as the subject appearing meaningless or irrelevant to children's needs, and the fear of exams. A serious lack of activities which would reflect real life situations and problems has been revealed.

Research (Schools Council Report 1965, Cockcroft Committee, 1982) has revealed that the teaching methods which are now been used in the classroom for mathematics, are still traditional and consisting mainly of exposition by the teacher and consolidation of fundamental skills. At the same time, it has been recognised that there is a lack of practical activities (see Chapter II, 2.3). Children are not provided with the opportunity to employ the mathematical skills they are being taught in the classroom, to real life situations. Therefore, the learning of mathematical concepts and algorithms remains meaningless for the majority of the children without any chance of enjoyment and real understanding.

According to many authors (Johnson & O'Neill 1984, Nixon 1982, Bolton 1984), educational drama has altered lately, and nowadays it is regarded as a valuable teaching method for many subjects in the curriculum (see Chapter III). Certain characteristics that make drama appropriate to be used in teaching are discussed in Chapter III. A summary of these follows:

- Drama reinforces:
 - the active and personal involvement of pupils,
 - their engagement to the task
 - the pupil's stimulation and motivation.
- Drama provides:
 - situations for high intellectual expression
 - connections with the real world
 - experiences to gain confidence and certainty.
- Drama sets up:
 - a learning environment
 - problem-solving and make-believe situations.
- Drama provides
 - chances for better communication
 - social relations and emotional expression.

On the other hand, the features of mathematics as discussed in Chapter II, which also constitute its importance for teaching and learning, could be summarised in the following:

- Mathematics:
 - is an intellectual activity, as it makes people think and learn.
 - improves the imaginative and intellectual expression.
 - accelerates the logical and rational way of thinking.
 - demonstrates the abstract way of thinking.
 - is involved with problem solving.
 - is a means for communication especially valuable for complex situations.

improvement of mathematics teaching and learning by using various forms of drama. A presentation of several research studies takes place in Chapter IV of the present study. Although the employment of such methods has been proved very efficient, there has been little research referring to the application of drama or other relevant activities to the teaching of mathematics in the secondary school. It seems that in the secondary school, learning through the active participation of pupils in the teaching process, through discovering and exploring and through personal experience on the teaching subject is very neglected. This very fact has been pointed out by several authors and in Chapter IV 4.4, there is a detailed examination of the matter.

Bearing in mind the valuable characteristics of drama as a teaching method and the features of the subject of mathematics, and also regarding the already identified causes of children's difficulties in understanding and appreciating mathematics, the following hypothesis was formulated:

"The use of drama as a teaching method, facilitates and improves the comprehension and appreciation of mathematics in the present classroom conditions of secondary schools.

Lack of time prevented an objective and practical testing of the effectiveness of drama as a teaching method in mathematics. Research on the objective effectiveness of a certain teaching method obviously demands much more time than the time available for the present dissertation, as it is a complex task needing to be approached from various perspectives. In the present study it was found impossible to investigate and to respond directly to the effectiveness of drama as a teaching method in learning mathematics. However, the already formulated hypothesis is the basis of the present research, which purpose is to explain, clarify and test the possibility of

objectively proving it. Therefore, the hypothesis under investigation which the present study will attempt to examine, was formulated as following:

"There is a potentiality of using drama as a teaching method of mathematics in the present classroom conditions of secondary schools."

By the term 'potentiality' the researcher means:

First, what benefits and values of drama as a teaching method could be employed for the improvement of mathematical learning in the present classroom conditions of secondary schools; and second, what limitations (problems, obstacles) may the teachers face in attempting to use drama as a method of teaching mathematics or prevent them from using it.

One must take into serious account both the benefits and values, as well as the obstacles that teachers may face when a new teaching method is being examined. The researcher regarded as important to investigate the benefits and values of drama in mathematics learning, with respect to the educational philosophy and purposes that any teaching method should maintain. At the same time it has been considered equally important to examine the limitations and obstacles that may prevent teachers from employing this method. It is of essential importance - when thinking and planning for education - to have in mind the real dimensions of the situation that the actual teaching practitioners face on an everyday basis. Their opinion should be valuable for the research purpose.

Therefore, the aims of the present research, as they derive from the analysis of the hypothesis under investigation, are:

- 1: "To identify the benefits and values of drama as a teaching method of mathematics in the present classroom conditions of secondary schools."
- 2: "To point out the limitations that teachers either face when

attempting to employ drama as a teaching method, or when prevent them from using it."

Having narrowed the scope of the research, the necessity of developing an appropriate methodology arises. Initially, a pilot study took place, testing and evaluating the hypothesis under investigation and helping the analysis and the formulation of the objectives. The researcher would therefore, be able to plan and design the main part of the research more precisely considering the real dimensions of the problem.

The pilot study was an informal discussion with the maths teachers of a secondary school in Avon, who constituted part of the future sample of the main research. Therefore, from the pilot study the researcher obtained a better insight concerning the teachers' appreciation of the learning difficulties of children in mathematics and the limitations that maths teachers face when challenged with new teaching methods.

Consequently, the results obtained by the pilot study assisted in the formulation of the following objectives in accordance with the research aim.

- O1: To identify the importance of teaching and learning mathematics, as well as the appreciation of mathematics from the teachers' and pupils' point of view.
- O2: To identify the difficulties and the reasons which cause difficulties for many children when attempting to understand and apply mathematics.
- O3: To examine the teachers' attitudes and opinions towards two different methods of teaching mathematics; the investigation and the exposition by the teacher.
- O4: To examine the benefits and values of drama as a teaching method of mathematics in the secondary school level.

- O5: To investigate the limitations that teachers face, when attempting to use drama in mathematics teaching, or the obstacles that prevent them from using it.

The main study took place mainly in a comprehensive secondary school in Avon, by seeking interviews from both maths teachers and pupils and by observing three case studies. However, another two comprehensive secondary schools, one in Oxford and the other in Milton Keynes were visited, seeking interviews from maths and drama teachers who already had experience in the employment of drama in teaching mathematics. It was regarded as important to consider both the experienced and the inexperienced teachers' point of view, in order to gain a global aspect of the problem and bring in all the dimensions.

The plan of the research was formulated as follows:

- Stage A: Interviews with two different samples of teachers. The maths teachers of the comprehensive secondary school in Avon who did not have any previous experience in using drama for mathematics teaching and three maths or drama teachers from the secondary schools in Oxford and Milton Keynes, who already had experience in using various forms of drama in teaching mathematics or other school subjects. Both sources of data have been regarded as valuable; especially from the source B it was expected to gain data concerning the benefits and values of drama as a teaching method.
- Stage B: Interviews with the pupils of the comprehensive secondary school in Avon. They revealed the importance that mathematics had for the pupils and the problems and difficulties they face in the learning of the subject.

Stage C: Observation of three case studies where mathematics were taught by using different forms of drama. The three case studies consisted of three different classes, again in the comprehensive secondary school in Avon, in an attempt to gain practical experience. In addition to the researcher's observation, interviews with both the teacher and the pupils took place after the completion of the case studies.

The presentation of the whole study begins with the introduction in Chapter I. After the introduction the literature review follows which includes three chapters II, III and IV.

In Chapter II, the features and characteristics of mathematics that add to the importance of teaching the subject in schools are examined. Following, an attempt is made to point out the deficiencies, problems and difficulties that children face in understanding, learning and applying mathematics. Finally, the causes of these deficiencies are investigated in terms of the teaching methods applied in the classroom and the learning environment.

The recent development of educational drama is examined in Chapter III, as well as the predominant theories concerning the view of educational drama as a way of education and as a method of teaching. Consequently, the different types and forms of drama are presented, as well as its characteristics and features. Finally, there is an attempt to examine the function of drama as a learning medium. At the same time examples of the employment of drama as a method for teaching other subjects are presented.

Through Chapter IV, the function and the potentiality of drama as a teaching method for mathematics is investigated. At present, there is not much in the literature concerning the employment of the whole range of the various types and forms of drama in mathematics teaching. However, certain types such as simulation games, representational play, role-playing and sociodramatic play

have been researched for their function in mathematics learning. Dienes' theory on the role and function of play in learning mathematics is examined and several examples of work published by individual teachers are presented in order to indicate the benefits of using drama as a method for teaching the subject of mathematics. Finally, the potentiality of the employment of this method in secondary schools is discussed.

Following the literature review, the presentation of the methodology in detail takes place in Chapter V. Chapter VI includes the presentation and the analysis of the findings obtained through the research. The conclusion is contained in the last Chapter VII.

The present study is encompassed in the context of research into teaching methods. In particular, it assists research concerned with the improvement of mathematics teaching.

According to Langeveld (1965), "*Educational studies... are a 'practical science' in the sense that we do not only want to know facts and to understand relations for the sake of knowledge, we want to know and to understand in order to be able to act and act 'better' than we did before*" (p.4).

CHAPTER II

MATHEMATICAL LEARNING DIFFICULTIES AND THEIR CAUSES

2.0. INTRODUCTION

In this chapter a brief presentation of the features of mathematics takes place with an attempt to point out what gives the subject its important profile both in society and in school life.

Although mathematics is regarded as an important subject to be taught in schools, most children face difficulties understanding and appreciating the nature of the subject. Much research (Schools Council Report 1965, Cockcroft Committee 1982) has revealed that most people fail to achieve certain mathematical skills in school, and most importantly children leave school with negative feelings towards mathematics.

Consequently there has been an attempt to examine the problems and difficulties that children face in learning and comprehending mathematics. Children seem to have difficulties to recall from memory already taught knowledge in mathematics, as well as to remember, and use effectively, algorithms. However, according to Orton (1987), the most difficult problems they face are in understanding concepts and in being able to manage problem-solving.

Finally, there is a reference to the reasons which cause those difficulties, with emphasis on those reasons which concern the inappropriate learning environment and teaching methods.

2.1. Features of mathematics

There seem to be different approaches towards the discipline of mathematics and different appreciations of the nature of the subject amongst people. The usefulness and the importance of mathematics has been seen from a range of different perspectives, sometimes contradictory. For the average person, mathematics is the science of numbers and shapes, as well as, the basis of technology; while others regard mathematics as a creative art, and as an aesthetic expression of the human intellect.

Kline (1982), claims that: *"Fewer people seem to be aware that mathematics carries the main burden of scientific reasoning and is the core of the major theories of physical science. It is even less widely known that mathematics has determined the direction and content of much philosophic thought, has destroyed and rebuilt religious doctrines, has supplied substance to economic and political theories, has fashioned major painting, musical, architectural and literary styles, has fathered our logic, and has ... furnished the best answers we have to fundamental questions about the nature of man and his universe. As the embodiment and most powerful advocate of the rational spirit, mathematics has invaded domains ruled by authority, custom, and habit and supplanted them as the arbiter of thought and action. Finally, as an incomparably fine human achievement mathematics offers satisfactions and aesthetic values at least equal to those offered by any other branch of our culture"* (p.15).

However, many people are aware that mathematics is not only the ability to cope with the arithmetic which is used in an every day basis, such as having the skill to add, to subtract, to multiply; it provides further concepts and skills needed by technology, science and art. There is a whole branch of

philosophy, called the Philosophy of Mathematics devoted to answer the question: what is mathematics?

Ernest (1986) in his article "What is mathematics", refers to Johnson and Rising (1967) who provide an overall picture of the different viewpoints towards mathematics in an attempt to combine many of the ideas (Ernest, 1986, pp.3-4).

They mention that mathematics has been seen as a logical and powerful way of thinking *"... as a way of thinking, it is used to solve all kinds of problems in the sciences, government and industry"*. At the same time *"mathematics is a creation of the human mind, concerned primarily with ideas, processes and reasoning"*. They further explain that *"... as a way of reasoning, it gives us insight into the power of the human mind and becomes a challenge to intellectual curiosity"*.

Consequently, they refer to mathematics as *"an organised structure of knowledge"* and they claim that as in philosophy and theology, logical structures in mathematics begin with certain undefined terms. *"These undefined primitive terms, such as point, line and plane in geometry are used to describe certain ideas"*. Further, mathematics has also been seen *"... as a language, a language that uses carefully defined terms and concise symbolic representations, which add precision to communication"*.

The Cockcroft Committee (1982), believes that *"...all these perceptions of the usefulness of mathematics arise from the fact that mathematics provides a means of communication which is powerful, concise and unambiguous"* (para 3). Because of its clarity and perception, mathematics enables us to complete complex tasks, to perform difficult computations and to solve problems, that would be impossible in any natural language.

Johnson and Rising (1967), point out that Mathematics is also the study

of patterns. As an example they present the "Radio waves, molecular structures, sequences of numbers, orbits of celestial bodies and the shape of the bee's cell (or even the seeds of flowers) all have patterns that can be described and analysed mathematically".

Finally, they emphasize that mathematics is also a creative art claiming that *"The beauty of mathematics can be found in the process whereby a chaos of isolated facts is transformed into logical order. The exploration of new ideas and the invention of new mathematical structures are challenges to the creativeness, the imagination and the intuition of the mathematician"*.

Because of all those characteristics, mathematics nowadays has been regarded as more important for life and work than ever before. Bruner (1968), claims that although mathematics is a new invention in the perspective of man's cultural history, it has been proved very powerful and he states that people should understand the ideas that lie behind the scientific advantages if they are not to live in "embarrassed dread" in the century ahead. The Cockcroft Committee (1982), makes it clear that: *"... it would be very difficult - perhaps impossible - to live a normal life in very many parts of the world in the 20th century without making use of mathematics of some kind"* (para 1).

In para 12, the Cockcroft Committee claims, amongst others, that *"... the mathematics teacher has the task of enabling each pupil to develop, within his capabilities, the mathematical skills and understanding required for adult life, for employment and for further studying and training..."* and *"... of helping each pupil to develop as far as possible his appreciation and enjoyment of mathematics itself and his realisation of the role which it has played and will continue to play both in the development of science and technology and of our civilization"*.

Therefore, mathematics is considered as a subject of essential importance to be taught in school, and there is a greater social and parental pressure for children to succeed at mathematics than at many other subjects such as history or geography. Even though children face many difficulties in learning mathematics and sometimes they fail to accomplish the necessary mathematical skills that are required by them.

2.2. Difficulties in learning mathematics

In recent years there has been considerable discussion about the teaching of mathematics in school, both in Britain and abroad. Much research has been concerned with the difficulties that children face in learning mathematics as well as the reasons which cause those difficulties. One of the most important contributions in Britain has been the report of the Committee of Inquiry into the Teaching of Mathematics in Schools, under the chairmanship of Dr W.H. Cockcroft. The Cockcroft Committee, was set up in 1978 as a direct response to the broad public concern about mathematics education. It was mainly concerned with examining the deficiencies in children's mathematical skills and to make recommendations for mathematics teaching.

The Cockcroft Committee (1982), among other things claims that standards of numeracy are generally inadequate, that school fails to assure the mathematical skills necessary to people for both their life and work, and that most children leave school with negative feelings towards mathematics.

It would be helpful to explain briefly what constitutes mathematical learning before proceeding further. Brown (1978), suggests in a clear way that there are four types of mathematical learning: recall, algorithmic learning,

conceptual learning and problem solving. Children seem to have problems and difficulties in each type.

Children should be able to recall from memory a variety of different symbols and formulas in mathematics, such as words, symbols, facts and theorems. The learning of mathematics is also concerned with the learning of algorithms such as long multiplication and division, multiplying and dividing fractions, adding and subtracting fractions. At the same time the learning of mathematics consists largely of building and understanding of new concepts onto previously understood concepts such as percentage, relation, similarity, limit. Finally, problem solving is the process by which the learner combines previously learnt elements of knowledge, rules, techniques, skills and concepts to provide a solution to a novel situation.

A serious problem is that children have difficulties recalling and presenting; difficulties to remember. According to Orton (1987), memory has been the focus for considerable research effort by psychologists over many years. It was believed that our powers of memory could be improved by exercising them. However, the modern view is that memory is a feature of overall intellectual capacity which is different from person to person. In the past, repetitive practice and the rehearsal was thought to be the answer to the problem of fixing knowledge in the memory. However, Claxton (1984) and Skemp (1971) agree with Orton (1987), who claims that *"retention and recall are easier if what is learnt is meaningful in terms of the network of knowledge already held in the mind of the learner"* (p.25).

Children face difficulties to learn the step-by-step procedure of algorithms either because they cannot understand the point of learning them or because they cannot make any connection to their previous experiences. According to Orton (1987), *"A worrying feature about algorithms in mathematics is that many which we expect children to remember and use with confidence are*

meaningless to the pupils, in terms of worthwhile knowledge and are sometimes completely irrelevant" (p.29).

The learning and comprehending of concepts is fundamental in mathematics. However, concepts are difficult to be learnt and taught. Orton (1987), states that although children face problems in remembering facts and formulas or learning meaningfully the procedure of algorithms, the hardest aspect of all is the realisation of the conceptual structure of mathematics. Skemp (1971), claims that we must not expect children to learn by definition. Gagne (1965) also argues that every attempt to define mathematical concepts is most likely to be a failure and unprosperous.

Many children face difficulties in problem-solving. The Cockcroft Committee (1982), has revealed an inability of the majority of people to cope with practical problems. In para 249, it is argued that although the ability to solve problems is at the heart of mathematics, many pupils have great difficulties in problem-solving which is the ability to apply mathematics in a variety of situations.

Orton (1987), claims that textbooks combine usually a set of routine exercises which are unlikely to involve problem-solving in the current accepted sense. One aspect of problem-solving in mathematics is that often the problems are divorced both from the mainstream subject matter and from the real world. Such puzzles may interest some children, but others may not see the point and be demotivated.

In addition to the deficiency that children have in learning mathematics and particularly in problem solving, the Cockcroft Committee (1982), reported that many children leave school with negative attitudes towards mathematics, and that many adults have deeply rooted feelings of anxiety and inadequacy about the subject. Children - and not only them - fail

to appreciate the nature of mathematics. Orton (1987), points out that a decision to study mathematics does not imply a positive liking for the subject. Children usually opt for the subject because it is generally agreed that it is a useful subject. Mathematics was considered to be a high status subject, particularly by boys. As it has been revealed from Cockcroft committee the majority of people regards mathematics useful mainly for better jobs and qualifications.

Kline (1982), argues that "... educated people almost universally reject mathematics as an intellectual interest...", because "... school courses and books have presented mathematics as a series of apparently meaningless technical procedures...". He continues claiming that due to the above reason "... mathematics detached from its rich intellectual setting in the culture of our civilization and reduced to a series of techniques has been grossly distorted... Consequently, a subject that is basic, vital and elevating is neglected and even scorned by otherwise highly educated people" (p.15).

It appears that having the ability to perform basic skills of numeracy is not enough, the most important is to be competent in employing these skills to real life practical problems. It has also been revealed that the majority of children leave school without this "wider mathematical understanding". Finally, most schools are not considered enough in growing this "wider mathematical understanding".

Dienes (1968), advocates that mathematics is an intellectual activity which should add to the quality of the personal and cultural development of the person. However, he argues that "... it is quite clear that things have not worked out this way. Mathematics is not used or enjoyed by people after they

leave school, so that if our aim was to allow children to participate in this aspect of our culture, we have certainly largely failed" (p.154). Why is this so, and what is it about the present planning and application of mathematics teaching which prevents most children from appreciating the beauty and the power of mathematics?

2.3. Reasons for difficulties in mathematics

Gannon and Ginsburg (1985), in their article "Children's Difficulties in Mathematics", claim that most problems in schools stem from social, personality or educational factors. Orton (1987), attempting to answer the question "Why do some pupils achieve more than others?", identifies reasons such as individual differences, certain intellectual abilities (convergent and divergent thinking, spatial ability), gender-related differences and finally preferences and attitudes.

The learning environment, often inappropriate, causes psychological problems anxiety and panic for some children. Buxton (1981), claims that the anxiety and panic that some children face, causes de-motivation. Some children do appear to panic quite badly, and this is clearly not helpful in fostering learning. We do not know what such anxious children might achieve under different circumstances. It is not possible to completely separate out the cognitive factors (intellectual skills, abilities) from the affective (interest, attitude, values and appreciations). Therefore, the problem of de-motivation through anxiety exists. Russel (1983), points out that pupils often perceive that mathematics classroom is a place for competition, which is attractive to some and not to others. Hudson (1966), and Russel (1983), agree

that mathematics does not involve the learner in revealing emotions or opinions to others. This actuality is not attractive to some children.

Additionally to the anxiety and panic that some children may experience there is also pressure placed on them. Hughes (1987), claims that many of the problems seem to arise from the pressure put on young children through their school lives either by overloaded syllabus or by pressure of exams, especially for the subject of mathematics.

Therefore, the learning environment is usually unsuitable, as it creates anxiety, panic and pressure for the children and finally demotivation. Another reason that causes demotivation is that the provision of meaningful relation of the mathematics being taught in schools and real life is missing. Mathematics is mainly concerned with abstract concepts, therefore it is a difficult subject both to teach and to learn.

The Cockcroft Committee (1982) claims that the application of mathematics must involve not only the use of these abstract concepts but also the translation from the real life into these concepts and the opposite. The latter is often neglected in the every day teaching process. For this reason a lot of emphasis has been given by the Committee which claimed that the method of teaching mathematics is still traditional and it is constituted mostly of exposition by the teacher. They stress that the lack of practical work, and the lack of reflection on real life situations bring lack of interest and lack of motivation.

The Cockcroft Committee in para 243 advocated that in order for mathematics teaching to be successful for children of all ages, it must include the proper mix of ingredients.

"Mathematics teaching at all levels should include opportunities for

- i) exposition by the teacher.*
- ii) discussion between teacher and pupils and pupils themselves.*
- iii) appropriate practical work.*
- iv) consolidation and practice of fundamental skills and routines.*
- v) problem solving, including the application of mathematics to everyday situations.*
- vi) investigational work".*

The above list is not new and represents an approach that has been much advocated for many years. All the evidence through the Cockcroft Committee indicates that in most classroom teaching, it is the ingredients of exposition and consolidation which predominate, while the use of practical work, with rare exceptions, is almost non-existent.

The assumption is that children, particularly young children, learn best by proceeding from the concrete to the abstract. Piaget (1952, 1962, 1973) and Dienes (1968), were from the first strong advocates of this view. The Cockcroft Committee (1982), suggests that for most children practical work provides the most effective means by which understanding of mathematical concepts is developing. They stress the lack of practical work as a reason for the difficulties that children face in school.

Hughes (1987), claims that ways should be found to built in the talents and interests that children possess when they first start school and so to reduce the large number of children who leave school lacking both comprehension and interest in mathematics. He claims that children possess some 'hitherto unsuspected' abilities to understand certain mathematical concepts before they go to school. He claims that young children have natural abilities to think of

mathematical concepts and believes that these abilities should be given much greater recognition than they are at present. This point of view has been advocated as well by Dienes (1968), in his experiments. These abilities are then contrasted with the difficulties which many children experience when faced with the more formal mathematics of school.

Orton (1987), stresses as a particular reason for the problems, that certain topics in mathematics were considered irrelevant by pupils. He argues that we all have a greater capacity for learning when we really want to learn: *"We cannot ignore the effect on quality of learning, on motivation interest, determination and the desire to succeed. The search is continually for ways to make school mathematics more appealing and exciting, more relevant and useful, because we know that children learn much better under such circumstances"* (p.9).

2.4. CONCLUSION

As it can be concluded from the above, although mathematics has been regarded as an important subject, children often have little appreciation for it and most children face difficulties. The most serious problem has been considered to be the disability that children have in problem-solving and in appreciation of the nature of mathematics.

The creation of an appropriate learning environment seems important. Dienes (1968) claims that a rich learning environment is necessary and he suggests that the employment of various teaching methods is important.

Another interesting point, based on the agreement of several authors, is that a precondition for understanding mathematics is to have an appreciation of the subject. However, this appreciation is lacking and most children maintain negative feelings.

There is a general agreement that there is a need for more active work, more practical activities in a learning environment which is meaningful to the children and at the same time more suitable to their nature. Children need to be stimulated during the teaching. They need to find their task interesting and find a meaning in being engaged in it. They need to discuss and to cooperate among themselves and with their teacher. Finally they need to learn how to use and enjoy mathematics.

The traditional way of teaching, using merely exposition has been proved in practice to be unsuitable for the majority of the children.

CHAPTER III

DRAMA AS A TEACHING METHOD

3.0. INTRODUCTION

This chapter examines the development of drama in our century. Emphasis is given to Dorothy Heathcote's philosophy and theory, because she strongly advocated drama as a precise learning medium and as an important method of teaching other subjects.

Consequently, the different types and forms of drama are demonstrated, since drama is not just theatre in the school timetable. The characteristics and features of educational drama are also examined, with an attempt to explain why drama has been considered as an invaluable teaching aid.

Finally, the function and the role of drama as a method of teaching other subjects is investigated, and some particular examples of individual teachers' work are presented.

3.1. The development of educational drama

According to Johnson and O'Neill (1984), educational drama has altered during the second half of our century and it is still changing. In the latest years emphasis has been given on the recognition of drama as a precise teaching instrument which works best when it is part of a learning process.

Bolton (1984), claims that educational drama has been associated with the progressive and romantic stream in Education, influenced by the notions of Rousseau and Froebel, and the principles of child-centredness and self-expression, as well as, the New Education movement in 1870s which introduces the notion of 'learning by doing', 'activity methods' and 'play way'. Bolton continues that, although educational drama started with a common base, two sets of drama teachers could find no basis for speaking to each other. They are those who see drama as a preparation for performance and theatre, and those who believe into drama's power of improvisation and exploration.

However, drama and theatre came to be two different concepts. Slade (1954), makes it very clear that he sees theatre as a final stage in the child's development. The International Encyclopedia of Education (1985), explains how educational drama is viewed today in schools. "... modern educators use the term 'educational drama' interchangeably with 'creative dramatics', 'drama in the classroom', 'informal classroom drama' and 'development drama'. Earlier educators often use the term 'playmaking' synonymously with the terms given above. Educational drama, as practiced in today's schools, encompasses all types and forms of improvised drama intended to have educational outcomes" (p.1453). Johnson and O'Neill (1984), claim that "Drama is considered as a unique teaching tool, vital for language development

and invaluable as a method in the exploration of other subjects" (p.42).

Therefore educational drama today, has been viewed as a medium for learning.

Bolton (1984), referring to the evolution of educational drama, has examined extensively the theories and philosophies of many main contributors in its development. The scope of the dissertation prevents the examination of all the theories and philosophies, so reference will be given here only to Brian Way and Dorothy Heathcote's contribution. Brian Way's view will be examined here, as he is one of the advocates of the distinction between drama and theatre, and has introduced the various dimensions that educational drama may take; and Dorothy Heathcote's as she has perceived drama as a learning medium for other subjects. Bolton (1984), claims that Brian Way and Dorothy Heathcote believe in the importance of intuition both for the teacher and for the child.

Brian Way has developed the philosophy and methodology of child-drama along a broader front. His work has embraced children's theatre, classroom drama and the integrated arts. Brian Way along with other educational thinkers, reflects the changing conception of drama in the classroom during the last decades. He has helped drama teachers by broadening the collection of activities that might be included in a drama lesson, believing that teachers should have the freedom to approach drama from different perspectives according to their skills and the individual class's needs and abilities. He opened the doors to all kind of activities (games, role-plays etc.) to be done in the name of drama. He was the innovator for the audience participation in children's theatre. He is interested in introducing direct experience into education and giving children different opportunities (ways) of learning. Way (1967), distinguishes between drama and theatre. "Theatre is largely concerned with communication between actors and an audience; drama is largely concerned with

experience by the participants, irrespective of any function of communication" (p.3). He describes drama as a participatory activity and emphasizes the individual experience. Much of that experience will consist of improvisation which stimulates the imagination and encourages its expression in physical and vocal terms. It has no particular concern with presentation and performance.

It is interesting to examine closer how Heathcote (1971) defines drama as she is considered one of the founders and most strong advocates of drama as a teaching tool. *"I define educational drama as being anything which involves people in active role-taking situations in which attitudes, not characters are the chief concern, lived at life-rate (that is discovery at this moment, not memory based) and obeying the natural laws of the medium. I regard these laws as being: a willing suspension of disbelief; agreement to pretence; employing all past experiences available to the group at the present moment and any conjecture of imagination they are capable of, in an attempt to create a living moving picture of life, which at surprise and discovery for the participants rather for any onlookers. The scope of this is to be defined by story-line and theme, so that the problem with which they grapple is clearly defined. I maintain that problem solving is the basis for learning and maturation"* (pp.61-62).

Heathcote advocates the use of educational drama in setting up an appropriate environment where problem solving is the central aim. She perceives as very important the creation of active situations where children are called to employ all their abilities and skills and come in some kind of emotional relationship with others. At the same time she believes that drama must have a 'story-line', a content or a subject matter in order to create a problem-solving situation. She is interested to give children an educational opportunity to provide ways and channels where children can learn. This is the

essential characteristic of Dorothy Heathcote's philosophy and theory concerning the educational drama. Bolton (1984), pointing out this feature claims that Heathcote's drama is thematic (has content) and that it always has a feeling of quality (emotional overtones). She has a thematic way of looking at content and it is exactly this way of looking at drama that makes it a powerful teaching medium. For her drama has more than one meaning according to the different contents. Thus, the teacher having chosen a certain topic to teach, can use the appropriate "story line" or content for his/her drama, in order to achieve his/her teaching purposes. The thematic difference was revolutionary and it is a key difference between Heathcote and other contributors.

Heathcote (1973), expects the children to operate intuitively in the "make-believe", but she believes that intuition can be a refined instrument, accompanied by a high degree of awareness, at its best, bringing about reflection on what one experiences even as one experiences it. For her, man's curiosity about the world is the very source of her interest in drama and of her interest in education and life. She uses the expression 'to live through' - which is the meaning that Greeks give to the word 'drama' - to describe the context in which she considers drama and the child's growth (p.80). Heathcote tends to see 'personal engagement' with the world through dramatic action as a proper way of helping the child to know the world. Her aims in drama are, amongst others, to respect the children's needs and ideas, to use their ideas and make them work; she regards the effort made by them when they work through drama to be more important than the result.

Another important feature in Heathcote's philosophy and theory of educational drama is that art and science must be part of each other. She advocated that both art and science are about how man makes sense of the world he/she lives in. Heathcote uses both of them in her teaching.

3.2. Types and characteristics of drama.

The word drama may appear on a school timetable under any number of different names and pseudonyms. Deriving mainly from Brian Way's influence, it is believed that teachers should be free to approach drama teaching from where they feel happiest and most confident.

Bolton (1979) attempts a classification of the main kinds of drama experiences that are promoted into schools and colleges. He says that the basic experience of drama offered to children falls into four major types: exercise, dramatics playing, theatre and drama for understanding. Here is a summary of what he suggests as the main characteristics of each type.

In the type of exercise the following forms of drama are included: directly experiential, dramatic skill practice, drama exercise, games and other act forms. The most common features are: the specific goal often known to both teacher and participants, and the answer to be found. Some kind of 'rules' are usually clear. Problem solving is often the main aim. Most often the participants are required to apply a high level of concentration and energy until the goal is reached. According to Bolton, exercise in drama is an amalgam of structural, educational and psychological features.

Dramatic playing, which is the second type, has a fixed place and situation and there is usually a story-line. A basic characteristic here is that the energy level is high and that there is freedom for individual creativity. It can also promote different degrees of co-operation and commitment.

Theatre, according to Bolton, is based on sharing with an audience in a formal or informal sense. In this type, there is a demand for clarity in speech and action, as well as, a demand for commitment and co-operation. The

external features of the action must convey the meaning of the play and story.

Finally Bolton names the last type, drama for understanding: in this type, drama's most significant feature is the 'internal action'. Into this type Bolton includes 'symbolic' and 'make-believe' play.

Heathcote (1984), claims that one can approach learning through drama in various ways. She says that "*each way makes a different journey, a different kind of demand on your planning and a different kind of demand on your class. Each way makes a different kind of learning happen*"(p.205).

However, Heathcote attempts a different classification considering seven different forms of drama: roles, mantle of the expert, analogy, text, dance-forms, simulation and games. In a summary, she explains analytically what educational outcomes a teacher should have in the employment of each form.

In roles, a person is the challenge. By using role-playing a teacher can teach facts and pose questions. It is a way to challenge attitudes and demand understanding. Through the mantle of the expert, the class is set upon a task in such a way that they function as experts. Using the 'mantle of the expert' type, the teacher demands a commitment from the children to learn the information and the skills they will need. Heathcote mentions that because of the need of the information this type of drama allows the teacher to use drama directly to run alongside and feed of the curriculum. Further, the teacher gains a discipline in the class which is provided by the framework of the work and where attitudes are contained without he/she imposing rules and demands. Finally, this type provides a task orientated situation where the job in hand must be done first. So, doing the job, fulfilling the task, is the vehicle which starts; creative ideas are following. In the analogy, one real problem is revealed by an exact parallel to it. Heathcote explains that analogy is the best way of making something fresh and worthy of consideration when it has

become too familiar, too full of prejudice. It provides a new face for old material. Every theme or concept is capable of having an exact parallel if you understand that it is the inner form which is important. Text is the interpretation of someone else's work in the means of learning. In the dance-forms the emphasis is on non-verbal signals, experiences and explanations, which become the means of discovery. Dance forms can be used when the teacher decides that his/her statements are complete without the needs for words. By using simulation, a teacher may gain an exploration of interaction and a chance to see the results of his/her action on other people. Simulation gives an opportunity to work with feeling and thoughts simultaneously. In games, the rules lead and control the playing. Games have a central idea to suggest the task and the actions following the task. The task and the goals are clear to be seen. Rules allow the teacher to be an equal player. Games usually have formalized processes and this can allow a problem to be clearly seen and repeated. Temporary relief from emotion can reveal the spine of the problem. Out of this insight comes energy and the purpose is clearer.

Finally Heathcote claims that whatever mode of drama is used, the first central part of each lesson is the focus. *"Out of the focus the task can be found and set. Out of the task arises all the potential learnings on which the teacher can focus for further tasks"* (p.207).

Furthermore, Heathcote (1984), explains analytically the characteristics and the potentialities of educational drama. The following is a concluding picture of drama's feature according to her view as well as a picture of how drama functions.

1. People have to work out the lives they are pretending to live in a together way. So drama demands co-operation.
2. People have to employ what they already know, about the life they are trying to live. So drama puts life experience to use and makes factual experience (information) come into active employment.
3. People have to be able to live in two worlds at once and not get them mixed up. So drama uses fiction and fantasy but makes people more aware of reality.
4. Drama stresses agreeing to all trying to sustain mutual support for each other while allowing people a chance to work differently to bring personal ideas into whole.
5. People have to express thinking, feeling, actions to each other. If they do not then no one in the group knows what is going on. So drama makes people find precision in communication.
6. Drama uses objects but often in a symbolic way. So drama stresses the use of reflection symbols become ordinary, but the ordinary also is seen to be symbolic.
7. Consequently, drama introduces you to living out : rises in a testing kind of way it tests your attitudes and your present capacities" (p.207).

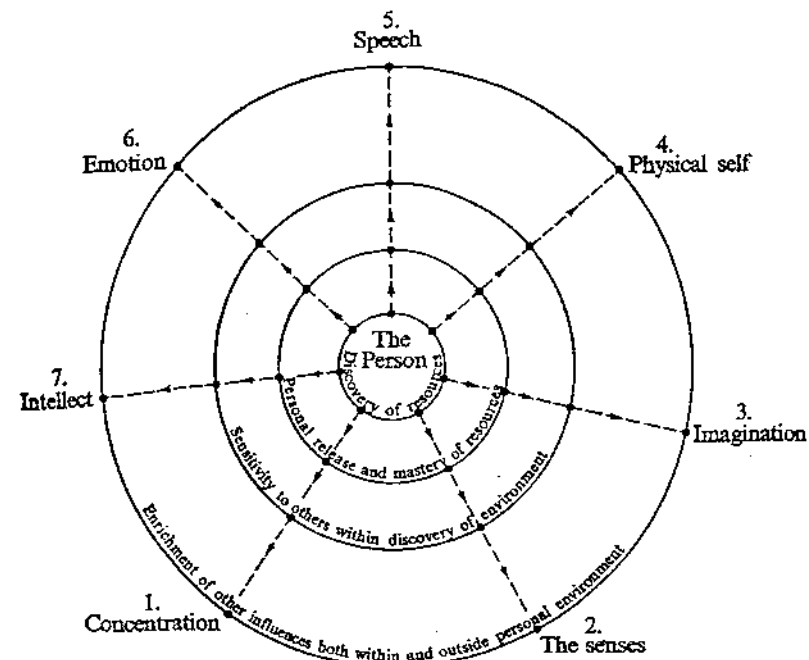
Drama has been regarded as an art form, self expression or as means for communication. It is a participatory activity developed primarily from moving, speaking and thinking. The formalization and discipline of these basic elements of human creates the art of drama.

Attempting to point out the characteristics of drama, it should be considered that drama as self expression consists of the exploration and

development of the particular qualities of an individual's voice, body and mind. It is the exploration and mastery of these resources that encourages an individual to become increasingly self-aware and to develop and enrich his/her own quality as a person. Drama has a particular strong claim as the most appropriate means of encouraging this personal awareness. Much drama, however, is concerned with the communication of ideas.

Drama in general, has been viewed as valuable for the overall development of the child's personality. Long term aim of drama teaching is to help the student to understand himself and the world he lives in. The drama teacher is trying to set up situations within which his/her students can discover why people behave as they do, so that they can be helped to reflect on their own behaviour. Way (1967) explains the function of drama on the development of the child using a circle. The inner circle is concerned with helping each individual to discover and explore his/her own resources, irrespective of other people. At a later stage, drama includes the discovery and exploration of one's environment including other humans. Again at a later stage one feels the need for the enrichment of resources quite outside of oneself and one's own immediate environment.

However, for each circle the points which concerned with existing human resources remain valid for every individual. Those resources, as it can be seen from the following figure are: Concentration, senses, imagination, physical health, speech, emotion and intellect.



(Way, 1967, p.13)

Way has chosen a circle to present the child's development through drama because he considers drama as a way of helping each person develop and not as another school subject. The circle corresponds to each individual from infancy to adulthood. Way claims that each point on the circle is "permanent and a valid" way for every individual from which to begin, moreover each is concerned with the potential of continuing development and needs to be returned to over and over again; each is subject not only to possible progression but to equally possible regression. He claims that although there will be a difference in the detail of each point on the circle for each person, because of the uniqueness of the personality, each and every person has the same points on the circle and the same potential to develop each point to its own fullness.

Part of the function of drama is to develop concentration. There are many factors that can interfere with, break down and perhaps even destroy the wholeness of the concentration.

Bentley (1965) perceives the elements of conflict in drama as very powerful. He claims that "... events are not dramatic themselves. Drama requires the eye of the beholder. To see drama in something is both to perceive elements of conflict and to respond emotionally to those elements of conflict" (p.4).

In order to illustrate the above, the following example might be of assistance. The idea of the example was taken from one of the interviews of the main research with teacher Y. Let us assume that the teacher wants to teach statistics. Statistics as such might not seem meaningful to pupils. But by using drama he/she can set up a situation where some of the pupils are unemployed and are in a really desperate situation, and some others have jobs and feel safe or are employers themselves. Then an emotional situation is provided through drama, where pupils are in conflict either with the reality or with the employer who has not given them a job. In this case, statistics ceases to be just numbers. It starts becoming important because it refers to the pupils' lives and through this dramatic instance they might find its real meaning.

Many authors (Day 1975, McGregor 1976, O'Neill 1976 and Bolton 1984) have emphasized not only the social but also the problem-solving characteristics of drama. They all agree that drama provides situations where pupils are engaged in problem-solving situations. Children are motivated to use past experience and prior learning in order to carry out certain acts

through the drama activity.

Concluding, McGregor et al (1977), present an overall framework concerning the aims and objectives of drama teaching in the 10 to 16 age range, provided by the work of the Schools Council's project team in 1974. Within the framework, the drama process is characterised from the following components.

"Social interaction: Drama is essentially social. As children participate they are encouraged to interact to both real and symbolic levels.

Content: Drama revolves around problems, questions and issues of understanding. The content of drama is united in that it is seen at the level of human behaviour and interpersonal response.

Forms of expression: As participants explore problems of meaning and understanding through drama they are experimenting with different ways of representing them through the roles and situations they devise.

Use of media - the 'language of drama': The way in which content is explored and the forms of representation which are discovered and used are affected by the participants developing skills in the media of drama" (pp.23-24).

3.3. Drama as a method of teaching other subjects

O'Neill et al (1979) have described drama "as the only teaching method stretching right across the curriculum to facilitate and deepen the whole learning process" (p.5). They advocate that drama is an essential tool for teaching because of its special features as they have already examined.

Heathcole (1969) emphasizes that "... drama apart from being a subject by itself, is also at the service of other areas of the curriculum..." (p.57)

She argues that drama is available to teachers of science, as well as to teachers of the arts provided that they will choose the appropriate forms for their purpose. Heathcote's approach to educational drama is interestingly relevant to education through drama. She regards drama mainly as a way of teaching. For her, drama means knowledge or learning about knowledge. Viewing drama from this point makes it both available and powerful as a teaching method for other subjects.

Wagner (1985), says that what Heathcote does is a "... conspicuous employment of the elements of drama to educate - to literally bring out what children know, but don't yet know they know". Heathcote calls this "... building volume within the student - quality education as opposed to quantity" (Wagner, 1985, p.13).

Johnson and O'Neill (1984), have made it clear that educational drama is a process, a mode of learning. They claim that drama as a learning tool has began to cross subject boundaries, and such cross curriculum functions implied that drama could offer a vital contribution to the entire curriculum.

Although the idea of using drama as a teaching method is new, it is very interesting to mention as an example the work of Miss Harriet Finlay-Johnson, a teacher in the first decades of our century. Her work has been known by a published book called "The Dramatic Method of Teaching", which she wrote explaining her teaching experience using drama as a teaching method. Everything to be taught in her school curriculum: history, nature-study and arithmetic was adjusted to dramatic methods. It is a fascinating example, in which a full account of an integrated dramatic curriculum has been given. Concerning the teaching of arithmetic, she claims characteristically that "Arithmetic may become a delightful subject when taught largely by means of plays" (p.224). She continues by giving several examples of teaching

fundamental mathematical concepts through representational or symbolic plays and stimulation games. In her work, Miss Harriet Finlay-Johnson has a conception of drama as being essentially connected with subject matter. The drama is used as a tool of mastering factual knowledge and content, and make it approachable to her pupils.

As we have already seen, Dorothy Heathcote also perceives that the content or subject-matter of any particular dramatic experience is what gives to drama its significance. Quite interestingly, this very fact is what makes drama an available and promising medium for teaching.

Drama has been employed in English teaching as a medium for improving the speech and for making literature more enjoyable and understandable to the pupils. O'Neill et al (1979) claim that "... speech in a make believe situation is more accessible to the pupil than narrative speech, since the situation is already represented, and the speech remains in context. The talk does not remain in isolation, but is embedded in the situation, and is subject to interaction and modification from the rest of the group" (p.15). They proceed claiming that the best way of encouraging children to talk is by providing a certain atmosphere where they could explore "talking situations". By a variety of drama experiences even the children whose attainment is very limited could improve their abilities. Furthermore, the children have the chance to evaluate themselves by testing the effectiveness of their use of language in a variety of drama activities.

As far as the benefits and values that different forms of drama provide in a teaching and learning procedure, Bousquet (1986) having examined the function of simulation games and role-playing explains that they allow children:

- "... a) to experience and consequently to understand from within a situation that is remote from them or beyond this compass.
- b) to put themselves in other people's shoes, and understand their points of view and
- c) to realize that problems are not simple and that their solutions are rarely 100 per cent good or bad, that they give rise to new problems which need to be tackled and solved in their turn" (p.472).

Resuming, Bousquet claims that applications of dramatic methods could be found in activities to develop attention, in remedial teaching and in situations to help children overcome certain learning difficulties when conventional methods of teaching have been proved unsuccessful. He emphasizes that besides, they are very effective in improving the communication and co-operation between pupils and teachers, games in mathematics "... teach us how to escape from the mental constructs in which we are trapped and to view new problems with a fresh outlook... Generally speaking however all games involve forgetting for a time one's usual concerns and customary systems and frameworks of emotion and thought. Playing means agreeing to change and this readiness to change one's mind is the very basis of creativity, discovery and learning" (p.471).

3.4. CONCLUSION

Drama - as it can be concluded from the above literature review - is an invaluable teaching method. Drama assists for the social development of the child because drama demands co-operation and mutual support. It makes people more aware of the reality as it brings people into an active involvement which reflect real life situations.

Another benefit that drama has, is that it provides stimulation and motivation. Drama because of the emotional investment that instilates to children and the elements of conflict, is very powerful in creating such environments where children feel interested to be involved. Heathcote (1984), recognizes the emotional investment as very essential. She advocates that something very important, but at the same time very difficult, is to gain somebody's commitment to the lesson and to overtake "group inertia". Drama seems to be very helpful for this task.

Finally, concerning the intellectual development of the child, it has been pointed out that drama can help children to develop their concentration abilities, to extend their language level and assist them to grasp concepts and face novel issues. Another important characteristic of drama that contributes to the child's intellectual development is that of problem-solving. Children, when confronted with a real situation or problem which demands resolution, have to employ what they already know in order to predict possible future actions, plan, organise and structure their movements, taking decisions. For all the above reasons, drama has been advocated as a method to explore and illuminate different subject areas. In the following chapter, the use of various forms of drama in mathematics teaching and learning is examined.

CHAPTER IV

THE USE OF DRAMA IN MATHEMATICS TEACHING

4.0. INTRODUCTION

In this chapter, the role and the function of play in mathematical learning will be examined, as it has been investigated by Z. Dienes. There is extensive reference to Dienes's theory, first because, rule bound and representational play are two types of drama, and second because as far as the present research is concerned there are no other published theories concerning the use of drama as a teaching method in mathematics learning. For both of these reasons it was regarded as essential to consider Dienes's theory from this aspect.

Consequently, reference to some previous research on the use of sociodramatic play and relevant dramatic activities in mathematics teaching and learning is made.

Finally, published examples of teachers' work will be presented, in order to indicate how individual teachers have evaluated the use of drama as a teaching method in mathematics learning under the typical classroom conditions.

4.1. The role and the function of play in mathematics learning:

The use of drama as a method of teaching mathematics is an aspect which has been very little researched. However, there has been some research concerning the use of play, which is one type of drama, as mentioned in Chapter III (3.2), in teaching mathematics especially for young children.

There must initially be a reference to Jean Piaget and his collaborators in Geneva School for their studies and research concerning the learning of mathematical concepts through game and play activities. Their contribution has influenced many other scientists. The work of Piaget (1952, 1962 and 1973), has been focused in suggesting that children learn by abstracting from concrete situations in which they have been actively involved. Piaget's theory is fundamentally concerned about action and interaction. He explains, that even when engaging in abstract mathematics our thought processes are founded on previous action. His message, adopted by several educationists, was that young children learn by doing.

Consequently Dienes (1968) has researched the function of play in the mathematical learning. Dienes and his collaborators carried out a research using experiments and observations on several case studies involved rule-bound play, manipulative play and representational play. Through this study Dienes attempted to define the role and the function of play and of other relevant activities in the domain of cognitive thinking which takes place in learning mathematics.

Information obtained from the above study seems to be very helpful to further research. Dienes (1968), as a result of his study, has developed a theory on the function of play in mathematical learning which will be presented

very briefly here. At the beginning of his study, he categorized and examined the different kinds of play which may be relevant to mathematical learning, as well as the features of each type. Further, he examined the changeover from the one type to the other explaining their function.

Dienes (1968), distinguished into two broad different forms of play: primary and secondary. He defined them as follows: "*Primary play is the playful activity directly resulting from the gratification of certain drives or instincts; in this case the payoff is immediate namely gratification. Secondary play could be defined as playful activity in which a certain amount of time-perspective is noticeable in the execution of plans, and the subject shows an increased awareness of his own activity. Payoff here is delayed, and it is not necessarily the gratification of fundamental drives in the first place...*"(p.22). Dienes claims that it is difficult to distinguish between the two types of play, because they are interrelated, and features of the primary type can be found also in the secondary. The affective loading is connected with curiosity in general and can be found in both primary or secondary play. Therefore, Dienes suggests that it is preferable to distinguish these two types according to a "... continuously or at any rate gradually changing degree of awareness, rather than of a dichotomy between primary and secondary processes" (p.22).

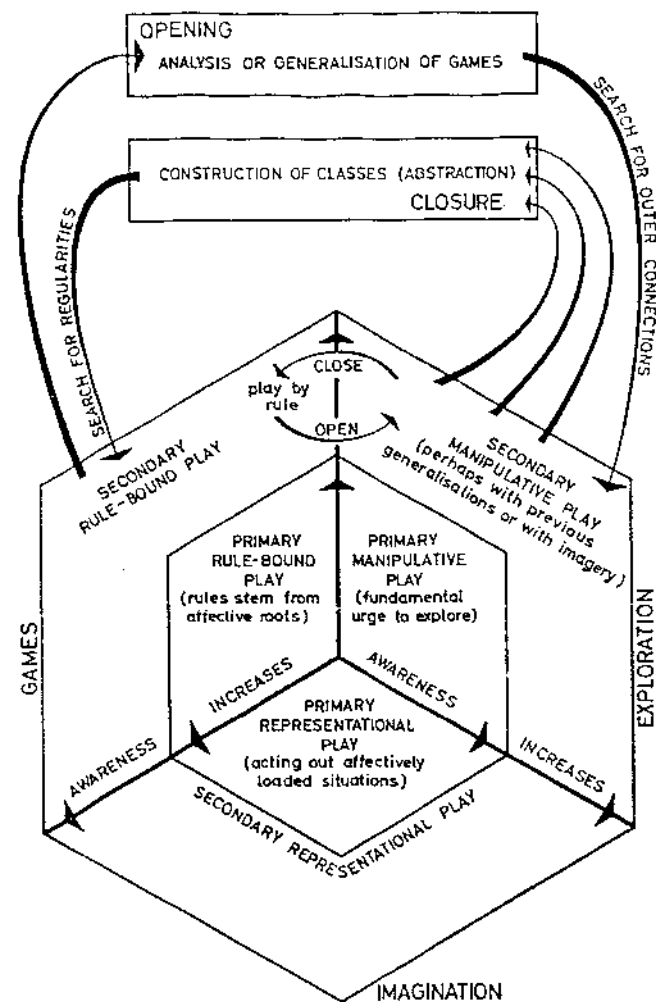
Further, he surveyed three different kinds of play according to their content, which may be relevant to mathematical learning: exploratory-manipulative, representational and rule-bound play. Dienes (1968), described exploratory-manipulative play as an activity which starts by curiosity. "*Children like to feel objects, they like to run their fingers down surfaces, to put things together and take apart... Then they may proceed to become aware of the properties of the material they are playing with, ask questions about what can or cannot be done and so generally move up along an*

awareness or time-perspective axis. Therefore awareness increases with the accumulation of experience" (p.22). Dienes claimed that there are two obvious directions in which a child might proceed, one is representation the other is search for regularities.

Representational play will appear as soon as the children start acting as if they are something or somebody else. There is a story framework and a component which is added to the activity of imagining. Thus, the objects or the children themselves may stand for animals, people, houses or even other people taking the role of a different object or character. Finally, play of any kind may move to a search of regularities and the kind of play which Dienes named, rule-bound play. He explained that when a rule, or rules are found, play which uses these rules may occur. Children enjoy regularities, and the formation of a rule structure is a situation where children feel safe.

Finally, Dienes explained that he does not imagine hard boundaries between the above kinds of play, but quite the opposite. He supported the act of passing from one type of play to another. He claimed that "... the changing back and forth between types of play may step up the energy for the more advanced cognitive processes which arise out of the play" (p.23).

Dienes examined the change over from one type to the other. As can be seen from the below diagram, the primary play is located in the centre of the hexagon. As soon as the primary play is moved to secondary play, awareness increases. Dienes also referred to the notion of closure and openness. He advocated that out of a variety of manipulative-exploratory play, which is possible with an endless variety of conditions available to us in our environment, children have many chances to construct concepts or classes which are the result of the discovery of regularities. He named this a closure. By the time children have discovered some rules while they were exploring a



[Dienes, 1968, p.25]

certain situation, a closure has been achieved according to Dienes. After that, rule-bound play takes place making use of the discovery rules. "Thus we have moved over from the manipulative play to the rule-bound play, but on the way we have been engaged in a cognitive activity which could hardly be

described as a play: we have constructed classes from their elements (abstraction)" (p.25). Once concepts and classes have been constructed, questions might be asked about the rules, or other rules may be proposed. This is explained by Dienes as an attempt to reopen the closure which has been established by the concept or class formation. This can be seen on the diagram through the arrow issuing from the area marked rule-bound play to the area marked "opening", the analysis and the generalisation of the rule structure. Consequently, the analysis often leads to further manipulative play, with an intention to search for more regularities which would lead to the formation of further concepts and classes. The cognitive work, according to this model, consists of bridging the two kinds of play and each time the bridge is crossed the play takes place on a higher level.

Dienes claims that "... energy is released for cognitive work every time play takes place, and so the power supply never dries up and the formation of classes of a higher and higher order goes on apace. In some cases representational play may come into circles, but it does not seem long before the rules in the 'stories' become more important than the stories themselves" (p.26).

Discussing the benefits and values of exploratory-manipulative play and representational play, Dienes (1968) comments that although some children may not be conscious or aware of the moment when mathematics are taught, the most important thing is that they have experiences which would facilitate further learning in a later stage. He emphasized that the play element provides the motive power for this mathematical activity. Most children regard the "story framework" with which usually the representational play begins, as of major importance. However, Dienes claimed that they soon come to be motivated by the structure of the problems underlying the story. Explaining the use of rule-bound play in mathematical learning, Dienes argued that rule-bound play is

maybe the most suitable type in teaching as it uses play-energy in the service of higher cognitive activity. However, he regarded both manipulative-exploratory play and representational as pre-rulebound and he considers them as very important for introducing children into the mathematical structure "... since rules cannot be extracted from the environment without first interfering with the environment" (p.31). He argued that those types of play have a great deal of motivating power which can be used for educational purposes, as the energy which is released by the play can be guided through the rule-bound play in creating learning mathematical environments. It is very important for the children to have the opportunity to discover the regularities of a certain mathematical structure through personal experience, than being given the rules which have eventually to learn and apply. Dienes suggested that representational play can be used in two obvious ways. "One is by inventing a story which is structured mathematically to provide the stimulus to investigate this structure. Another is to take advantage of the hidden mathematical qualities of children's representational games and guide the children by asking them questions about whose, answers would lead them to discover mathematical structures" (p.32).

As it has already been seen, Dienes emphasized the importance of the "story framework" by which the representational play begins. He regarded the story content as a medium through which the children would be stimulated and the teacher would guide them in discovering mathematics learning. It is very interesting to mention in this point that the way Heathcote perceived the teaching drama is quite similar. As explained in Chapter III, her philosophy and theory of drama is described as thematic or literary, because she conceives as valuable the presence of a certain content and "story-line". Heathcote, like Dienes saw the "story-line" or content as a motivation for the children and as a way of giving drama the opportunity to provide certain educational

outcomes. Similarly, she advocated that the teacher had the chance to guide his/her pupils into certain areas by using the appropriate content in drama.

Dienes claimed that the role of play in the mathematical learning varies by the way the teacher introduces the material. There are usually natural ways of passing from the one type to another, by suggesting problems to children after they had spent some time in explanatory-manipulative or representational play. Further, Dienes suggested that it would be possible to structure plays mathematically, which would serve to improve mathematical thinking. The plays can be played with real objects (manipulative) or in the children's imagination (representational), making use of them to serve mathematical ends.

Dienes (1968), referring to the experimental case study where he used representational play for mathematics teaching (example 4, pp.39-40), comments that *"...Certainly the initial interest was aroused by the imaginary created by the story. The animals the children playing with them, the animals getting hungry and needing to be fed were all situations which aroused considerable affective response, and you could hear a pin drop while the story was told. It was not long however, before the intricacy of the rule structure took over as the chief motivating factor"* (p.40).

4.2. Previous research:

No research has been found concerning directly and extensively the use of drama in teaching mathematics. However there has been some research concerning the use of different kinds of play, which is one type of drama, in mathematics learning. Hassan and Butcher (1966), researched the relationships between play processes and mathematical abilities in children 10-12 years of age, through a correlation study. The results showed that a significant relationship existed between play processes and mathematical abilities.

Zammarrelli and Bolton (1977) attempted to examine the mathematical concepts learning in children of 10-12 years of age by using the manipulative play. The results showed that a greater understanding and a better memory of the rules concerning a cultural concept can be provided through the active experience of the children.

Both the above studies concern the use of play of the manipulative type. However, Yawkey (1981), examined the effects of guided sociodramatic or group pretend play on young children's mathematical behaviour. He supported his study with Singer's (1973) and Bruner's (1972) evidence that sociodramatic play is a more advanced form of pretend play, and because of peer group interaction it demands children to use greater cognitive and linguistic processes.

Piaget (1962), Bruner (1972) and Singer (1973) within the last three decades have established through research, the importance of symbolic or pretend play in the intellectual development of young children. Furthermore, several researches undertaken by Smilanski (1968), Salts, Dixon and Johnson (1977) and Smith and Dutton (1979) have shown, that sociodramatic play facilitates the conceptual and linguistic learning, in problem solving and language learning situations.

Considering all previous research and especially the importance of sociodramatic play in facilitating problem-solving and cognitive processes, Yawkey (1981) conducted a research to examine the effects of guided sociodramatic or group pretend play on children's mathematical behaviours. The results of his study showed that sociodramatic play is a facilitator of children's mathematical behaviour. In addition, the results of the study showed, a significant relationship between sociodramatic play behaviours and mathematical performance. It was recognised that the conceptual strategies required for mathematical learning, for playing and for divergent thinking are similar. Children participating in sociodramatic play have a greater chance in developing and practicing productive thinking strategies which are required for mathematical learning. As a result, Yawkey (1981) suggested that sociodramatic play, among other possible educational implications, should be approached in school with greater emphasis and that it could be employed with young children as a facilitator of mathematical abilities.

Finally, Smith (1983) in his article "Training in fantasy play" discusses the idea of training children in fantasy and sociodramatic play in a systematic way. Referring to several studies, he argued that fantasy and sociodramatic play can lead to significant improvements in mathematical readiness and group problem solving. He concluded that fantasy and sociodramatic play has an important value in the resolution of emotional fears and conflicts. This was also considered valuable for the cognitive aspects of development. Furthermore, he claimed that drama is a good way of fostering both adult and peer interaction and growing experiences that these naturally bring about.

4.3. Examples of teachers' work:

The use of different types of drama in teaching mathematics has been employed by several individual teachers. Published examples will be presented next.

Tytherleigh and Watson (1987), in their article "Mathematics and Dance" claim that mathematics can be perceived in dance in several levels. On the technical level, there is the mathematics of balance, leverage, stress, strain, force and motion. The language of dance has the same mathematical components as music (note values, beat, rhythm, time signatures and intervals and the harmonics), however the mathematics of position and space are added.

Tytherleigh and Watson attempted to exploit the relationship of dance and mathematics in the secondary classroom, but in doing so they discovered that dance techniques, as well as using mathematics, were an excellent medium for giving information about numbers, space, symmetry and structure. Furthermore, they identified that dance also, allows us all to take part in this process because it is accessible to almost everyone, it does not necessarily create situations in which a student can be wrong or right and the relationships between mathematics and dance, in particular those relating to language and composition, can be used very easily in the classroom.

Light (1986) in his article 'Acting takeaways' described his first experience of using drama in arithmetic with a classroom of 8-9 year olds. The idea was to give children mental arithmetic questions and then to ask them to write a story which would give rise to some of these questions. He suggested they worked in pairs, and rehearse their story with their partner. The actors' job would be to put the subtraction (or addition) over clearly to the audience, whose job was to guess what the subtraction was - this guaranteed audience

participation and tied the lesson together.

Finally, evaluating this attempt, he said that there was an obvious improvement in the children's ability to organise, cooperate improvise and produce stories in which the arithmetic played a real part.

Nave (1983), in his article "Drama + Mathematics = Dramatics" has used drama (play and skits) to convey mathematical concepts. He considered this as a valuable way. He explained that although the repetition found naturally in memorizing one's lines and in rehearsing and performing is helpful, this is just one benefit. On the other hand, as Nave stressed there are more important reasons why drama is very useful as a teaching method. He claimed that: *"It is the belief which the teacher will create to the students, the necessity for the task. The children will feel part of the task, they feel that the task to be solved is their personal problem from the insight of their hearts..."* (p.24). Furthermore, he confess that dramatics gives him a chance to see his students in a different light. *"Many of those who struggle under the daily work routine, sparkle under the bright lights of the stage..."*(p.25).

4.4. Drama in teaching mathematics in secondary school:

As revealed from the available literature and research review, there is quite a lot of evidence that dramatic method is a facilitator for mathematical thinking and learning. Unfortunately, as far as the present study is concerned no research on the use of any form of drama as a method of teaching mathematics at secondary school level has been conducted. Again, most of the examples and studies that have been found in the literature concern the employment of various forms of drama mainly in primary school.

One of the many causes of this neglect might be that primary school is generally considered as more flexible than secondary school; the pressure of exams does not exist, and it is not compartmentalised. Secondary school is divided in different subject departments and usually the access from the one type to another is very difficult. Also, secondary school has been regarded, especially in the last years, as a place for exam preparation. Drama and other activities which demand the active involvement of children may be regarded as time consuming. Therefore in secondary school the use of such methods may be considered as difficult. The present research is also concerned on gathering data about this issue.

Another reason is the attachment to the Piagetian stages of thinking which correspond to certain ages. Shayer and Wylam (1981), showed that Piagetian stages of thinking do not generally follow the age levels that Piaget identified. A large number of students has not reached the stage of formal operations at the age of sixteen.

The Cockcroft Committee (1982), recognised the importance of using practical activities in teaching mathematics and stressed the point that the use of such activities and methods should not only be referred to primary level or to low ability students. Potari and Searl (1989), also stressed that

practical work is a fundamental element in the learning of mathematics at all stages of education, including the secondary school stage.

Orton (1987), emphasizing the importance of providing a rich learning environment as a factor in promoting the understanding of mathematics for all ages of children, raises the following question: *"Do we need to do anything for older children in, for example, coming to terms with algebra?"* (p.5).

Concerning the use of drama in older ages as a teaching method, Male (1973) explained: *"This activity is so important that it should not be confined to the infant classroom. The basic need still requires satisfaction as the child grows through the junior into the secondary school and adulthood. The name of the activity may change to 'Improvisation', 'Role play' or 'Management Games', but it remains fundamentally dramatic play and as such must be handled seriously and sympathetically"* (p.21).

4.5. CONCLUSION

As discussed in this chapter, although Dienes considered that the rule-bound is more suitable for mathematics learning, he claimed that to move from one type to another facilitates the procedure of learning. Representational play which starts with a story framework, motivates the children and influences them to engage in the task. Soon certain rules or a problem-solving situation environment arises, which provide mathematical ends.

According to Dienes, when moving from one type to the other, awareness increases. Energy for cognitive work is released whenever play takes place. Play provides the motive power for children to start work. Another valuable effect is that children create experiences which would facilitate further learning in a later stage.

Through the review of the previous research, it was revealed that the use of sociodramatic play in mathematics learning assists in developing and practicing productive thinking strategies. Evidence has been given that the systematic use of it can lead to significant improvements in mathematical readiness and group problem-solving. Results from relevant research shows that drama is a facilitator for cognitive aspects development including mathematics.

Further, in the present research it was revealed that the conceptual strategies required for mathematical learning and for dramatic playing are similar.

Finally, the discussion concerning the provision of a rich environment, which would include drama or practical activities for learning mathematics in secondary school level, indicated the following: There is an equal need for provision of more opportunities in active and personal involvement with the task in children of the secondary as there is in the primary school. A single

attachment the traditional method of teaching - through exposition - has been criticised, and considered responsible for children's failure to employ their mathematical skills in problem-solving situations and to appreciate the nature of mathematics (see Chapter III, 3.3).

CHAPTER V

METHODOLOGY

5.0. Introduction:

In this chapter, a detailed presentation of the methodology planning, designing, and completion takes place. At the beginning, there is a general description of the research methodology design in relation to the research aims. Then, a detailed description of the sample follows. In the next two sections 5.3 and 5.4, the analytical description of the pilot study and the main research takes place. Into those two sections, the formulation of the research objectives is explained, and the instruments used as well as, the process of both the pilot study and the main research are described, too. Finally evidence is given concerning the reliability and the validity of the present research.

5.1. The research design:

As already mentioned, the hypothesis under investigation is:

"There is a potentiality of using drama as a method of teaching mathematics, in the present classroom conditions of secondary schools."

And the research aims are:

- 1: "To identify the benefits and the values of drama as a method of teaching mathematics, in the present classroom conditions of secondary schools."
- 2: "To point out the limitations that teachers either face when attempting to employ drama as a teaching method, or prevent them from using it."

The type of research employed is close to the type of the ethnographic research. According to Denscombe (1983), *"ethnographic research of teachers like ethnography in general, aims to describe and explain the culture of a social group and examine the circumstances in which this culture arises. Rather than focus on the outcome of the teaching process... ethnographers are primarily interested in the customs and behaviour of the group and, in particular, the member's understanding of the world in which they operate"* (p.107).

Similarly, the researcher wishing to investigate the potentiality of using drama as a teaching method of mathematics, gave emphasis in obtaining information on individual teacher's background, opinions, attitudes and perceptions concerning different styles and methods for teaching mathematics, the importance and appreciation of the subject of mathematics, the difficulties that pupils face in learning mathematics as well as the reasons for those difficulties.

At the beginning, a pilot study took place in order to test and develop the hypothesis and to evaluate the problem in its natural environment (the school classroom). This was done through a discussion with the maths teachers of the school, who served as the research sample.

The results of the pilot study lead to the formulation of specific objectives to be further examined in the main research:

- O1: To identify the importance of teaching and learning mathematics, as well as the appreciation of mathematics from the teachers' and pupils' point of view.
- O2: To identify the difficulties and the reasons which cause difficulties for many children when attempting to understand and apply mathematics.
- O3: To examine the teachers' attitudes and opinions towards two different methods of teaching mathematics: the investigation and the exposition by the teacher.
- O4: To examine the benefits and values of drama as a teaching method for mathematics in the secondary school level.
- O5: To investigate the limitations that teachers face, when attempting to use drama in mathematics teaching, or the obstacles that prevent them from using it.

The design of the main research utilises two basic techniques: interviews and observation in three case studies; supplemented by a study of relevant literature. As can be seen from the following stages, interviews were sought from different sources with the hope that this would help to overcome the weakness or biases of a single study.

In stage A, interviews were taken from two different samples of teachers. The first sample was the maths teachers of a secondary comprehensive

school in the county of Avon. The second sample consisted of maths and drama teachers from different secondary schools who already had previous experience in using drama as a teaching method in mathematics.

In stage B, interviews were taken from five groups of pupils of different classes of the secondary school in Avon who had also taken part in the case studies.

Finally, in stage C, the researcher observed three different case studies with different classes of the same school but with the same teacher. After the case studies, the teacher and the pupils were interviewed.

Next, a description of the samples follows, as well as a detailed presentation of the pilot study and the main research.

5.2. The sample:

5.2.1. Teachers:

There were two different samples of teachers. The first was a convenience or accidental sample, where the maths teachers of the comprehensive secondary school W were chosen to serve for the interviews. The comprehensive secondary school W was located in the county of Avon and was been suggested by the maths-advisor in the Avon county.

The second sample was purposive. The teachers who were included in that sample had experience in using different forms of drama for mathematics in the secondary school level.

The first sample consisted of six maths teachers (A, B, C, D, E and F). All of those teachers had already taken part in the pilot study; teacher E took part in the case studies as well.

Teacher A: male, 40 years old, 23 years previous teaching experience.

Teacher B: female, 35 years old, 10 years previous teaching experience.

Teacher C: female, 37 years old, 13 years previous teaching experience.

Teacher D: female, 30 years old, 5 years previous teaching experience.

Teacher E: male, 34 years old, 10 years previous teaching experience.

Teacher F: male, 34 years old, 6 years previous teaching experience.

The second sample consisted of three teachers (X, Y and Z). One of them was a maths teacher and the other two were drama teachers.

Teacher X: maths teacher, female, 40 years old, 8 years teaching experience, school in Oxford.

Teacher Y: drama teacher, female, 30 years old, 5 years teaching experience, school in Oxford.

Teacher Z: drama teacher, male, 40 years old, 12 years teaching experience, school in Milton Keynes.

5.2.2. Pupils:

Five groups of approximately four pupils in each group were interviewed. They were randomly selected from three different classes. A balance between boys and girls was attempted. There were 19 pupils in all, nine boys and ten girls.

Group K: three boys and one girl, 14-15 years old, 4th years, took part in the case study CS3.

Group L: three girls, 14-15 years old, 4th years, took part in the case study CS3.

Group M: two boys and two girls, 12-13 years old, 2nd years, took part in the case study CS2.

Group N: two boys and two girls, 11-12 years old, 1st years, took part

in the case study CS1.

Group O: two boys and two girls, 11-12 years old, 1st years, took part in the case study CS1.

5.2.3. The school W:

The school W was a comprehensive secondary school of Avon. It was located in a small town with a rural environment and had approximately 1040 students. It was a mixed ability school.

The classrooms were decorated with students' work on various subjects. Usually the resources, such as paper, calculators, pencils, colours etc. were provided by the pupils, however the school kept always some spare materials.

One of the school policy's aim is to prepare well all pupils for Public Examinations and for a purposeful adult life, as referred in the school's prospectus.

5.2.4. The classes that took part in the case studies:

Three case studies took place in the school W, by the guidance of the teacher E. The three classes who took part in those case studies are described in the following.

Class 1: The first class constituted of 27 pupils, with an approximately equal number of boys and girls. They were first year pupils, 11-12 years old. They took part in the case study CS1. Their behaviour was described by their teacher as very well motivated, enthusiastic, friendly and generally showing a high level of participation.

Class 2: The second class also, constituted of 27 pupils, with an approximately equal number of boys and girls. They were second year pupils, 12-13 years old. They took part in the case study CS2. The overall pupils' behaviour was described by their teacher as friendly, cooperative but not very studious.

Class 3: the third class constituted of 26 pupils, again half boys and half girls. They were fourth year pupils, 14-15 years old. The pupils behaviour was described by their teacher as friendly, sociable but not really studious.

5.3. Pilot study:

It was decided that some preliminary investigation was required to give sufficient perspective to the research hypothesis, the methodological problems and the state of the data. The pilot study of the research was conducted through a discussion with the maths teachers of the school.

According to Davis (1977), a discussion could provide the necessary insight on the research in order to identify the practicality of the preplanned technique and the probability of being able to get good data. The researcher wanted to identify the real dimensions of the already formulated aims and to be able to formulate the objectives of the main research.

More specifically, the researcher's intention from the pilot study was to discover:

- a. The degree to which teachers, pupils and society appreciate the teaching of mathematics.

- b. The teachers' attitudes and opinions towards using drama as a teaching method for mathematics in secondary school level.
- c. The difficulties and problems that they identify.

Discussion was considered the most appropriate of all the available methods. Compared to the use of a questionnaire, discussion is far less time consuming, and although it needs greater effort to analyse the results there is no time spent in waiting for replies. At the same time the discussion has the advantage of personal communication. The personal contact and interaction between the researcher and the teachers was very important for the present study, as the object of the investigation was probably novel to the majority of the teachers. Therefore, it was necessary to have the flexibility of answering possible questions and provide further explanations, in order to help the process of the discussion.

5.3.1. The process of the pilot study:

The discussion took place during the maths department meeting on the 14th of May 1990. The arrangement of the discussion was made after an oral negotiation with the head of maths department of the school. In the discussion all the maths teachers of the school took part: three male and three female. Their ages were between 30-45. All of them had previous teaching experience of at least 6 years and up to 23 years.

The discussion was an informal one and was not audio recorded, but full notes were taken. In order to strengthen the validity of the results, the approval of each teacher was asked through a personal letter which presented the researcher's view of what had been discussed and encouraged criticism by using respondent validation.

At the beginning, a personal introduction took place, where the researcher clarified the purpose of the discussion and the way it fitted into the research methodology. The importance of the discussion as well as, the aims and the hypothesis under investigation were explained.

Consequently, the researcher gave a brief introduction on the evolution of drama in our century, with emphasis on its use as a teaching method. Record cards (15 X 20 cm) with several definitions of drama were presented, in order to provide teachers with better understanding and additional evidence (see Appendix, no1). Next, some articles on other teachers' work were presented as examples (see Chapter IV, 4.3).

With the above strategy the researcher wanted to make sure that the maths teachers understood the topic of the discussion. There was a need for clear communication in order to collect useful data, since the majority of the maths teachers did not have any previous experience related to the topic under discussion.

The questions which were discussed in the pilot study can be found in the appendix no2, and they are categorized in the following sections:

a. How do pupils, teachers and society appreciate mathematics?

Initially a discussion about the subject of mathematics came up, where teachers expressed their opinion about the importance of teaching and learning mathematics. At the same time the different appreciation of mathematics that exist amongst teachers, pupils and society was discussed.

b. What are the teachers' attitudes towards using drama as a teaching method in mathematics?

The teachers were asked for their opinion on the subject under

investigation and their view concerning the possibility of the employment of drama in the secondary school level mathematics.

c. What difficulties or problems do they identify.

Finally, the difficulties, problems that this method of teaching mathematics may cause to the management of the mathematics teaching as well as to the learning of mathematics, were discussed thoroughly.

5.3.2. The results of the pilot study:

Concerning the appreciation of mathematics by pupils, teachers and society, it was admitted that there were different points of view. They claimed that most pupils and parents perceive mathematics as a way of getting a "good job". Therefore, they placed much emphasis in succeeding with exams. Concerning the teachers' attitudes towards using drama as a teaching method for mathematics in secondary school level, teachers expressed a moderate interest. They also expressed their uncertainty about whether drama is useful enough in teaching mathematics in secondary school.

Concerning the difficulties and problems they may identify, they claimed that there are many reasons which prevent teachers from introducing new teaching methods and especially dramatic activities such as:

- a. lack of time
- b. lack of resources
- c. difficulties in controlling the children
- d. lack of skills and abilities to manage dramatic methods.
- e. responsibility towards children's parents (parents want their children to succeed in exams).

f. responsibility towards authorities (National Curriculum - school's policy).

One of them said that she didn't believe that drama could help children to think deeply about mathematical problems and exercises. Another said, that drama was more suitable for primary school teaching and another claimed, that she had already tried relevant activities but she needed new ideas and new inspiration. As a problem identified the lack of communication between teachers.

The results from the pilot study helped the formulation of the main research objectives. The fact that the teachers identified certain limitations, which prevent them from using drama as a teaching method for mathematics, was something to be further investigated in the main research. At the same time sufficient insight provided the designing of the methodology to be adopted. As it can be seen, there is a direct correspondence between the pilot study's results and the main research objectives. The structure of the interviews, and the scheduling of the case studies observation according to certain key-informants was formulated taking into serious account the results of the pilot study.

5.4. Main study:

5.4.1. The instruments:

The instruments used in the main part of the research were interviews and case studies. The necessity of personal contact led to the choice of interviews to obtain the research data.

It considered important to avoid typical answers and to observe attitudes, seek for answers and explanations to questions which concern a novel topic.

According to Tuckman (1972), interviews provide opportunities to probe deep to the problem and access to what is "inside a person's head", making it possible to measure what a person likes and dislikes (values and preferences) and what a person thinks (attitudes and values).

With the employment of interviews, the researcher is able to follow up ideas and probe responses. It is also possible to investigate motives and feelings which the questionnaire can never do. At the same time a response in an interview can be developed and clarified.

Kerlinger (1970), suggests that interviews may be used to follow up unexpected results or to go deeper into the motivations of respondents and their reasons for responding as they did.

Furthermore, the employment of the interview can ensure a better rate of response. Teachers are usually extremely busy. They often have to rush from one class to an other, so obviously any other method, such as the questionnaire, would have great possibilities of remaining unanswered.

Besides the interviews, three case studies were used in the research. The employment of the case studies would help provide a full picture of the

problem under investigation. Adelman et al (1980) claim that data obtained through a case study is strong in reality because case studies are "down-to-earth".

Due to the fact that time for the present dissertation was very limited and therefore there was not enough time for continuous and extensive observation, the use of the case studies was more complementary to the basis of the research. However, through the three case studies, it was possible to gain an initial idea and an intuition concerning the benefits and values of drama as a teaching method, and the problems that teachers could face.

5.4.2. Interviews with the teachers:

Two different samples of teachers were used, as described on page 64. Both sources of data were valued as equally important for the required information.

The first sample was the maths teachers (A, B, C and E) of the secondary school in Avon, who had already taken part in the pilot study. After the completion of the pilot study, a personal letter to each teacher who took part in the discussion was sent, asking for further assistance by taking part in the interview. In the letter, the aims of the research were explained again, and the confidentiality of the interview was assured.

The second sample was consisted of the maths and drama teachers (X, Y and Z) of the secondary schools in Oxford and Milton Keynes. The selection of this sample was purposive as those teachers had already previews experience in using various forms of drama in teaching mathematics and other subjects. Again a letter was sent to every teacher, requesting their participation in an interview.

The interview with the teachers was a structured one. The content and the procedures were organised in advance. However, enough freedom was given to the interviewees to express their opinion and elaborate on the topics as they wished. It was expected that the interviews with the teachers would provide sufficient data on all the objectives (O1, O2, O3, O4 and O5) of the research which through the pilot study developed as:

O1: To identify the importance of teaching and learning mathematics, as well as the appreciation of mathematics from the teachers' and pupils' point of view.

O2: To identify the difficulties and the reasons which cause difficulties for many children when attempting to understand and apply mathematics.

O3: To examine the teachers' attitudes and opinions towards two different methods of teaching mathematics; the investigation and the exposition by the teacher.

O4: To examine the benefits and values of drama as a teaching method for mathematics in the secondary school level.

O5: To investigate the limitations that teachers face, when attempting to use drama in mathematics teaching, or the obstacles that prevent them from using it.

Throughout the interviews there had been an attempt to avoid "closed situations" (answering with yes or no). The questions that were used were open in order to give greater flexibility to the respondents. Nevertheless, a need to follow a preplanned schedule was recognised, in order to cover the whole range of the topic under investigation, and to be able to compare and analyse the data obtained.

The schedule of the interview, that can be found in the appendix no3, included six sections which will be described below.

Section I: Introduction. At the beginning a personal introduction took place, where the researcher explained again the research aims, and the way in which the interviews were to help the procedure of the research. Consequently some personal background information was asked from each teacher concerning his/her work at school and further responsibilities. Finally, every teacher was asked to describe an ordinary lesson of his/hers. This introduction was regarded as essential firstly to establish a friendly and relaxed environment of mutual understanding, and secondly to select some necessary background information about each teacher.

Section II: Appreciation of mathematics. In this section, an attempt was made to examine the appreciation of mathematics and mathematics teaching from the teacher's point of view, and to discover the importance of teaching and learning the subject. Through the questions, which were addressed to all teachers, the researcher expected to find out the way in which maths teachers appreciate and view mathematics, as well as the different opinions which exist amongst teachers. Finally to examine whether mathematics has a different meaning to teachers, pupils and society.

Section III: Reasons which cause difficulties to children in learning mathematics. Here some of the reasons that cause difficulties to children in mathematics learning were discussed. The researcher addressed some specific questions to the teachers, but the main interest was to leave the teacher to approach the subject as he/she wished through his/her classroom experience. However, answers were sought concerning the ability of the children to

think abstractively and to discover how ready they were to adopt mathematical language and to appreciate the nature of mathematics.

Section IV: Approaches to different methods of teaching mathematics.

Consequently, the teachers' opinion and attitudes towards different methods of teaching were asked. It was important to talk about teaching methods, since the subject under investigation - drama as a method of teaching - belongs to the same area. Although the main interest was to talk about drama as a teaching method, it was predicted that the first sample of teachers (A, B, C and E) who did not have any previous experience of using drama in mathematics teaching would find it difficult to answer any of the Section's V questions. Therefore it was decided to start by discussing the use of investigations and the use of exposition, in order to enter a situation where discussion about different teaching styles, including drama, would arise.

Section V: Benefits and values of drama as a teaching method for mathematics in the secondary school level. The questions of this section were addressed mainly to the second sample of teachers (X, Y and Z) since they already had previous experience in using drama, as well as to the teacher E, who took part in the case studies. In this section it was expected to find out what benefits and values the various teachers had identified in using drama as a teaching tool. At the same time the teachers were asked to present examples and to suggest topics in mathematics where dramatic methods may be most suitable.

Section VI: Limitations that teachers either face when attempting to use drama in mathematics teaching, or prevent them from using it. In this last section, both samples of teachers were asked about the difficulties and problems they could identify in drama as a method of teaching mathematics for the secondary school level. Special interest was given to the discussion of the problems of time, resources, skills and abilities of the teacher, children's attitudes and co-operation with other teachers and departments.

5.4.3. Interviews with the pupils:

Five groups of pupils (K, L, M, N and O), with approximately four in each one, were interviewed. There were nineteen pupils in all, nine boys and ten girls, all attending the comprehensive secondary school in Avon. The selection of the sample was random from the classes which took part in the case studies. Lack of time prevented a broader selection.

Negotiation for the interviews were made via the teacher who asked the pupils whether they wish to take part. By interviewing the pupils, the researcher's aim was to find data for the objectives O1 and O2 of the research, which are:

- O1: To identify the importance of teaching and learning mathematics, as well as the appreciation of mathematics from the teachers' and pupils' point of view.
- O2: To identify the difficulties and the reasons which cause difficulties for many children when attempting to understand and apply mathematics.

The kind of the interview employed with the pupils could be characterised as informal. However the interviewer had a number of key issues

that she raised up in conversational style instead of having a set of questions. It was considered important to use that type of interview as otherwise the pupils might not have been so eager to respond. The establishment of a friendly atmosphere and of a state which would be similar to a discussion rather than a formal answering of questions, was necessary.

The schedule of the interview, that can be found in the appendix no4, followed these sections:

Section I: Introduction.

A personal introduction where the research and its aims, as well as the usefulness of the interviews were explained briefly to the pupils. At the same time confidentiality was assured and subjects were reminded that everything discussed would only be used for the research purposes. It was important in this section to establish a friendly atmosphere, so that children would speak freely.

Section II: Appreciation of mathematics.

In this section, the questions which were addressed to pupils aimed to discover their degree of appreciation and their view towards the subject of mathematics teaching. The researcher wanted to find out how important mathematics is to pupils concerning the every day life and the extend to which mathematics is connected with the real world outside school.

Section III: Difficulties in understanding and learning mathematics. Reasons for those difficulties.

The difficulties that children face in understanding and learning mathematics were discussed with them. Although it was expected that would be difficult for the children to talk about their

learning difficulties for several reasons, there was an attempt to encourage such a discussion as it was considered important to explore the children's own perspectives.

5.4.4. Case studies:

There were three case studies, namely CS1, CS2 and CS3. Three different classes, of approximately 27 students each, took part in the case studies. In the case study CS1, the class was a first year group and of mixed ability. In the case study CS2, the class was a second year group and in the CS3 a fourth year group. Therefore, a satisfactory range of ages was obtained.

The three case studies comprised of three mathematics lessons which were taught using different forms of drama as teaching tool. The inspiration and planning of the lessons were these of teacher E in the secondary school of the county of Avon. Lack of time and experience prevented the use of sophisticated forms of drama or of a perfect preplanned strategy. In the case study CS1 the most frequently met form of educational drama, the stimulation game, was used by teacher E in order to teach a numerical progression in algebra. The detailed description of the CS1 lesson can be found in Chapter VI, 6.3.1.

In case study CS2, role taking was used mainly, while the drama employed could also be described as representational or symbolic game. At the same time there were some elements of practical activity. The CS2's description can be found in Chapter VI, 6.3.1.

The case study CS3 was mostly characterized as a practical activity, even though there were some dramatic elements in it, such as the element of conflict. As described in page , the desks of the classroom were used to

divide the classroom into three areas where the children were isolated either in the area A or in B (see diagram on page 121). This is a conflict situation which is very much used in drama and which leads and accelerates the problem-solving procedure.

The main limitation of the case studies was the lack of sufficient time. Usually case study observations take place over an extended period of time and the researcher is able to develop a more intimate and informal relationship with those he/she is observing and is also able to deepen these observations.

As already explained the purpose of the case studies' employment, was to get a full picture of the topic under investigation. More specifically, the researcher expected to gain data concerning the last two objectives of the main research, which were:

Q4: To examine the benefits and values of drama as a teaching method for mathematics in the secondary school level.

Q5: To investigate the limitations that teachers face, when attempting to use drama in mathematics teaching, or the obstacles that prevent them from using it.

The methods of observation followed by the researcher, were both participant and non-participant observation, depending on the circumstances. The researcher as a particular observer took the same roles as those of the children as a "frog" or a "point" attempting to observe not only the pupils' behaviour but also the way in which they expressed their feelings and thoughts.

Bailey (1978) explains that in a natural setting such as "teaching setting", it is difficult for the researcher who wishes to be covert and not to act as a participant. If the researcher does not participate, little can be explained about his/her presence, as he/she is very obvious to the actual participants.

Due to the limited time available for the research, there was a need to compromise as to what would be possible to be investigated through the case studies. Therefore, the aspects of the observation were narrowed into two areas, the children's behaviour during the lesson, according to certain key concepts and the teachers' problems and difficulties. The researcher had pre-scheduled her observation according to those two areas, and the key concepts she had identified, were obtained through the literature review and the pilot study.

Concerning the benefits and values of drama as a teaching method, the researcher observed the children's behaviour during the lesson according to the following key concepts:

1. Active participation
2. Consideration / engagement.
3. Enthusiasm / motivation.
4. Understanding / intellectual activity.
5. Communication / co-operation with others.
6. Feeling of boredom, confusion and being lost.
7. Feeling of indifference.

Through the observation of the above instances the researcher expected to gain data which would enable her to refer to the quality of the learning environment, in which drama as a teaching method can be set up, and to the ability of this method to stimulate the children's interest for commitment and engagement in a mathematics task or problem solving situation.

Concerning the limitations that teachers face attempting to use drama as a teaching method, the researcher had the chance not only to observe but also to understand from within the difficulties that teacher E faced. The key variables that the researcher followed during the observation were the

teacher's difficulties to:

1. control time and space.
2. find resources.
3. design, plan and carry out the drama lesson.

After the completion of the three case studies the researcher sought interviews from the teacher and the pupils, in order to strengthen reliability and validity of the research. Through the teacher's interview, it was expected to gain a better view, concerning the benefits and values of drama as they have been identified from his experience during the case studies. In order to be able to relate the teacher's opinion with that of the researcher, the interview with the teacher followed the same schedule as that of the observation.

At the same time, the pupils were also asked to express their opinion on the case study lesson. The aim was to gain information concerning their understanding of the purpose of the lesson and the clarity of drama's contribution to the mathematics teaching. Finally, to examine the extent to which this method of teaching was preferable comparing to others and why.

5.5. Reliability and validity of the research:

The reliability of the research is the degree to which its results are consistent, compatible and harmonious to the research aims and objectives. The validity is the degree to which the research measures what it claims to.

In this study in order to strengthen both reliability and validity, planning on the research's aims and objectives was carried out taking into consideration the pilot study's results. Moreover, considerable attention was paid so that the questions used in the structured interviews and the schedule for the observations in the case studies, would be in accordance with the

research initial objectives.

Furthermore, the researcher was aware in every stage of strengthening the reliability and the validity of the study. Therefore, after the completion of the pilot study, respondent validation from each of the maths teacher who took part in the discussion was asked. A personal letter was sent to each individual, where the discussion's procedure was presented as well as the researcher's appreciation of the discussion. Through these letters the researcher invited all teachers to a further interview and also sought their criticism concerning her appreciation of the discussion.

Data from the teachers' interviews were obtained from two samples. The maths teachers of a comprehensive secondary school in Avon and the maths teachers who had already experience concerning the subject under investigation. This strategy assisted in gaining a view from sources' opinion and in making the data obtained, more valid.

The researcher was aware that the observation through the case studies had the weakness of being subjective. In order to strengthen reliability and validity of the data gathering procedure in the case studies, two methods were employed. First, a schedule was completed to help the researcher during the case studies observation, and secondly teachers' and the pupils' interviews were sought, after the completion of the case studies.

Finally, the methodology of the main research included two different instruments, interviews and case studies and at the same time data was obtained from different sources. Therefore, there was a triangulation in two different dimensions. First, the method of obtaining data (interviews, case studies and study of relevant literature) and second, the sources (teachers, pupils and the researcher).

CHAPTER VI

PRESENTATION AND ANALYSIS OF THE RESEARCH'S FINDINGS

6.0. INTRODUCTION

In this chapter, there will be an attempt to present and analyse the data collected through the interviews with the teachers, the interviews with the pupils, and the case studies. The analysis of the data is qualitative. The small size of the samples does not permit the use of quantitative methods of analysis. In terms of confidentiality there is no reference to the actual names of the teachers and the pupils, capital letters have been used instead.

In the following, the presentation of the findings takes place into three parts 6.1., 6.2. and 6.3. In each part, summaries can be found at the end of each section.

6.1 INTERVIEWS WITH THE TEACHERS.

6.1.0. Introduction

As it has already been explained in chapter V, there were two different samples of teachers who were interviewed. From the six teachers who are included in the first sample, and were asked to take part in the interview, four were interviewed eventually, the teachers A, B, C and E. From the second sample all the teachers who were asked, the teachers X, Y and Z were interviewed.

In the following section, the findings obtained from these interviews are presented. In order to facilitate understanding, the presentation takes place in accordance with the sections in which the questions of the interviews were classified (see appendix no3). In this way the reader can have a more global view of what has been said in the interviews from different teachers and can more easily make comparisons.

Although the interviews were structured, answers concerning one topic may be found in different sections. That is because the topics are interrelated and the teachers tended, by answering one question, to answer also others. For example, when some teachers were asked questions concerning the importance of mathematics, they extended the discussion into the difficulties that pupils face in learning mathematics.

However, as the main aim was to obtain data, which would allow an examination of teachers perception through answering the questions and expression of their opinions, the researcher did not press any of the teachers to follow strictly the structure of the interview.

After the end of each of the sections II, III, IV, V and VI there is a summary.

6.1.1 Section I: Personal details for each teacher concerning his or her way of teaching

In this section details concerning the personal style of each teacher are presented. The teachers were asked certain questions as it can be seen in the appendix no3, and their answers are paraphrased by the researcher.

Teacher A:

This teacher teaches Personal and Social Education besides maths in school W. His general aim is to have pupils understand and enjoy maths. He claims that his main skill is communicating through talking. For that reason he does not employ new methods. In his teaching he likes to check that every pupil has done the homework. Although he knows that exams are not the main purpose of education, he teaches topics so that children will understand the subject sufficiently, and pass the exams later. At the same time, he believes it is very important to give children the chance to ask for themselves personal questions related to their difficulties in understanding mathematics. He encourages teacher-pupil contact as much as possible.

Teacher B:

Teacher B attempts through her teaching to reinforce the skills that the pupils already have and to develop new ones. She says that almost in every lesson she starts by talking for fifteen minutes and then she gives exercises and marks in order to prepare the children for exams. She likes to talk about every problem that arises concerning the maths

lesson and not to leave any gaps for later on. However she avoids continuing for too long on the same subject in order to avoid boredom.

Teacher C:

She claims that her way of teaching varies according to the level and the ability of the class. Generally she uses "talk and chalk", investigation, and discussion. She starts with an introduction on the subject and then a practice session follows "...with some input from me and hopefully, some from the pupils"; she tries to go through a certain syllabus by a certain time period, as she wants children to be prepared for the exams.

Teacher E:

This teacher tries to use a mixture of activities. He does not teach a class as a body. According to the time available, he tries to work at different speeds. He least prefers working with books. He claims that his general aim is to encourage children to enjoy their work in maths. Although he attempts to organize his lesson in advance, he is very flexible and usually leaves the children to take over with a new idea.

Teacher X:

She is a maths teacher and at the moment the mathematics coordinator in her school. The maths department of her school uses the A.T.M. (The Association of Teachers of Mathematics) syllabus for G.C.S.E. That has among its aims, *"to encourage students to enjoy mathematics and to develop positive attitudes towards it... to encourage co-operative work... to provide a syllabus that is sufficiently open to allow innovation in the classroom... to permit assessment to be dependent upon student activities..."* (ATM, 1988, p.3). She teaches by using a range of activities and a combination of teaching styles including drama. Her main interest is the use of dance in learning and

exploration of mathematics.

Teacher Y:

Teacher Y is a drama teacher, teaching at the same school as teacher X. She maintains a special interest in cross-curricular activities. She believes in co-operation between different departments in the school. Concerning drama, she perceives it as a way of learning and as a teaching method.

Teacher Z:

He is a drama teacher and his post in school is drama coordinator.

He is very interested in team-teaching and cross-curricular activities using drama as a teaching method. The policy of the school he works in strongly encourages teachers to work in teams and be involved in cross-curricular activities. He was a student of Dorothy Heathcote at the Newcastle-Upon-Tyne University, and he is very much influenced by her in seeing drama as a powerful method for teaching other subjects.

Summary:

The teachers A, B and C make clear that they teach mathematics, having in mind that their pupils must be prepared for exams. It seems that all the teachers try to raise up the children's interest and make them enjoy mathematics.

The teachers X, Y and Z seem to work under conditions where cross-curriculum work or team teaching is encouraged by the school policy.

6.1.2. Section II: Appreciation of mathematics by teachers

The questions of this section can be found in the appendix no3. The data obtained from this section correspond to the objective Q1: To identify the importance of teaching and learning mathematics, as well as the appreciation of mathematics from the teachers' and pupils' point of view. The answers are presented in most places into quotations as they were given by the teachers.

Teacher A:

"For me, mathematics is having the right tools to solve problems, and for me to teach that, is to communicate and build the children's skills in solving problems. In society, people think mathematics is beyond their understanding, outside of their comprehension. Therefore, for them a maths teacher is somebody very "up there". Most parents want their children to do the kind of maths that would enable them to live fulfilled lives in society, which means being able to add, subtract, multiply, understand what inflation and percentages means; being able to discuss the everyday mathematics. In most jobs the same amount of mathematics is required; however there are some jobs which demand more maths".

Teacher B:

"Usually pupils regard mathematics as a tool. They do not study mathematics for itself. For me, mathematics is an intellectual activity... It provides a way of bringing your mind to think, to work. It enables you to think, to make extensions and generalisations for other situations. For society, maths is important and hard. People

regard it as a tool to sort out everyday life".

Teacher C:

"Pupils find mathematics as a pressure. The parental pressure caused by the pressure of the society, because they know that maths is important. Pupils think maths is about an answer. They think it is about something right or wrong. They find it neither logical or exploratory. They cannot appreciate that there are different ways of sorting out the same task. I find it an enjoyable area - but it cannot be like this at the end, because it is a push push subject".

Teacher E:

"Mathematics for me, is a hidden model of the world. It is about patterns. A way of describing patterns. There are different aspects of mathematic's appreciation in school. Pupils are not taught to appreciate mathematics, on the contrary they are taught to pass exams. Both views are not compatible. The need of assessment determines the style of teaching. Pupils think it is something they have to do, something obligatory. Some find some personal involvement. For the majority, the influence is that you have to learn maths in order to get a good job. They do not have a clear idea about what mathematics is".

Teacher X:

"Mathematics is a world of beautiful structures and creations... and also of operations. For society, it is different. In fact, we do not need much of mathematics appreciation in order to live everyday life. It is always a matter of what kind of life we want to live... The government wants people to obey rules, therefore they want number

tests. The government does not want to see mathematics about people counting and controlling and feeling confident about all the machinery... Mathematical proof has to do with certainty. In the end, when children cannot have any other kind of certainty, they can have some kind of certainty through maths... In mathematics we always push pupils from the real situations to the abstract, trying to demonstrate the abstract by using the concrete. Children are required to think in an abstract world... Mathematics is a world of beautiful structures. Pupils think that it is something about computing at the moment, money, work. They cannot imagine it is about anything, not even themselves. They ask how things like dance, drama etc. will help them with their work. That happens more with maths than with other subjects".

Teacher Z:

"There are different appreciations of mathematics and, generally of teaching in school. Some think it is discovery, so they provide experiences to students to make discoveries. Others insist on a logic-systems approach. The approach depends on the teacher's personality. Society says that maths is good for you. However society's appreciation on mathematics is that it is about numbers, adding up money, logic and sorting out complex task systems... For me, it is the wandering of natural patterns".

Summary

All the teachers expressed their appreciation of the subject of mathematics and the importance of it being taught in schools, by pointing out some of its crucial characteristics. They all agree that mathematics is an

intellectual activity, a way of thinking and reasoning, as well as assisting children to think in an abstract way.

For all the teachers, mathematics is not be viewed only as a tool; as teacher A claims "...mathematics is having the tools and being able to solve problems". Teacher X also claims that mathematics "...is about people being able to count and control and to feel confident about all machinery".

At the same time, teachers C, E, X and Z indicate that mathematics is about discovery and exploration; teacher C, "...I see the pattern of mathematics", teacher E: "...mathematics is a hidden model of the world, a way of describing patterns...", teacher X, "...mathematics is a world of beautiful structures and creations" and teacher Z, "...it is the wandering of the natural patterns".

However, it is interesting that all teachers agree that there are different appreciations of mathematics between teachers, pupils and society. They all claim that both pupils and society know that mathematics is an important subject, but their appreciation of its importance is different from the one that teachers hold. All the teachers say that for society, mathematics is mainly about getting better jobs and using the basic arithmetic. Teacher A claims that for parents mathematics means to know how: "...to add, to subtract, to multiply and to understand what inflation and percentages are". Teacher B says that unfortunately for pupils mathematics is studied only as a tool to "...sort out everyday life". Teacher X says that for society mathematics "...is only for operations" and that pupils think that "...it is something about computing, at the moment, money work...". Finally, teacher Z seems to agree by claiming that for society mathematics "...is numerical, adding up money and doing complex task systems...".

6.1.3 Section III: Reasons which cause difficulties to children in mathematics learning.

The questions for this section can be found in the appendix no3. The data obtained from this section of the interview corresponds to the objective O2: To identify the difficulties and the reasons which cause difficulties for many children when attempting to understand and apply mathematics. The answers are presented sometimes by paraphrasing what the teachers said and sometimes by directly quoting the teacher.

Teacher A:

As he explains, one of the reasons that mathematics is difficult is that it seeks from the pupils an abstract way of thinking. Mathematics demands much written work, and is tiring in a way. There is a danger that a gap may open. Some children never get to the abstract.

He continues by mentioning another reason for those difficulties, that "pupils are very little, almost zero, motivated to tackle every hard task".

He finds that there is a proportion which is barely motivated and some others who never get involved.

Teacher B:

"Mathematics is an important subject compared to the others... Children do not have enough confidence..."

Teacher C:

"Mathematics leads from the concrete to the abstract".

She claims that "Pupils do not see the point of learning mathematics.

they do not appreciate the subject. Pupils like or dislike mathematics according to their ability to cope with it. There is a prejudgement that they cannot enjoy maths. ... In maths, some pupils cannot even start, they cannot express themselves, they cannot even think. They do not understand the problem, they cannot make connections in an abstract way...

Other reasons are the curriculum pressure, and the pressure of examinations. Children must be prepared to face the exams. Thus, teachers must test all the time; by testing you cannot teach. At the same time, due to the national curriculum teachers must teach the same things as pupils must be compared at the end of the course".

Teacher E:

As he explains, everybody has to do maths. "Mathematics has pressure, compulsion in it".

He argues that mathematics demonstrates an abstract way of thinking, "...children should learn things by doing". However in fact this opportunity is missing. According to him, most children do not understand the language and the symbolism. He says that. "by investigations and dramatic activities children find more space to explain and describe things using their own words..."

Teacher X:

"We always push from the real situations to the abstract. Trying to demonstrate the abstract by using the concrete: pushing them to think abstractively".

As she explains, only few children have enough confidence in their own intellect to be able to think and work abstractly. Some seem that to

work in an abstract way, but in fact they work following someone else's rules. For them, working successfully means they have been able to follow the rules. These are the extremely well-behaved children according to her, although that does not mean an abstract way of thinking.

Teacher Y:

"I remember being taught facts for which I still have no logical understanding. I cannot make any theoretical connections about them".

She claims that most pupils find mathematics "dead knowledge".

Summary

First of all, all the teachers agreed that most of the children face serious difficulties in learning mathematics and that their appreciation of the subject is very low.

One of the most fundamental reasons that they all agreed on, is that mathematics demands an abstract way of thinking, which the majority of the children have not developed. As teacher C claims, *"...some pupils cannot even start, they cannot make connections or relations in an abstract way"*. The teacher X as well, agrees that the children's ability to think and work abstractively is not strong, and teacher B that *"...confidence is lacking"*.

Mathematical language and symbolism seems to be hard for some others as teacher E identifies. Therefore, most children do not see the point of learning mathematics, they find it meaningless, they do not appreciate it. As teacher Y says *"...pupils find mathematics 'dead knowledge' and they cannot make any logical connection between the facts they have been taught"*. All the pressure put on the subject of mathematics according to teacher C causes *"...a*

prejudgement that they can never enjoy mathematics".

Finally, as teacher E points out, one of the major reasons is the lack of the appropriate learning environment, *"...where children could learn things by doing"*. Teacher A claims that most children are not very motivated.

Teacher C points out that teachers cannot teach properly because of two kinds of pressure, the national curriculum and examinations. Both reasons prevent teachers from showing to children that mathematics is an enjoyable area and that they can do well in it, because teachers have to test. She says characteristically *"...by testing, you cannot teach"*. The fact that teachers must teach the same things and in a certain way, in order to focus in preparing children to pass exams is, according to her, a major reason why pupils cannot appreciate mathematics and thus face difficulties.

6.1.4. Section IV: Approaches to different methods of teaching.

The questions of this section can be found in appendix no3. The data obtained from this section aim to fulfill the third objective O3: To examine the teachers' attitudes and opinions towards two different methods of teaching mathematics; the investigation and exposition by the teacher. The answers are presented mostly by paraphrasing the teachers, and in some cases by using their own words.

Teacher A:

This teacher is very much in favour of investigations, as he believes that they develop problem-solving ability which is the heart of mathematics. However, as he explains, "... there is a danger of giving pupils too much, too soon". He does not like the investigative approach for everything, "... as it is a waste of time in some cases". He claims that pupils must be provided with some earlier guidance and they should not be expected to find out everything by themselves.

He finds a need for a combination of both exposition by the teacher and an investigative manner, but at the same time he argues that, although it is necessary to have some practical experience, pupils should learn "... the proper presentation of mathematics and manipulation through formal symbols".

Teacher B:

Teacher B uses and appreciates very much the investigative way of teaching mathematics. She encourages pupils to go further, push them to make extensions and generalisations and to try to find a formula. She also finds a need for demonstrative work on the board.

Teacher C:

This lady uses investigations, and she puts most emphasis on the discussion of the outcomes that follow. She prefers a combination of styles.

She argues that "...if you use drama all the time you lose the emphasis" and that "...you must create an environment appropriate to what you are doing. A teacher must be very flexible".

Teacher E:

He finds that investigations have a power in mathematics teaching compared to mere demonstration; he feels that there is a need for demonstrative work afterwards.

[Teacher E is the teacher who took part in the case studies CS1, CS2 and CS3 where he used different forms of drama in three mathematics lessons. In the appendix no5 the reader can find a diagram in which teacher describes his own view concerning the three different ways of teaching demonstration, investigations and drama. The teacher explains the diagram as follows.

"Dramatic activities, resources and the content of the subject of maths, are the subsets of the maths lesson where dramatic method is used. When those overlap we have learning. In a dramatic environment people learn more. The four essentials features for a learning environment are involvement, enjoyment, appreciation and understanding. Drama is closer to the pupils needs. Learning increases from investigations to the dramatic methods".

He argues that "Demonstrative is the easy way, as it demands the least impact. If you are an excellent teacher and the blackboard is approachable to everybody then it is O.K."

Summary

The most interesting point here is perhaps, that all the teachers (A, B, C and E) agree on the need of the employment of the demonstrative manner of teaching (exposition by the teacher) and they all agree on the usefulness of the investigations. However, it seems that they give different emphasis to the use of these methods.

For teacher A, although he claims that investigations develop the problem solving ability of the children he prefers to provide guidance and use a combination of both the demonstrative and investigative way of teaching. Teacher B extensively uses investigations, encouraging her pupils to go further, to make extensions, generalisations and guesses to find a formula. Teacher C claims that a teacher "needs to be flexible". She advocates the combination of styles.

Teacher E finds that the demonstrative work should come afterwards: He already has the experience of using drama through the case studies, where he found the chance to explain his view concerning the demonstrative, investigatory and dramatic way of teaching. He argues that drama is "closer to the pupils needs... it merges the real with the abstract through activity". For him, demonstrative teaching is the best way, although it is difficult to employ it successfully. "If you are an excellent teacher and the blackboard is approachable to everybody then it is O.K."

6.1.5. Section V: Benefits and values of drama as a teaching method

The questions of this section can be found in the appendix no3. The data obtained from this section aim to fulfill the objective O4: To examine the benefits and values of drama as a teaching method for mathematics at the secondary school level. The replies are mostly direct quotes.

Teacher X:

She argues that *"Drama is more than theatre. It is emotion, creation, expression. It is a response from within to a situation. People learn best when they are involved in something, do something by themselves. feel that they contribute to something, create something. Participation is terribly important... As Brian Watkins claims, drama 'deals with relationships under stress' (see appendix no 1, for Brian Watkin's definition of drama). The idea of stress is important. There has to be some kind of stress or oppression so that learning will take place... Children learn best when they are engaged in learning and make effort to accomplish it, but this is a decision they have to make. The teacher does not have control of this. Teachers cannot do anything beside showing the children the way. In drama you do not have to dress up, but you must raise up a personal involvement. You act in order to stimulate students"*.

Teacher Y:

"Drama involves students in active learning. For example kids become frogs... They have to cooperate with each other and to value each other's ideas. This is the main principle of drama. Drama is a way of giving children confidence and the chance to understand themselves and

everybody else. They gradually learn to trust themselves and their abilities. It is about exploring emotions and situations, giving the students the chance to experiment in possible ways of learning in situations. It gives the children the opportunity to find out, to discover a situation even in fiction and using symbolism and analogy. Drama has the potential to see beyond figures. To see the relationship between simple figures and real life. In drama you can use materials from all over the curriculum, including maths.

Role-playing in mathematics is possible, if you have the right information. In drama is important to give another role to the child than him/herself as that helps the child to understand other people and begin appreciating other roles, it focuses their attention.

For example if you do statistics - it is something boring. But if we are doing something like looking at unemployment figures it looks like real life. If we did a role play where some people are unemployed and some employed then numbers would become real people and then children would recognize that there is a connection and would focus on life; then statistics have meaning. They are about life, and not simply a mathematical exercise. It gives children the opportunity to relate mathematical exercises to the real world; something essential if they are to find a meaning for what they are doing and find a belief.

It gives them a real life example.

People in drama can respond emotionally as well as intellectually. You can bring them to understand about community and society; suddenly just a number on a page becomes a lot more".

Teacher Z:

"Drama is a unique system - a teaching method: it is a part of an active pedagogy".

At the moment he works in a cross-curricular project called "Bakery" which involves maths, humanities and English, using drama as a teaching method.

"Drama has emotional investment, taking its roots from the ancient Greek theatre. Drama is when you and I are not watching but are active protagonists. Greeks gave us the emotional protagonists. Children in drama feel they are involved because have chosen so and not because it is obligatory. So, it shifts the responsibility to the pupils. Drama teachers have a view of children discovering, being collaborators. Children already know quite a lot. Teachers should help them to discover what they already know. Children have a right to be engaged in learning, a right to be powerful.

In a school, one should learn to analyse the world, the society. Drama has a representation of the world that children must create, through active engagement. Through drama they can take responsibilities. For example, through drama they may take a responsibility which takes them into other areas such as mechanical engineering, maths, etc.; that is the value. Therefore they learn in order to carry on their own responsibilities. Dramatic situations necessarily entail the use of maths. Teaching is effective if it comes through something. Drama is a medium, maybe the best medium".

Summary

Concerning the benefits and values of drama as a teaching method, teachers X, Y, and Z answered extensively by using several examples of their work in an attempt to illuminate the topic.

They all agreed that one of the main benefit a teacher gains by using drama is that he/she can manage to stimulate and motivate his/her students. Teacher X makes it clear, *"In drama you do not have to dress up, but you must create a personal involvement. A teacher acts out in order to stimulate students"*. Teacher Y claims that drama *"...focuses their (the children's) attention"*.

Another valuable gain, as teacher Z points out, is that *"Drama as a teaching method is part of an active pedagogy"*. Teacher Y agrees by claiming that *"drama involves children in active learning..."*. As teacher X explains, *"people learn best when they are involved in something, do something by themselves, feel that they contribute with something, create something..."*. Therefore drama by involving children in certain situations provides the benefit of making learning meaningful.

As teacher Y points out *"...in drama you can use materials from all over the curriculum, including mathematics"*. It depends on what roles the teacher has chosen, what the content is for his/her drama. Whenever the content is related to mathematics then you have a maths lesson. As teacher Z claims *"...teaching is effective when it comes through something"*.

Teacher Y emphasizes the value that comes through drama, *"of giving children confidence and certainty about their abilities"* and that *"... they have to co-operate, to value each other's ideas"*. Teacher Z says that *"drama involves pupils in discovering and finding out what they already know. ...through drama they can take responsibilities"*. Finally they all agree that through drama children find meaning as well as a belief in what they are doing.

6.1.6 Section VI: Limitations that teachers either face when attempting to use drama in mathematics teaching, or prevent them from using it.

The questions of this section can be found in the appendix no3. The data obtained from this section aim to fulfill the objective O5: To investigate the limitations that teachers face, when attempting to use drama in mathematics teaching or the obstacles that prevent them from using it. The teacher's answers are paraphrased.

Teacher A:

The main problem that this teacher identified is time; as he explains, the government has imposed more regulations and administrative work, and thus the time remaining for designing and organising the lesson is limited. Accommodation is another serious problem as there is not enough space, and thus some teachers do not have their own classroom and must move around. Cooperation with other teachers is an issue which he claim must be examined. Teacher's skills, willingness to get involved, as well as the National curriculum, the syllabus that must be got through, and preparation for exams, are some more limitations mentioned.

Teacher B:

"Time,

You must prepare pupils for exams,

Easier with younger pupils than with the old ones".

Teacher C:

As she explained the physical buildings is a problem, continuing that: *"Time is not enough. Cooperation with other departments is good in theory, not in practice. It needs an awful lot of organisation".*

In her opinion the conditions are much better in primary schools as you have a teacher for the whole day; the secondary schools' philosophy is fragmented.

Teacher E:

He argues that pupil characteristics (e.g. age, sex, intellectual ability) do not pose problems on the type of pupils, even though you may do more with low ability groups. High ability pupils want to practice themselves on exams and do not want to waste time in fun. In his opinion attitude is the main limitation. If the teacher does not believe in the benefits and values of drama, it is never done. *"If there is a belief, then time and resources become problems to be solved"*. Inspiration is the second most important, it is helpful to have somebody to work with you; cooperation or team-teaching is very important. He argues that, *"It supports the exchanging of ideas and mutual encouragement"*.

Teacher X:

The fact that *"Teachers do not have skills"* and time to plan the project is a serious problem, she explained. She emphasized that teachers must believe in cross-curricular work. They must find the idea exciting enough to try - but it is totally dependent upon every individual's personality. She also added that the efficiency of using drama depends on the pupils past experience. Usually children have a clear idea about what a teacher is and what he/she is supposed to do.

from their background and experience.

Concluding, she said that younger children are more open and fresh, therefore better to work with. Older children find it difficult because they are not used to it. Sometimes they are not shy, not confident, unsociable etc; drama can help to overcome all these restraints.

Teacher Y:

Teacher Y argues that the use of drama depends on students' experiences, how comfortable they are when working in groups, discussing etc. Usually they get confused if the teacher comes in suddenly with different methods. In drama they have to "play a role" which does not happen in other lessons.

She mentions that drama is a very strange subject for many teachers as well; sometimes the teacher has to be by himself/herself in a role, and this is frightening for many teachers as they feel they are losing control. It is very possible to lose control. Sometimes this is successful, sometimes not depending on the class; this is a risk taking. However it must be planned according to the class and pupils personalities.

She claims that *"Drama lessons should be provided in every programme for teacher training. Education needs to stop being compartmentalised. It has no benefit for teaching and learning; outside, in the real world things are not like that. Obviously the school should teach people to exist in society"*.

"Of course there is not enough time or resources; this is largely dependent on personalities though it depends on how much one wants or believes on the development of new ideas and if they recognize a need

to develop those ideas".

Teacher Z:

"Dramatic methods need time, team work and commitment".

Summary

Of the limitations that teachers face attempting to use drama as a teaching method, time has been revealed to be one of the most serious. Teachers have found that there is not much time for them either to organize and plan a new teaching method or to employ it in the classroom because there is the pressure of exams and the syllabus, which has to be completed in a certain time.

As the teacher A claims, teachers have to do more administrative work, and this does not leave enough time for organizing and designing the lesson. At the same time, the fact that teachers have to follow the National Curriculum and to prepare children for exams, is another essential reason for the limited time of the teacher. The teacher C, says that drama as a method of teaching probably needs co-operation with other teachers *"...co-operation is not easy in practice"*.

Another problem is resources and accommodation. Classrooms usually seem uncomfortable for certain types of activities. Cooperation with other teachers has been pointed out as another important factor, by several teachers as they feel the necessity of getting inspiration and exchanging ideas with other teachers. The skills and the abilities that teachers have is also another drawback.

However, teachers E, X, Y, and Z emphasized that the most important limitation is the teacher's attitude. Teacher X, mentioned that teachers must

believe in cross-curricular work and also be inspired by the idea if they are to succeed in it. Teacher Z also stressed the importance of the teacher's personality and the strong belief in what he/she is doing, because the use of drama demands commitment.

Teacher E, agreeing that the teacher must believe in the benefits and values of drama, states that *"if there is a belief, then time, resources become problems to be solved"* and teacher Y points out that *"...there is always a lack of time and resources - but it largely depends on the teacher's personality... How much one wants or believes on the development of new ideas and if they recognize a need to develop those ideas"*.

Finally, the pupils' attitudes and past experiences from different teaching methods has been considered important as well. The teachers B and C both agree that using drama with younger children in primary school is better, and teacher C explained that a reason for this is that secondary school is fragmented into different departments, teachers are under pressure to work to exams, therefore the conditions are not suitable. In addition Teacher X says that younger children are "fresher", and they do not have prejudgements as to what and how they should be taught. She says that sometimes older children have a clear idea as to how a maths teacher should teach. Therefore, whenever a teacher comes out with some new ideas they are not at ease with this. Some children are very shy and unsociable as well. Teacher Y says that it depends on children's past experience, how much they are used to working in groups and discussion.

6.2 INTERVIEWS WITH THE PUPILS

6.2.0. Introduction

As it has already been explained, there are five groups which were interviewed. There were nineteen pupils altogether (9 boys and 10 girls). The interviews took place at the school W and although they were structured, the researcher found it necessary either to allow the pupils to be free to speak or to ask more questions in order to help them clarify what they wanted to say.

Generally, most of the pupils were shy at the beginning and appeared not to feel comfortable, mainly because they found it hard to answer the questions. It was difficult for the majority to express themselves or to speak extensively. They usually used short sentences. However, by promising them strict confidentiality and by explaining clearly the purposes of the research and where these interviews would help, a friendly environment arose and the pupils seemed to become more related and comfortable.

In the following, there is a presentation of what the pupils said in the interviews, grouped according to the questions they were asked. As it has been described in the methodology the pupil interviews include two sections of questions: Section I: Appreciation of mathematics and Section II: Difficulties in mathematics and reasons for those difficulties. At the end of each section a summary follows.

6.2.1. Section I: Appreciation of mathematics

The questions of this section can be found in the appendix no4. The data obtained from the pupil's answers under this section aim to fulfil the objective O1: To identify the importance of teaching and learning mathematics, as well as the appreciation of mathematics from the teachers' and pupils' point of view. The pupil's answers are presented mostly as direct quotes.

Group K:

"You need mathematics in work... Most of mathematics is numbers... Different than the real world... You do not use them outside; it depends on what job you are doing... But you need only the easy things, not hard things, such as Pythagoras theorem".

Consequently the pupils were asked to specify in what type of jobs may somebody use Pythagoras theorem. One said that Carpenters and Architects use it but most mathematics is mainly used in shops, sales, wages, banks. When they were asked if there is any connection between mathematics, music and art they were all negative.

Group L:

"Maths is something important because you need it day to day..."

"I do not think it is something important unless your job has to do with it..."

"I think you should only learn the basics".

Group M:

"Mathematics are important as you need them for qualifications, jobs; to figure out, to calculate..."

"Mainly used in banks"

Being asked on the connection between mathematics art and music the two girls answered *"You use portions as an artist... or fractions in music". "... you use your imagination in shapes"*.

Group N:

"Mathematics is boring at the moment... It is only work through textbooks".

A girl said: *"I like investigations, I like to think and work"*.

"You need maths when you get older; you get very far when you grow up".

"It is important because you get a very good job".

Group O:

"Mathematics is learning, knowledge..."

"If you need to be qualified you need to know it when you grow up... you do not need them now"

"It is needed especially for jobs... in school sometimes it is boring, sometimes good".

"You use them in all lessons and even in art. They are fun when you solve some problems... I think they are very useful".

Summary

The majority of the pupils who have been asked about what mathematics means to them, expressed their low appreciation of its nature. The most frequent answer was that learning mathematics is important because then you get a good job. It was interesting that some children emphasized that *"... you need mathematics when you grow up... you do not need them now"*. Some others said they think that mathematics is important, but they could not explain why. The common view that comes out of almost every group is that mathematics is numbers, you need in employment and especially in banks.

As it can be seen the majority find it boring at the moment. However there were only a few individual pupils, who said that they like to work in mathematics or that they see that *"mathematics is learning knowledge..."*.

6.2.2. Section II: Difficulties in understanding and learning mathematics. Reasons for those difficulties.

The questions addressed to the pupils in this section can be found in the appendix no4. The data obtained from this section aim to fulfil the objective O2: To identify the difficulties and the reasons which cause difficulties for many children when attempting to understand and apply mathematics. The pupils' answers are presented in quotation as they were originally recorded.

Group K:

"Maths is hard. Maybe because there is no connection with the real world".

"It would be easier if we had examples from real life..."

"The fault is both the method and me; I am not concentrating..."

"Sometimes the teacher is not clear... you need somebody to explain before he expects you to go on..."

Group L:

"There is no way to enjoy maths..."

"There is a gap. In the primary school I think I missed some things".

"We need to know the relation/connection with the real world".

"We do not understand what is the use of the things we do".

Group M:

"Algebra is harder, because you have to use your brain. In geometry you need your imagination".

"You need examples, simple explanations..."

"As long as you get the message over simply then it is O.K..."

"When you have only homework and work then you hate maths..."

Group N:

"They must make mathematics more exciting..."

"Pupils would enjoy taking part in activities..."

Group O:

"Some pupils have problems".

"The way of teaching maths? They use hard questions you do not understand..."

Summary

All the pupils appreciated that mathematics is a hard subject either for them or for their classmates.

Quite interestingly, all the groups of pupils agreed that they need examples from real life. Answers, such as *"...it would be easier if we had examples from the real life..."* or *"we need to know the relation and connection with the real world"* and *"you need examples, simple explanations"* show that most children do not really know what the meaning of what they have been taught is. The pupils have identified several other reasons beside the lack of "real life" connection. They confessed that there is usually a lack of communication between them and the teacher. For example, *"...you need somebody to explain before he expects you to go further"* or *"as long as you get the message over simply, then it is O.K."*. It is also a pity that the majority finds mathematics boring. Answers such as *"They must make mathematics more exciting..."* gives evidence of this fact.

6.3 CASE STUDIES

6.3.0. Introduction

This is the last section where the presentation of the three case studies CS1, CS2 and CS3, takes place. The researcher's purpose in the case studies, was to gather data for the objectives O4 and O5: To examine the benefits and values of drama as a teaching method for mathematics in the secondary school level. To investigate the limitations that teachers face, when attempting to use drama in mathematics teaching or the obstacles that prevent them from using it.

At the beginning, the description of each case study is presented where there is an explanation of what is the teacher's aim, concerning mathematics learning, as well as the relation of each case study to a mathematical area. Subsequently, the researcher's observation, the teacher's and the pupils' interview concerning the three case studies are presented.

6.3.1. Description of the case studies.

a. Case study CS1:

The lesson took place outside the classroom, in the school yard.

--"We need 7 bags on the ground, or 7 jackets, or 7 baskets..."

--"Yes sir!"

--"... and then we need three red frogs and three green frogs! It is difficult to find frogs in such a day! Oh dear... Let's be frogs!! How do you fancy the idea? Of course Liz would prefer to be the little princess ... but this is life. She can always be a pretty frog..."

The lesson started in this way, and then the teacher attempted to explain the rules of the game to the children. At the beginning, the seven jackets on the ground helped to indicate where the places for the frogs would be. As can be seen from the diagram there were three red frogs at one side and three green frogs at the other. According to the game, two groups of frogs had to change places, in the least possible movements. An additional rule was that a red (green) frog can jump either over one green (red) frog or at the adjacent empty place.

The type of drama to which this case study belongs is the simulation games type. According to Heathcote (1984), by using simulation games the teacher provides an opportunity for children to work with feeling and thoughts simultaneously. The rules which exist lead and control the playing, and at the same time there is an examination of all types of drama, including simulation games.

The aim of the teacher was to provide a chance for the children to

discover a numerical progression through active participation and cooperation with each other. The relation of the lesson to a certain mathematical area is looking at functions and a number-pattern, and finding out a mathematical formula for describing the quickest method.

The children were asked to divide themselves in groups of six "frogs", three red and three green. Some spare children took the role of an "observer" who should count the number of the movements of each group and observe if the rules were followed properly. After having completed some attempts with six frogs, they were asked to try with eight frogs, ten frogs etc. Finally, the teacher proceeded to the "mathematical" task, and he asked the children to find if there is any formula which could be applied for any number of frogs.

START



FINISH



b. Case study CS2:

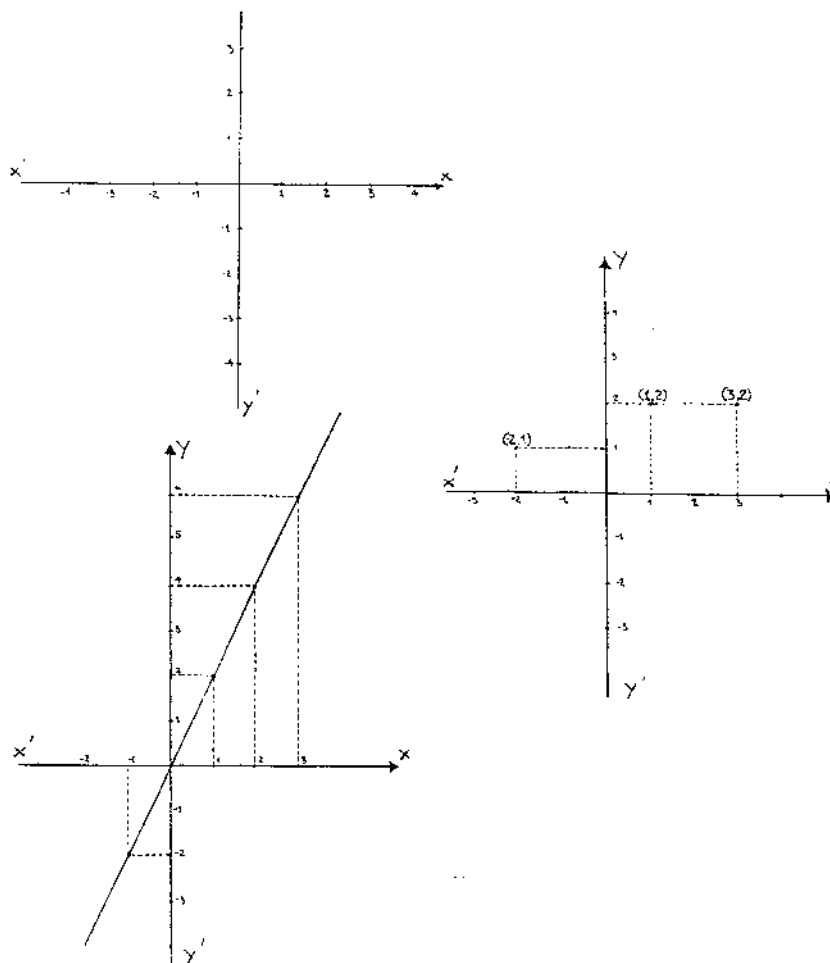
The lesson took place again in the schoolyard. The teacher brought three ropes along. Two of the ropes were to be used in representing the two axis XX' and YY' . At the beginning the teacher explained to the children that they were going to reproduce the two well known axes on the ground (the children had already learnt graphs in a previous lesson) by using the two ropes and that afterwards, they were going to choose a point to represent it. The points he proposed were the points on the two axis XX' and YY' and some other points such as $(3,2)$, $(-2,1)$ and $(1,2)$. The children acted as the points, and had to find their place on the system which the two axes were creating on the ground. They were told that they should help each other in their attempt to find their place. Subsequently, they were asked to find the plot of the equations $y=2x$, $y=2x+3$ and $y=2x-3$ and to represent it by using the third rope.

The form of drama to which this case study belongs is the representational or symbolic play. Heathcote (1984), claims that a teacher by using role-playing can teach facts (in this case study the properties of coordinates) and seek understanding. According to the explanation she provides of the analogy type drama in chapter III, this lesson could also stay in this type; as a new different way is provided for an already known topic. The children can see again the lesson that they had been taught but with a fresher look, in a parallel perspective.

The aim of the teacher was to improve the pupils' understanding of graphs and relations through their experience of being points and coordinates. The relation of the lesson was graph plotting and use of coordinates.

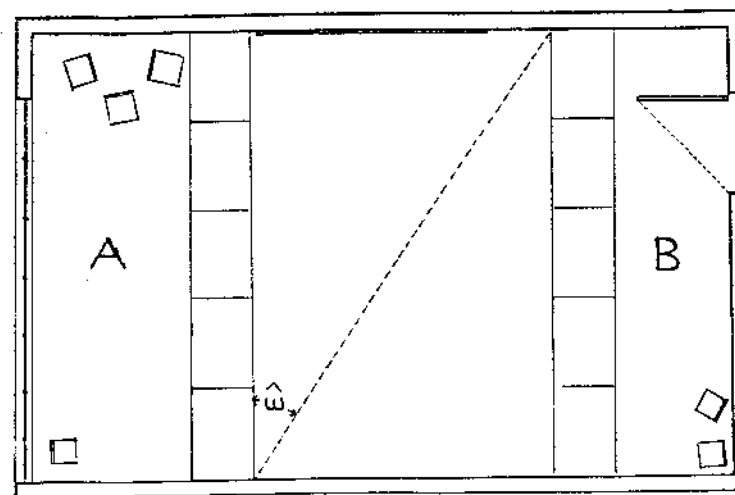
The children set up the two axes on the ground, making sure they were perpendicular (as they had been taught) and then started to arrange themselves on the two axes taking the role of the points. Some of them had to be

positive, others negative numbers. The number zero was especially attractive to many children.



c. Case study CS3:

The lesson took place in the classroom. The classroom had to be rearranged for the purpose of the lesson. As it can be seen from the diagram the desks were put in two rows in order to isolate the two areas A and B. The children were either in the area A or in the area B, and they were not allowed access to the other area.



The problem situation that the teacher posed to the children was to estimate the area of the classroom. That would be an easy problem if they could measure the two sides of the classroom. But the physical obstacles (desks) prevented them from this. Therefore they would have to employ another method. The teacher proposed they could use the fundamental principles of the trigonometry for this task, which they had been taught the previous day. He gave them some instruments such as tape-measures, meter ruler and protractor.

This case study could be described mostly as a practical activity. However, there is a strong dramatic element in it, which is the element of conflict. As previously explained the pupils were isolated in the two areas A and B, having to solve the problem while not being able to use the easy way they already knew. This conflict situation leads children to search ways to solve the problem, and as Bentley (1965) claims it is very powerful. At the same time this lesson could be characterised as the "mantle of the expert" type which has been described by Heathcote (1984) in Chapter III. As she explains, this type functions by having the class to work on a task as if they were experts. It demands the children to use factual knowledge and their skills in a problem solving situation. Heathcote emphasises, that because of the need of factual knowledge (information), this type of drama allows the teacher to use drama in different areas of the curriculum.

The teacher's aim was to provide them with an active experience of using trigonometry in a real problem solving situation, where the necessity of using it was obvious. The relation to a certain mathematical area is to the teaching of trigonometry, and particularly the application of $\sin x$, $\cos x$ and ratios.

A task that they had to do first was to learn how to estimate angles by using the protractor. As soon as they gained confidence in estimating angles, then they could apply their knowledge in estimating the angle w , as it can be

seen in the diagram. Consequently, by applying the basic rules of trigonometry on the rectangle triangle they could solve the problem.

The teacher, after having explained everything about the task, asked the children who were in the area A and in the area B to work as groups and to compare their findings at the end.

6.3.2 The teacher's interview

The interview with teacher E was preplanned (see Chapter V, p.81). The questions that were addressed to him were divided into two sections: a) children's behaviour and b) difficulties and problems that he faced, following the key concepts and variables of the case study plan. It was intended to gain data for the research objectives O4 and O5.

Concerning the children's behaviour the teacher claimed that the level of active participation, enthusiasm and motivation was very high in all case studies. He argued that all children were involved and they all seemed to communicate and cooperate with each other. However, he identified some children who seemed lost or confused, and as he explained that was probably because it was their first experience of such activities in mathematics.

When asked about the understanding and the intellectual expression of the pupils, the teacher said that approximately two thirds of the children could show immediately during the practicing of the case studies that they had comprehended the task. The teacher had also noticed a great difference when he continued the lesson in the classroom on following days. Children seemed to have gathered experiences which helped learning in later stages. According to his observations, the children who took part in the case study CS2 were more confident in using graphs and even those who had great difficulties could manage to figure out how to place coordinates and what was their meaning. He also argued that the experience the children had during the case study CS1 was valuable as the game demanded high 'mathematical' thinking; to be logical (organizing and structuring their thinking), to make predictions, and generalisations. Through the case study CS3, the children had a practical experience of using trigonometry and have an opportunity to appreciate the importance and use of mathematics. As he argued, trigonometry has been

considered as a very mystifying lesson by the majority of the children, therefore it was very good that they had a chance to see where trigonometry can be used in real life problems.

As far as the difficulties faced by the teacher were concerned, he said that the drama lessons were slightly more difficult than the ordinary ones mainly because these were his first attempts at using this method of teaching. He confessed that he knew from the beginning that he would have to have different expectations from the children and organise time and space differently. The fact that lesson duration was only 40 minutes was an other obstacle, as well as the availability of resources. The school did not provide everything, and the teacher had to ask in order to find the ropes for the case study CS2. For some activities the classroom might also be uncomfortable; either too small, or too big. As he explained, for him the children's attitude was not a problem as the pupils had a very positive behaviour. The plan and designing of the lesson was not a problem, although he would have preferred to cooperate with another teacher and have a chance to talk and exchange ideas.

6.3.3. The pupils' interview

The five groups of pupils were asked for the three case studies. The interview was unstructured. The researcher's aim was to have a free discussion with them. Through the pupils' interviews it was intended to obtain data concerning the O4 objective of the research.

Group K: (took part in case study CS3)

They said that they enjoyed taking part in the case study, as they found that they need examples of the use of mathematics in everyday life.

Group L: (took part in case study CS3)

One girl in this group claimed that she could not understand the purpose of the activity. The rest expressed their satisfaction. The girl was further asked about the reasons and she said that she does not like mathematics at all. *"...I dread maths... anyway, I will be a nurse when I leave school".*

Group M: (took part in CS2)

The group was totally satisfied by the case study they took part in. They particularly stated that the combination of drama followed by explanation from the teacher was very useful. However they noticed that some children did not really work.

Group N: (took part in CS1)

They also enjoyed the participation. They considered the refusal to think as the main reason for some children avoiding work.

Group O: (took part in CS1)

This group found that they needed more explanation at the beginning to avoid confusion.

The pupils said that not all of them really worked in the case studies. In general, the majority said they enjoyed those kind of activities and that they preferred them to ordinary lessons. They found the provision of examples very useful. The interesting point is that they felt that a combination of different styles would be better for them.

6.3.4. The researcher's observation

The researcher's observation was either participant or non-participant, depending on the circumstances. A plan was followed, which can be found in the Chapter V (p.81), where certain key concepts and variables were observed concerning two sections: a) the children's behaviour and b) the teachers difficulties. The intention was to gather data for the research objectives O4 and O5.

Concerning the children's behaviour, the majority of the children showed an active personal involvement, and also expressed a great enthusiasm during all the case studies. They all responded positively either in being "frogs", "observers", or "points", or in taking part in estimating the area of their classroom. However, there were some children who seemed lost or confused. For example, at the beginning of the case study CS2 it was obvious that some children had not understood what they were supposed to do and the teacher had to explain this again. The confusion may have been a result of their lack of understanding of the concept of coordinates. However, they started to discuss with each other, trying to find out how they could manage to solve the problems. Soon, after discussion and cooperation, the children who had the points (3,0) and (0,2) came happily to the conclusion that the coordinate (3,2) was on the vertex of the parallelogram which joined them. The child-point (3,0) called to the point (3,2) "You come to me!!..". And in that particular instance, it seemed that there was evidence that this child managed to understand what a coordinate means.

In CS1 they all participated, either taking the role of the "frog" or of the "observer". The children very quickly took up their roles. Those who were frogs, jumped as frogs and some of them also imitated frog's voices. However, very soon they got very engaged in the task, which was to find the

quickest method for the frogs to change places. Dienes (1968) has also underlined that children behave in the beginning like playing, but gradually awareness increases. Evidence is also found in the other case studies, where children were initially involved in playing or in exploring the properties of certain instruments - like how to use the protractor in the classroom - but very soon they were found to be engaged in the mathematical task.

Not all the children could manage to find the quickest way at the first attempts; some groups were better than others. The ones that could not manage it immediately had the chance to repeat it as many times as they wanted. It was interesting to observe how much they were asking for repetition when they wanted to "see" it better. The fact that they were in an active situation and confronted with other classmates, made it much easier for them to continue trying. Children were able to evaluate themselves, and as Heathcote (1984) explained they could test their "present capacities". Teacher Y, also claimed in the interview that children can evaluate each other ideas and learn to judge themselves.

Understanding and intellectual expression was obvious by the majority. The "observers" along with the "frogs" tried to write down the formula they found so that they could explain it to the other groups. They run to find papers and they tried to write down all the actions step by step. As soon as they saw the pattern they made, they were able to make generalisations, to find for example how many movements needed for 8 frogs, for 10 etc. The observations corresponded well with Heathcote (1984) descriptions (see Chapter III) that children have the chance of expressing their thinking. In all case studies lessons, the drama activity provided the means and motivation for the children to get involved in the mathematical exercises.

The feature of communication and cooperation was found again in every case study. In the case study CS1, the "frogs" of the same group had to find a

clear code of communication and cooperation in order to achieve the purpose of the game. This was obvious through their discussion. Children who had found the formula earlier, were explaining it to the rest of the group, children who had doubts were asking them to repeat their explanation. In the case study CS3 co-operation amongst the children of each group was necessary, and it occurred spontaneously. It is interesting to mention that everybody wanted to have a go in using the protractor to estimate the angle.

Finally, in the case study CS2, the children were very involved in discussion of the many aspects of the problem. For example, they were confronted with the fact that they should keep an equal distance from each other. Thus, after some discussion, they agreed to keep a distance of one meter between each point. After managing to be "proper points" on the axis, they had to find the location of the co-ordinates. Communication and co-operation as benefits and values of drama as a teaching method for mathematics, had also been identified through the teachers' interviews. Heathcote (1984) has emphasized the fact that "...drama makes people find precision in communication" (p.207), as they are interacting with each other.

Concerning the limitations that the teacher faced, it seemed that they were different with different activities. For the case study CS1 the time was adequate. Resources were not needed, apart from the setting up of the 'drama situation'. The teacher had to spend some time at the beginning to explain the rules and make sure that everybody had understood. Then the children had to be organised into groups and start.

The designing and planning was not something which was difficult in any of the case studies. The difference in CS3 was that the application was in a classroom and the teacher had to make the children believe that they must try.

With the case study CS2, resources were a problem. The teacher faced some difficulties in finding the ropes because they were not available from the school. At the same time, there was not enough time to plan every detail. Things had to happen very quickly in approximately 40 minutes. The end-of-lesson bell rang when they had managed to sort out the first equation $y=2x$. They wanted to continue with the next equation, but everybody had to go for the next lesson.

6.4. CONCLUSION

Though this chapter the findings, obtained from all the stages of the main part of the research, were presented. The findings were directly related to the objectives of the research. Here the main findings are summarised.

For the objective O1: "To identify the importance of teaching and learning mathematics, as well as the appreciation of mathematics from the teachers' and pupils' point of view", data was gathered from both teachers and pupils.

All the teachers expressed their appreciation of the subject of mathematics and the importance of it being taught in schools. They pointed out some of its essential features, such as that mathematics is a high level intellectual activity, a way of thinking and reasoning and that it improves problem solving abilities. Some of the teachers also claimed that mathematics is also related to discovery, exploration and control of the world's properties. Finally, all teachers agree that different appreciations of mathematics are possessed by teachers, pupils and society. They argued that the majority of pupils and their parents regarded mathematics only as a way of finding a good job and getting better qualifications.

The data obtained from the pupils, concerning their appreciation of mathematics, reinforced the data obtained from the teachers. When they were asked for their perception of the importance of mathematics, the vast majority responded that mathematics is only needed to obtain good jobs. They emphasised that they thought they did not really need mathematics in everyday life. Although they said that mathematics was important, they did not know why.

For the objective O2: "To identify the difficulties and the reasons which cause difficulties for many children when attempting to understand and apply mathematics", data was again gathered from both teachers and pupils.

Firstly, they all agreed that most children face serious difficulties in learning mathematics, and they also have negative attitudes about the subject. They underlined that most children still in secondary school are not able to think in an abstract way, and are unable to use the mathematical language and symbolism, demanded by mathematics teaching. Therefore, they find mathematics meaningless. Some of the teachers emphasised that usually the mathematics learning environment is inappropriate, lacking motivation and concrete real examples. Finally, all the teachers claimed that the pressure of preparing children for exams prevent them from providing a better learning environment and also an enjoyment of mathematics to children.

The data obtained from the pupils about their perception of the difficulties they face in mathematics and the reasons for those difficulties, reinforced the data obtained from the teachers. All the pupils agreed that mathematics is a hard subject either for them or for their classmates. Quite interestingly, most of them identified as a reason for their difficulties the lack of real life examples, which they felt could make mathematics meaningful. They also pointed out reasons, such as lack of communication, and the fact that mathematics is boring. Therefore, they needed to have a motivation and an interest in their mathematical activities.

For the objective O3: "To examine the teachers' attitudes and opinions towards two different methods of teaching mathematics; the investigation and the exposition by the teacher", data was gathered from the first sample of teachers.

Firstly, all the teachers agreed that the use of investigations was

valuable and developed the children's problem solving abilities. At the same time, they also agreed on the need for exposition by the teacher. The interesting point here is that they differ in the degree to which they use investigation and exposition in their teaching and on the emphasis they give to each method. Given evidence from the data collected in section 1, where information was sought about each teacher's teaching style, it seems that although teachers find the combination of styles very important, the expositional way of teaching remains the most frequent, or sometimes the only method used. Among the reasons identified in different sections of the questions are, the pressure of exams, and particularly the pressure of the National Curriculum. They also claimed that other teaching methods (investigation, drama) need more time which is not available in secondary school, as teachers have either to prepare children for exams or to complete the predefined syllabus.

For the objective O4: "To examine the benefits and values of drama as a teaching method for mathematics in the secondary school level", data were gathered mainly from the second sample of the teachers and from the case studies.

All the teachers answered the questions from their experiences of using drama in teaching mathematics, or other subjects, at the secondary school level. Summarising, the benefits and values they identified were the provision of motivation and stimulation in order for a children to find an interest in the mathematical activity, the encouragement of active participation, co-operation and communication in the learning of mathematics and the connection and relation to real life examples and concrete experience, mainly through the study framework and symbolism.

Through the case studies, data were obtained from the researcher's

observation, from the teacher and from the pupils. Concerning the provision of motivation and stimulation as well as the encouragement of active participation, co-operation and communication, both the teacher and the researcher agreed that it was very high in all case studies. In terms of children's intellectual expression and understanding of the mathematics being taught at the case studies lessons, the researcher observed that many children seemed to be involved either from the beginning, or soon after they had spent some time playing or exploring. The teacher said that approximately two thirds of the children could immediately show their understanding, but the striking point for him was that this increased dramatically when he subsequently continued the lesson in the classroom. However there was a very small number of children, identified by both the teacher and the researcher, who seemed confused, especially at the beginning of the lesson.

At the same time, the pupils claimed that they found the provision of real life examples very useful, and the majority expressed their preference for this method. They also stated that in some instances they could not understand immediately, and that not all of their fellow-classmates worked.

For the objective O5: "To investigate the limitations that teachers face when attempting to use drama in mathematics teaching, or the obstacles that prevent them from using it", data was gathered from the teachers and from the case studies.

The limitations and obstacles that teachers pointed out were time, accommodation and resources, teachers' skills and abilities, teachers' attitudes and personality, co-operation among teachers and departments, and finally children's past experience and attitudes. The first sample of the teachers placed more emphasis on reasons such as time, accommodation and resources as well as the children's past experiences and attitudes, and the

second sample on the teacher's attitudes and personality.

Through the case studies, data were obtained from the researcher's observations and from the teacher. Gradually, the limitations that the teacher faced were considerably less than the ones identified in the teacher's interviews. Time for planning and organisation, which was stressed as a serious obstacle largely by the first sample of teachers, was not a problem. The teacher pointed out that the duration of the lesson (only 40 minutes) was not enough. Although resources were a difficulty (the teacher could not easily find the ropes for CS2 and the classroom in CS3 was small), it was not the biggest problem. Also, the teacher did not have any specific skills and abilities in drama, even though he managed to organise the lessons. Finally, according to the teacher, the most important factor is the co-operation and interaction between teachers, and the exchanging of ideas.

In the following chapter, there is a discussion of the findings related to each objective, with an attempt to compare and analyse them, and provide a conclusion concerning the potential role of drama as a teaching method in secondary school mathematics.

CHAPTER VII

DISCUSSION – CONCLUSION

In this chapter, the findings from the main research and the literature study, concerning the objectives of the research are discussed, attempting to answer the hypothesis under investigation:

"There is a potentiality of using drama as a method of teaching mathematics in present classroom conditions of secondary schools."

And the aims of the present research are:

- 1: "To identify the benefits and the values of drama as a teaching method of the mathematics teaching in the present classroom conditions of secondary schools."
- 2: "To point out the limitations that teachers either face when attempting to employ drama as a teaching method or which prevent them from using it."

The above aims were examined, through the investigation of the objectives O1, O2, O3, O4, and O5, which were formulated by the assistance of the pilot study. The findings concerning all the objectives were presented at the previous chapter (VI). They were obtained from different sources and by using different instruments, in order to strengthen the validity and the reliability of the study and reduce the biases. Although the sample of the research is not sufficiently large in order to permit extensive generalizations, it is possible to compare the findings obtained from the different sources and thus consider the research question. Therefore, in this chapter a discussion concerning the findings from the research and from the literature survey takes place, with an attempt to compare and to approach them critically.

Concerning the first aim, the benefits and the values of drama as a method of teaching mathematics in secondary school, which are identified from both the main research and the literature survey, are: the provision of

motivation and stimulation, the encouragement of active participation, co-operation and communication among pupils, and the connection and relation to real life examples and concrete experiences.

All the teachers of the second sample, X, Y and Z pointed out, that the use of drama supplies motivation and simulates the interest of the children. Characteristically, the teacher Z claims that *"Dramatic situations necessarily entail the use of maths"*, and teacher Y suggesting that drama *"... focuses their (children) attention"*. Through observation in the case studies, the children's motivation and the high expression of their interest to be involved in the task was identified, which seemed to support the claims.

At the same time, the children's demotivation is a reason for constraints in learning mathematics, pointed out by both teachers and pupils during the interviews. For example, teacher A said *"... pupils are very little, almost zero, motivated to tackle every hard task"*; a group of pupils advocated that *"they need to make mathematics more exciting.."*, as another group said *"...mathematics is boring at the moment"*. However, the provision of interest in teaching and learning is one of the main purposes of schooling and education in general. It seems from the above, that the use of drama has many possibilities to supply motivation and increase interest in mathematics teaching.

The findings from the research agree with the findings from the literature survey. For example Dienes (1968), providing evidence deriving from his experimental case studies, claims that the use of representational play, which is one type of drama, is very valuable for the teaching of mathematics, as the motivation which comes as a result of the play can be guided by the teacher towards mathematical ends.

Therefore, the supply of motivation and initial stimulus is one of the benefits and values that drama provides as a method of teaching mathematics.

Drama in teaching mathematics, as was revealed from the present research, encourages also the active participation, co-operation and communication. Several teachers gave evidence for the above. For example, the teacher Y claimed that *"...(children in drama) have to cooperate with each other and to value each other's ideas"* and as teacher Z explained *"...children in drama are collaborators"*.

The researcher's and the teacher E's observation through all the case studies, identified that the active participation, the co-operation and the communication among the pupils were very high, when drama was used. The pupils not only had to talk and discuss certain instances, but they also had to reach an agreement. It was interesting to notice that all the pupils wanted to express their opinion and they asked questions very freely. In the case study CS1, as "frogs" and "observers" managed to communicate and understand each other's way of thinking and reasoning in order to achieve the purpose of the game. In the case study CS2, the co-operation and communication between them was obvious. Discussions were arising among them when attempting to find their places as points, and later on when they tried to find the graph of the equations they were given. Finally, in the case study CS3, the pupils had to share between them certain sub-tasks of the problem they had to solve. That meant again co-operation, responsibility and trust for each other.

In the literature survey, Bruner (1972) claims that sociodramatic play reinforces peer group interaction, Heathcote (1984), Way (1967) as well as Bousquet (1986) advocate the vital role of drama in the children's intellectual and physical development by the reinforcement of their confidence and certainty.

The learning of mathematics is being facilitated, through such a situation; as teacher X argues *"...people learn best when they are involved in something, do something by themselves, feel that they contribute with*

something, create something. Participation is terribly important". Another important feature is that in such a situation children are able to test their own abilities and also do that by themselves, without having to feel the failure of an exam. Teacher Y emphasized that children learn also to value each other's ideas and *"...gradually trust themselves and their own abilities"*. Therefore, the provision of confidence and certainty comes naturally.

Amongst the purposes of schooling and education is to provide such learning situations to all children, that they would be able to develop confidence and certainty of their abilities and skills, and eventually being able to enjoy and get involved in learning.

However, among the reasons for the children's difficulties in mathematics learning the teachers identified the lack of confidence and certainty, as well as the difficulties which some children have to express themselves in a mathematics situation.

At the same time, from both the research and the literature survey, evidence is provided that by giving an activity in which all children have equal chances to contribute, the activity becomes certain and more personal. As seen, when children in the representational plays of both the case studies CS1 and CS2 were "frogs", "observers" or "points", they reacted with a serious responsibility for the roles they represented, they participated in the mathematical task more actively, and as the teacher E identified, their confidence and certainty was reinforced as it could be seen from later lessons. Therefore, drama reinforces and increases the children's abilities in group work (co-operation and communication), and their active participation in a mathematics lesson.

Drama also, provides real life examples through "the story-framework"

which assists the children to make meaningful links with the subjects they are taught. The above is pointed out by several teachers and pupils. Teacher Y, with her example concerning teaching statistics in mathematics through the use of drama, claimed that in this way statistics becomes meaningful to children. At the same time, teacher Z explained that *"teaching is effective when it comes through something. Drama is a medium, maybe the best medium"*.

Through the case study CS3 evidence is also given for the above. The children had the opportunity to experience, through the lesson, one application of trigonometry. Trigonometry, as the teacher said, is usually considered difficult and children do not understand in what real life example it could be applicable.

At the same time, the necessity to provide connections and relations with real life situations or with concrete examples, is recognised through the interviews by several teachers and pupils.

It is interesting to mention that all the teachers pointed out that a reason, which causes difficulties to children in mathematics learning, is that mathematics demands thinking in an abstract way. All the teachers admitted that most children find it very difficult to think abstractively. For example, the teacher A said: *"Some children never get in the abstract ..."* and the teacher X claimed that although, *"... some seem that they work in an abstract way, but most of them work following someone else's rules..."*

The pupils also claimed that they need real examples. They argued that they need to know what is the connection with the "real". The fact that children in secondary school still find it difficult to think in an abstract way is also emphasized. From the literature review, in the Chapter IV, Potari and Searl (1989) pointed out the need for provision of practical work in the secondary school level. They also emphasized that even at this age, the

majority of children still find it difficult to think in an abstract way and to follow mathematical ways of thinking and reasoning.

From the above findings, it seems that drama, by the provision of real life examples and concrete experiences, assists those children who have not yet developed the ability to think in an abstract way. Therefore, drama could be a valuable medium for mathematics teaching and learning, which facilitates meaningful and logical understanding, and provides relation and connection between the concrete and the abstract.

Consequently, as far as the second aim of this study is concerned, the limitations that the teachers face attempting to use drama for mathematics teaching in secondary school, or the obstacles which prevent them from using it, were investigated through interviews with teachers and case studies. The problems and obstacles that teachers pointed out were time, resources, teachers' skills and abilities, teachers' attitudes and personality, co-operation among teachers and departments and finally children's past experience and attitudes.

Time was identified by all the teachers as a serious problem. Teacher A explained that *"Government imposed more regularities and administrative work and eventually time remaining for designing and organising the lesson is limited"*. The teacher B and C found that there is not much time because pupils must be prepared for exams. However, in the case studies, the teacher E did not find that the time needed for planning and organising is a problem, even though he noticed that the lesson duration, which is 40 minutes, is usually not enough for the dramatic method.

Teachers' skills and abilities is another obstacle. Usually teachers do not feel that they have the proper skills to employ drama. As teacher Y claimed through her experience, *"... sometimes the teacher has to be by himself in a role, and this is frightening for many teachers, as they feel they*

are losing control...".

Co-operation between teachers or between different subject departments in school, is another issue emphasized by many teachers. Usually co-operation is missing; teacher E in the case studies, underlined the importance of exchanging ideas from personal experience.

The teachers' attitudes and personality is the most serious limitation according to the teachers X, Y, Z and E, who all have experience in using drama for mathematics teaching. What they identified as very important, was the extent to which teachers believe and perceive that there is a need for his/her teaching to use dramatic methods. Teacher E pointed out *"...if there is a belief, then time and resources becomes problems to be solved"*, and teacher Y emphasized that there is always a lack of time and resources in the school reality, thus *"...it is largely depending on personalities"*.

Finally, the pupils' past experiences and attitudes is another restraint. When pupils have a pre-concept of the way in which maths teachers should teach, they usually find new methods difficult to adapt to. This is why teachers suggested that it is better to use drama with younger children in primary school.

Therefore, examining the limitations that teachers face, both samples of teachers pointed out several problems, which they have either experienced, (second sample and teacher E), or think that they might (first sample). Based on the findings, it could be suggested that, although drama as a teaching method demands several obligations from the teachers' point, the main limitation is possibly the teachers' attitudes and personality.

Concluding, as far as the aims of the present research are concerned, the following were found:

1: The benefits and the values, that drama as a teaching method of mathematics has in present classroom conditions of secondary school, were

identified as:

- * provision of motivation and stimulation, so that children can find an interest in the mathematical activity,
- * encouragement of the active participation, communication and cooperation between the children in mathematics teaching,
- * connection and relation to real life examples and concrete experiences, mainly due to the content and the symbolism.

2: The limitations that teachers face when attempting to use drama in mathematics teaching or prevent them from it, are pointed out such as:

- * time,
- * resources,
- * teachers' skills and abilities,
- * children's past experiences and attitudes,
- * teachers' attitudes and personality,
- * cooperation amongst teachers and departments.

Therefore, the hypothesis under investigation seems to have some resolution. There seems to be a potentiality (benefits / limitations) of using drama in teaching mathematics in present classroom conditions of secondary school.

The present study had a number of limitations. First, there was not much relevant literature, or previous published research available concerning the topic under investigation. At the same time, as the topic is novel, not many teachers were informed about the recent development of drama as a teaching method. Therefore, there was a need for a brief and clear introduction and supply of further information. The number of teachers of the second sample,

which could provide data from their experience was limited and difficult to reach. Secondly, the time available for the planning, organising and completing the research limited the scope of the research. Furthermore, the timing added complication, for teachers and pupils during the end of the year are always busy in several activities on in exams preparation. Therefore, the researcher had to interview the teachers and pupils during their breaks and under rush conditions. Finally, the employment of the case studies, as explained in Chapter V, was considered as a complimentary part of the research. The fact that the researcher did not have a rich experience of the children's previous behaviour was another limitation of the present study, as well as, the fact that there was not enough time to continue the case studies with the same class for more than one lesson.

Next, further findings and considerations from the present research are presented. Due to the above benefits and values that drama has in teaching mathematics, the result seems to be that it provides a learning environment full of experiences for the secondary school pupil, and also assists the enhancement of pupil's appreciation for mathematics.

The lack of the appropriate learning environment has been admitted by several teachers and pupils in the research. Teachers and pupils advocated the need for a combination of styles and that the teacher must be flexible. In the literature review, both the Cockcroft Committee (1982) and Dienes (1968) have emphasized that mathematics teaching should combine different methods. They also stressed the fact that the use of active learning environment is missing. As it has already been seen drama provides the active environment.

The lack of high appreciation for mathematics, by the pupils, is found in the teacher's and pupil's interviews. It is revealed that pupils regard mathematics mainly as a way to gain better qualifications or to find a "good

job". This happens because of the parental and societal pressure, they feel that mathematics is an important subject and they must manage to get good marks at the exams. Teacher E claimed that pupils are not taught to appreciate mathematics, "*they are taught to pass exams*", and at the same time teachers A and C admitted that they give a priority in preparing their pupils to succeed in the exams. Characteristically, teacher C argued that "*... when you test, you do not teach*". This is a pity, as education then appears to be only interested in exams preparation and that school is an exams oriented institution. On the other hand, children leave school with negative feelings towards mathematics as the Cockcroft Committee (1982) pointed out.

Concluding, as far as the aims of the present research were concerned, it was found that : drama as a teaching method for mathematics in secondary school level, can improve the pupils' learning environment and their appreciation of the subject. This can be achieved by the provision of motivation, the encouragement of group work, and the connection and relation to real life examples and concrete experiences. At the same time there are many limitations that a teacher will possibly face when attempting to use drama in his/her teaching, such as time, resources, teachers' skills and abilities and pupils' past experiences. However, the most essential limitations, which at the same time make teachers more hesitant in employing new methods, are probably their attitude and personality, and the lack of cooperation and interaction between them.

The findings of the present research provided an important evidence for future research on the initially proposed hypothesis and a valuable basis for examining it.

As mentioned in Chapter I, the initially proposed hypothesis was:

"The use of drama as a teaching method facilitates and improves the

comprehension and appreciation of mathematics in the present classroom conditions of secondary school level."

As explained in Chapter I, the present research had a very limited scope, whereas the initially proposed hypothesis concerned a quite complex topic. Therefore, the circumstances prevented the researcher from examining it. Future research in the value of drama as a teaching method for mathematics, could be conducted employing a comparative study, or using extensive and continuous observation in case studies. The findings of the present research can be used as variables or indicators in assisting the methodology of future research.

Epilogue

The value of the present study is not only that it provides insight into another method of teaching mathematics. Many other questions concerning the field of education and teaching also arise. Issues such as: the usage of the National Curriculum, the exams pressure imposed on both teachers and pupils, the teachers' own training and the need for cooperation amongst teachers. These issues seem to maintain a crucial role in the every-day life of school management as well as the life of both teachers and pupils within the school itself.

Throughout this study, the main reason which prevents teachers from attempting other methods beside exposition, identified by the majority of teachers, is the pressure of both the National Curriculum and the exams preparation. Concerning the pressure of the National Curriculum, they claimed that the fact that they have to teach a certain syllabus in a certain period decreases the flexibility in planning and organising the lesson. However, the interesting point is that the National Curriculum for Mathematics (1989), advocates the use of activities and various teaching methods. As mentioned in para 5.3, *"The order of activities should be flexible... mathematical concepts form a network through which there are many different paths. Different pupils will need to take different paths through the network, and approach learning from a variety of perspectives"*.

The contradiction here is that, while the National Curriculum statement seems to encourage the flexible use of teaching methods in mathematics, and also advocates the use of various activities; the teachers claim that the imposition of the National Curriculum restrains the flexibility of their teaching. This is an issue which demands further investigation.

Consequently, the pressure that both teachers and pupils feel because

of exams preparation in secondary school, is another issue that also needs examination. Exams means much more to pupils than merely an evaluation of their capacities. The success in exams is the "ticket" for entering higher education, and for a good career life. At the same time they feel a great parental and societal pressure to succeed in it. All teachers in the present research pointed out that they feel responsible towards pupils and their parents, and that they want to provide pupils an adequate preparation in order to succeed in exams. That of course, means that their lesson is automatically organised according to this claim. Therefore, the main interest in teaching, as many teachers argued, is testing. However, although the success is not the only purpose of schooling and education, it seems that eventually most teachers and schools are mostly concerned about it. Finally, the time and energy remaining for other activities is very limited.

Furthermore, through the present research, many teachers pointed out their lack of skills and abilities, as well as the lack of cooperation between them, as essential reasons. A conjecture could be, that teachers are not sufficiently enough equipped with all the skills that are usually needed for an integrated teaching schedule, that includes various teaching methods. Teachers usually impose much of their personality onto the lesson, and usually their attitudes, beliefs or even habits can prove obstacles. At the same time teachers in secondary schools seem to work mostly in isolation. The need of cooperation and exchanging of ideas were pointed out as essential parametres by most of the teachers in the present research. Teachers need to discuss their ideas and difficulties, to get inspiration in planning and organising their work. Therefore, it appears that issues such as the provision of sufficient training, and chances for more cooperation and interaction between the teachers need to be tackled.

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APPENDIX No1:

The definitions of drama:

1. Brian Way, 1967, "Development through drama".

He distinguishes between theatre and drama. *"Theatre is largely concerned with the communication between actors and an audience. Drama is largely concerned with experience by the participants, irrespective of any function of communication"* (p.3). He describes drama as a participatory activity and emphasizes individual experience. Drama has no particular connection to presentation or performance. Much of that experience will consist of improvisation which stimulates the imagination and encourages its expression in physical and vocal terms.

2. David Morton, 1984, "Drama for capability".

He claims that drama process is in itself a "model" of the process towards capability, and that *"... Capability is to do with those skills, attitudes and values that include the capacity to appreciate, to make judgements, to think and to feel rationally... Capability has to do with the art and the business of living. It is about the foundation and the solution of problems, with doing, making, designing and organizing with productive, constructive and creative activities of all kinds."*(p.1).

3. Brian Watkins, 1983, "Drama as game".

"The game framework is a model of behaviour of man under problematic situations of a similar nature... Drama might be defined as an imitation of people's interaction. It deals with relationships under stress, a problem that requires resolution or alleviation and the need for decisions that will affect others for better or worse..."(p.36).

5. The International Encyclopedia of Education, 1985.

Dorothy Heathcote: *"Educational drama is anything which involves persons in active role-taking situations... in which attitudes, not characters are the chief concern live at life rate (discovering at this moment not memory based) and obeying the natural laws of the medium."*(p.1453).

APPENDIX No2:

Questions for the pilot study's discussion:

a. How do pupils, teachers and society appreciate mathematics?

1. What is mathematics for pupils?
2. What do math teachers mean when they talk about mathematics and what do others understand?

b. What are the teacher's attitudes towards using drama as a teaching method in mathematics.

1. How do you feel about the idea?
2. Do you find it as impossible to apply drama in the common secondary school teaching circumstances, because of various difficulties?

c. What difficulties or problems do teachers identify:

1. Which could be the most important obstacles for you
 - a. lack of resources?
 - b. lack of time?
 - c. lack of inspiration?
 - d. difficulty in control?
 - e. leisure activities- nothing to do with learning!!

or very little?

or very limited?

2. How can you be sure that everybody has received the mathematical message of the dramatic activity?
3. How can you be sure that mathematical concepts have been understood when teaching through drama?
4. How can you distinguish the frontiers of leisure and activity?

APPENDIX No3

INTERVIEW WITH THE TEACHERS

SECTION I: Introduction.

Could you please, describe an ordinary lesson of yours?

- * teaching methods you use
- * general aims and purposes of your lesson
- * materials and resources you usually use

SECTION II: Appreciation of mathematics by the teachers' point of view.

1. How does a maths teacher view mathematics and mathematics teaching?
2. Are there many different appreciations of mathematics amongst maths teachers?
3. What is the meaning of mathematics for pupils and their parents?

SECTION III: Reasons which cause difficulties to children in mathematics learning.

1. Some teachers view mathematical thinking as abstract ideas which can be expressed in a written way using the appropriate symbolism. Do you agree with this view, or do you believe that pupils require practical experience in order to appreciate mathematics?

2. Do you think, from your personal experience, that maths teaching takes pupils beyond a concrete stage of development and into abstraction before they are ready for it?
3. Do you think that pupils achieve a satisfactory competence and appreciation of mathematics at secondary school?
4. How do you explain the difficulties many students face to adopt mathematics language and symbolism, the hostility towards mathematics and the failure in exams.

SECTION IV: Approaches to different methods of teaching mathematics.

In recent years there have been major changes in the way mathematics is taught and assessed in this country. Arising largely from the findings of the Cockcroft Committee's report (1982), a large amount of investigational work concerning maths teaching is now carried out involving pupils and teachers.

1. Do you favour the use of investigational work in maths teaching?
2. Do you think there is a need for demonstrative work (exposition by the teacher)?
3. Is it possible to combine the two approaches?
4. What are your thoughts concerning the idea of using drama in maths teaching?

SECTION V: Benefits and values of drama as a teaching method of mathematics in the secondary school level.

1. Do you think that drama can create a more powerful and active environment for the teaching of mathematics?
2. What benefits and values do you identify in using drama for mathematics teaching?
3. What sort of dramatic activities do you think are appropriate for maths teaching and learning.
4. Could you suggest topics where dramatic methods are appropriate and justified?
5. Are there any limits regarding the type of pupil (eg age, intellectual ability, culture etc.) for whom dramatic methods are suitable?

SECTION VI: Limitations that teachers face when attempting to use drama in teaching mathematics.

1. If you have worked with drama in your maths lessons,
 - a. Please describe what you did, the topic and type of pupil involved.
 - b. How did you manage the time, the resources?
 - c. How did you arrange this within the curriculum, syllabus?
 - d. How did you design your lesson, where did your ideas come from?
 - e. Please point out any difficulties or obstacles which you encountered.

- f. What changes would you make if you were to try this again?
 - g. What benefits did you experience from this approach?
 - h. How did the pupils respond?
2. If you have not used drama in your maths lessons, what limitations prevented you from doing so?
 - a. lack of time
 - b. lack of resources
 - c. lack of inspiration
 - d. lack of skills and abilities
 - e. children's attitudes
 - d. other
3. Do you think that training or supply of information about dramatic activities in teaching mathematics is necessary? It seems that more and more people are interested and are practising with it. Are you informed about other people's work?

QUESTIONS FOR THE PUPILS

SECTION I: Appreciation of mathematics

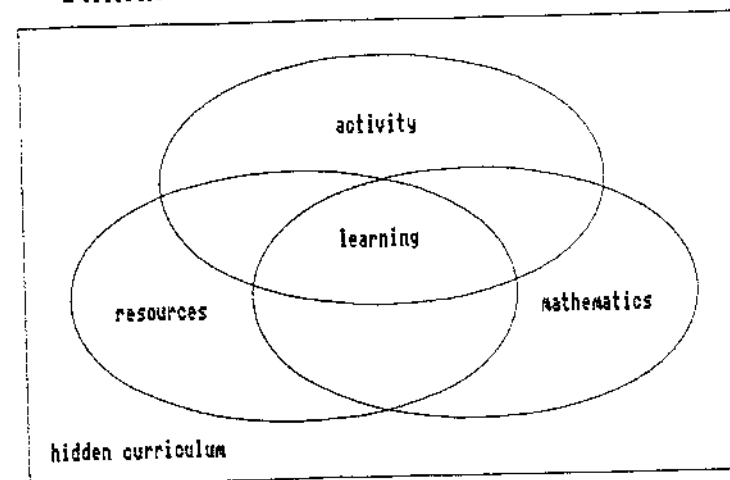
1. What does mathematics mean to you? What could you do with mathematics?
2. Do you find that mathematics has any connection with the real world? Please, explain what and why.
3. Do you find that mathematics is useful or not? Please, explain why.

SECTION II: Difficulties in understanding and learning mathematics. Reasons for those difficulties.

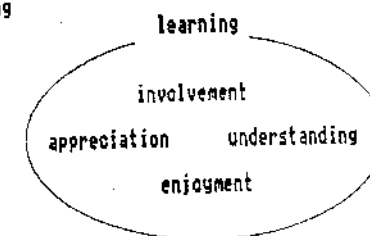
1. Do you believe that mathematics is for clever students?
2. Do you believe this is a difficult subject? A complicated one?
3. Do you always understand what your teacher explains?
4. What are the reasons that cause those difficulties?
 - a. The teacher?
 - b. The method?
 - c. or your abilities?
5. Do you think that you have gaps -some missing knowledge - which prevent you from understanding the new topics in mathematics?

MATHS AND DRAMAModel of a dramatic environment for learning.

DRAMA



Aspects of learning



Teaching Methods

