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Effectiveness of Classroom Practices to Achievement in Mathematics

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Abstract
The study examined the effect of problem solving strategy on Secondary school students' achievement in Circle Geometry in Emuhaya district of Vihiga county, Kenya. Two research objectives were used in the study to make the investigation. These were: (i) To establish the classroom practices and activities commonly employed by mathematics teachers, and (ii) To determine students' coping mechanisms in the learning of mathematics using conventional approaches. This study was based on the Constructivist learning theory which originates from works of cognitive scientists like Jean Piaget and John Dewey. Constructivist teaching is based on the belief that learning occurs as learners are actively involved in a process of meaning and knowledge construction as opposed to passively receiving information. According to this theory, learners are the makers of knowledge and meaning. The study was a true experimental research design based on Solomon Four-Fold design. The purpose of the study was to investigate the effect of using problem solving method on secondary school students' achievement in mathematics. Since the poor performance in mathematics is as a result of the decimal performance in the key topics, this study used circle geometry to establish any effect of the method. Two mathematics teachers with equal qualifications, teaching experience and considerably equal teaching potential were selected and trained to teach the two groups. Same lesson plans and worksheets were developed and used along with the direct teaching strategies for both groups. The control group was kept under a control condition by providing traditional competitive situation in class while the experimental group was provided with the Problem solving method as a treatment. The academic achievements of the control and experimental groups were examined through a post-test. In the experimental groups, one group was pretested, treated then post-tested while the other one was only treated then post-tested. In the control groups, one group was pretested then post-tested while the other one was only post-tested. Several implications of the findings are highlighted in the study as reported in this paper. The findings showed that most students who were ill-equipped mathematically tended to look for the teacher at the slightest level of difficulty and challenge in mathematical problems. They showed over-reliance on others rather than persist in looking for alternative methods of solving the same question. They were somewhat reluctant to attempt to solve the problem if the method was not perfectly obvious or if the problem was one that was unfamiliar. The researcher recommends that teachers should inculcate problem solving skills in their students to help them cope well with the ever changing and demanding needs and be better problem solvers in mathematics.
Keywords: Problem Solving, Conventional Methods, Classroom Practices, Circle Geometry, Coping Mechanisms.

1. Introduction

Mathematics is a leading logical science upon which other sciences like Chemistry, Physics, Biology and Geography depend. It is considered a basis for social life and the exploration of the entire universe. It has been regarded as an essential part of the Kenyan schools education curricula. In spite of this importance, the performance in the subject in national examinations is still poor compared to other science subjects. This continues to jeopardize the students' post secondary school career placements since mathematics is heavily emphasized as a basic requirement. According to the KNEC reports of 2008 and 2009, most students showed inabilities in answering application questions related to some key topics in mathematics. Questions on Circle geometry which constitute 38% of the mathematics curriculum in Kenyan secondary school are the worst performed according to the KNEC reports. SMASSE baseline survey of 2004 holds the same view that KCSE candidates over the last decade show lack of competence in their solutions to questions relating to circles, chords and tangents and vectors. SMASSE INSET programmes for mathematics and science teachers were rolled out countrywide. Despite these initiatives, the performance was still wanting. These two reports informed the government's initiatives to mitigate the problem

Mathematics being a service subject has some considerable influence in future courses or employment opportunities of all students. Poor performance in the subject means that a large number of students are being examined for purposes of selection for further studies and employment opportunities where they may not excel. In spite of this enormous importance, performance in mathematics has not been impressive. This in effect has led to a general perception in some quarters that the teaching of mathematics at secondary school level has not made sufficient effort to deal with the backgrounds and needs of present day students. All the education stakeholders

and the general public have expressed a lot of concern about the poor performance in mathematics. Kiragu (1986, p.36) asserts that:

Despite national efforts made in developing a curriculum that is responsive to the needs of this country, coupled with teacher training efforts, performance in secondary school examinations has been relatively poor over the last ten or so years and particularly in mathematics.

Besides, despite the concerns raised and efforts made to improve results in mathematics, performance in the subject has continued to be poor over the years. The 2009 KCSE results indicated that out of the 337404 candidates, only 13371 scored A- and above, which constituted only 3.9629% of the total candidature. The results also indicated an 18.1% mean score for girls compared to the boys' 23.63%. The overall mean score for mathematics in 2009 KCSE examination stood at 21.13% (KNEC, 2010). This performance is not good especially for a country gearing for industrialization and realization of Kenya vision 2030. Wasike (2006) observes that mathematics plays a central role in scientific progress and development. Its fundamental role lies in its everyday application in most social sciences and engineering, biological sciences, medicine, military, aerodynamic advancements and household chores.

There is a need to consider remedial methods of teaching quite different from the routine ones. Problem solving method is one such a remedial method that enhances the students' active role in the lessons. In the conventional approaches, problem solving is one of the two broad methods of teaching, the other one being transmission or expository method. In the teaching of mathematics, problem solving has been expanded to include other techniques such as Problem-Based Learning (PBL), cooperative learning, collaborative learning and team teaching. In this case Problem solving strategy now includes such techniques, among others. Polya (1957) sees a great opportunity through problem solving instructions for the learner to discover his mathematical talents. He asserts that if the teacher challenges the curiosity of his students by setting problems proportionate to their knowledge and helps them solve their problems with stimulating questions, he may give them a taste for and some means of thinking.

This suggests that a properly planned and executed problem solving instruction enables learners to:

(a) Reflect on their past experiences to determent if the latter can be applied on the present problem situation.
(b) Support their problem solving actions with evidence or valid arguments rather than anything for granted.
(c) Consider other possible ways of solving a particular problem.
(d) Try varying conditions of the problem to see if the same solutions procedures will be required.

It is therefore through problem solving that learners' thought processes can be shared and translated into action, thereby making them develop confidence in their ability to solve mathematical problems. However, if the teacher spends most of the time drilling learners in routine operations, he kills their interest, hampers their acquisition of independent thinking and denies them the opportunity of discovering their talents.

Similarly, Burton (1984) has observed that:

> The overwhelming importance of problem solving . . . is the opportunity it provides for teachers and pupils to enter into the spirit of enquiry, and through that sprit to establish different styles of teaching and learning.

Through problem solving, learners are exposed to different strategies of solving problems. They become curious to see the nature of solutions they get to challenging problems. With time, the learners are motivated to solve variations of given problems and then more complex problems. This means that learners refine and sharpen their problem solving skills by solving more problems and this forms the basis for future problem solving endeavours. Under the problem solving method of teaching, there are specific strategies that are used during the instruction. These include Problem-based learning (PBL), cooperative learning and collaborative learning, all which embrace learner-centred approaches.

Circle geometry constitutes 38% of the mathematics curriculum and it is the worst performed topic in KCSE mathematics examinations making the overall subject performance very poor. Since the topic involves a lot of applications to real world situations and proofs, it is problem solving method that can best handle the difficult and challenging concepts. The poor performance in the topic has been due to the teacher-centred methods of teaching revolving around lecture methods, speedy syllabus coverage and explanatory approaches keeping the students as mere recipients of knowledge as the teacher remains the dispenser of the same. These conventional methods have been in use since the advent of the teaching practice. Table 1 shows Emuhaya District 2009 KCSE mean scores of selected subjects.

Table 1: Emuhaya District KCSE Mean Scores of Selected Subjects

	ENG	KIS	MATH	BIO	PHY	CHEM
2009	5.700	6.063	3.480	4.169	4.408	3.506
2008	4.963	5.250	2.824	4.810	4.632	3.884
2007	4.498	4.765	2.170	4.665	4.546	3.809

Source: KNEC, 2009 Examinations Report.

As seen in Table 1, the performance in Mathematics for the period 2007-2009 has been low compared to other

subjects. The mean score of 2.170, 2.824 and 3.480 translates to a mean grade of D for the three years, which is far below a mean grade of C+ which is the basic requirement for studying majority of science based courses at tertiary institutions in Kenya.

In Kenya, the Mackay Report of 1981 recommended a change from 7- 4 - 2 - 3 system of education to the current 8- 4- 4 system of education. This change in the general education system also necessitated a change in the mathematics curriculum. In the 8 - 4 - 4 mathematics curriculum, one of the main focuses is on learner centred teaching methods. Teachers are urged to give due attention on these teaching and learning approaches in their planning and teaching.

One of the interventions made to mitigate the recurrent failure in the KCSE mathematics examinations is the Strengthening of Mathematics and Sciences in Secondary Education (SMASSE) project which was launched in 1998. This project was borne out of the need to improve performance in key subjects of mathematics and sciences through national and district In-Service Education and Training (INSET) programmes. In spite of all the changes in the school mathematics curriculum, the creation of more facilities, many years of the SMASSE INSET programmes, performance in Kenya Certificate of Secondary Education (KCSE) has continued to be poor nationally. This implies that the interventions seem to have had little impact and the solution still remains elusive. Several studies conducted in Kenya have indicated the continued use of the traditional methods among secondary school Mathematics teachers (Too ,1986; Kiragu 1986; O'Connor, Kanja & Baba (Eds),2000). For example, Too (1986) in a study of the availability and use of instructional media in Kenya found that the traditional/conventional methods were dominant in most mathematics classrooms. Similarly O'Connor, Kanja and Baba (Eds) (2000) in a survey of SMASSE project reported that whole-class instruction was the dominant approach used by most mathematics teachers in Kenyan secondary school classrooms. They also found out that the main role of the teacher is to dispense knowledge according to traditional form of prescription.

This picture of Mathematics teaching and learning portrayed above contrasts with the recommended methods in mathematics education. Here problem solving is presented as a major theme for the curriculum. This view of the importance of problem solving in mathematics education is parallel with the opinion put forward by several mathematics educators (Lester, 1977; Begle, 1979; Cockroft, 1982). Begle (1979), for example, is of the opinion that the core of teaching mathematics is problem solving. Official reports such as NCTM (1980), Agenda for Action and the Cockroft Report (1982) recommends the adoption of problem solving approach to the teaching and learning of mathematics. According to the KNEC reports of 2008 and 2009, most candidates exhibit inabilities in tackling application questions related to some key topics in mathematics that are common in the KCSE examinations. Questions on Circle Geometry which constitutes 38% of the secondary mathematics curriculum are the worst performed according to the report.

The SMASSE report as outlined in the Baseline Survey of 2004 and 2006 pointed out Circle Geometry and Vectors as topics in which a majority of KCSE candidates lacked competence and performed very poorly. I The two reports by KNEC and SMASSE informed the government's initiatives in setting up more in-service training sessions, workshops and training of more professional teachers of mathematics. However, despite all these initiatives and awareness, the performance continues to remain poor. The many efforts being put in place by individual schools, including extra remedial, holiday tuition and even early syllabus coverage do not seem to provide a lasting solution. This study therefore seeks to investigate the effect, if any, of problem solving strategy on students' achievement in mathematics. More specifically, the study examines the effectiveness of classroom practices as a key component of problem solving to achievement in mathematics. Circle geometry will be used in this study as one such topic which poses the greatest challenge to students and its application of the six levels of cognitive domain; knowledge, comprehension, application, analysis, synthesis and evaluation.

1.1.1 Public Images of Mathematics

It is widely claimed in the literature (Mtetwa & Garofalo, 1989; Ernest 1996; Lim, 2002) that negative images and myths of mathematics are widespread among the public, especially in the developing countries. Henderson, (1987) cited in Lim (2000) claims that:

> The majority of people today are scared of mathematics (and mathematicians) and feel powerless in the presence of mathematical ideas.

According to Ernest (1996), many people's images of mathematics portray the subject so negatively that it is perceived to be 'difficult, cold, abstract, and in many cultures, largely masculine'. If the public image of mathematics is negative, then according to Howson & Kahane (1990) the image of a mathematician is even worse. They observe that mathematicians are regarded as 'arrogant, elitist, middle class, eccentric, male social misfits, who lack social antennae, common sense, and a sense of humour.'

According to Peterson (1996) in Lim (2002), even scientists, engineers and mathematics teachers whose job relate to mathematics 'often harbour an image of mathematics as a well-stocked warehouse from which to select ready to use formulae, theorems and results to advance their own theories". Apart from the findings above, some students with mathematical learning difficulties and some pre-service teachers were also

found to hold some common myths about mathematics. Some of these myths are 'mathematics is computation', 'mathematics is difficult' and 'men are better in mathematics than women'. Even though myths about mathematics are not necessarily false beliefs, they are mostly negative and could be harmful by distorting the image of mathematics to the students.

There have been propositions and speculations about the causes leading to the claimed negative and unpopular images of mathematics. Studies cited by Lim (2002) reveal that among the causes of unpopular images of mathematics are: teachers' attitudes, the formality of much mathematics teaching, lack of relevance of mathematics to everyday contexts, fear of the subject, gap in schooling and parental expectations.

Bell (1989) cited in Lim (2002) says that most people initially have the capacity to appreciate the beauty of mathematics as an art, but sadly this appreciation "often gets suppressed by distasteful school experience". Likewise Ernest (1996) claims that experiences of learning mathematics in schools, especially the negative ones, are possibly the dominant sources leading to the public image of mathematics. Henderson (1981) cited in Lim (2002) argues that: many people viewed and learned mathematics in a rigid and rote way that hindered their creativity. Brown and Porter (1997 in Lim (2002) propose that mathematicians themselves are to blame. This is because "mathematician themselves fail to define and explain their subject in a global sense to their students, to the public and to the government and industry" (p. 11).

In summary, these propositions seem to suggest that three of the possible factors that influence negative public images of mathematics are (i) teachers (ii) school experiences and (iii) parents. However, there seems to be insufficient empirical data to support these propositions. Subsequently, information gathered with regard to these factors will enhance a better understanding of the roles of teachers and parents in mathematics education.

Among these factors the teachers' role in learning is unquestionable. Teachers exercise a great influence on the student learning, especially in selecting appropriate tasks and organizing classroom discourse. Furthermore, teachers can also influence how mathematics reform is implemented. Conceptions of the nature of mathematics are a critical aspect of teachers' actions before they are able to help students learn. Consequently, the assessment of teachers' conceptions concerning mathematics and problem solving seem to be an important prerequisite for planning appropriate teaching and learning activities. In-spite of these indicators of claimed poor public image of mathematics (and mathematician) widespread myths about mathematics, relatively few studies have been undertaken on the mathematician's conceptions of mathematics in general and problem solving in particular.

1.1.2 Role of the Mathematics Teacher in Instruction

Orhan and Ruhan (2006) observe that merely telling is not teaching and simply listening is not learning. The role of the teacher is to encourage student-centred learning where he is merely a facilitator or guide to the learning process. In all active learning processes the learners learn according to their own needs and pace. They further observe that the teacher here gives them the relevant opportunities to make decisions regarding various dimensions of the learning process and to perform self regulation.

The teachers' role is to awaken the learner to think for himself and make his own discoveries. This improves the understanding and mastery of the concepts learnt and can make appropriate applications. Bruner (1961:22) explains that, 'for whether one speaks to mathematicians or physicists or historians, one encounters repeatedly an expression of faith in the powerful effects that come from permitting a student to put things together for himself to be his own discoverer'.

The kind of assignments given may also indicate the direction of learning and achievement. Matsumura, et al (2002) looked at the effect the quality assignments have on student achievement. Using hierarchical linear modeling, they find that a small part of student test scores variance can be predicted by assignments quality. The relationship between assignment and student achievement is also analyzed by Neumann et al (2001). They find that more intellectually challenging assignments are related to higher gain in test scores, hence their importance.

Wenglinsky (2000, 2002) uses multi-level structural equation modeling to analyze the impact of different teaching methods employed by the teacher on students' test scores in mathematics and sciences. He finds that the use of hands-on learning activities like solving real world problems and working with objects, an emphasis on thinking skills and frequent testing, more individualized assessment through projects are positively related to student test scores, taking into account student background and prior performance. Hopkins (1997) asserts that in the execution of their work, teachers as facilitators of learning need to establish the classroom as a safe and secure learning environment in which students expect warmth and acceptance. The environment should be free of tensions, worries and threats.

National council of teachers of mathematics (NCTM) recommends that students in grades 3-5 should have frequent experiences with problems that interest, challenge and engage them in thinking about important mathematics (NCTM, 2000).

1.1.3 Traditional versus Innovations in Teaching Mathematics

Manjunath (2009) observes that learning takes place best when students have opportunities to express ideas and get feedback from their peers. This feedback ought to be analytical, suggestive and come at a time when students are interested in it. He asserts that this can only happen on an active learning class. In the 80's and the years before, mathematics teaching and learning took the traditional view which portrayed the teacher as a dispenser of knowledge as the students remained passive listeners.

According to Ernest's model, there are three views of the nature of mathematics. These include Instrumentalist view, Platonist view and the Problem-solving view. Teachers who followed the instrumentalist view of mathematics tended to take an instructor's role in teaching where the main objective was for students to master the skills needed in mathematics. The basis of knowledge here was rules and not necessarily understanding. The Platonist view is associated with the explainer model of teaching where learning is seen as the reception of knowledge. Teachers holding this view tended to lecture and explain the concepts, focusing on mathematical content only. The teachers emphasized students' understanding of ideas and processes, particularly their understanding of the logical relationships of mathematical concepts. These aspects defined the traditional mode of instruction. The traditional methods of teaching are no longer adequate to meet the demands of mathematics education in line with the changes in technology and Vision 2030. Any idea or a concept presented in a simple and appropriate form and the way that is suitable to learner's ability and aptitude provides the best understanding of it (Bruneer, 1966).

1.2 Theoretical framework

This study is based on the Constructivist learning theory which originates from works of cognitive scientists like Jean Piaget and John Dewey. Constructivist teaching is based on the belief that learning occurs as learners are actively involved in a process of meaning and knowledge construction as opposed to passively receiving information. According to this theory, learners are the makers of knowledge and meaning.

Constructivist teaching fosters critical thinking, and creates motivated and independent learners. This theoretical framework holds that learning always builds upon knowledge and that a student already knows; this prior knowledge called schema. Because all learning is filtered through pre-existing schemata, constructivists suggest that learning is more effective when a student is actively engaged in the learning process rather than attempting to receive knowledge passively. A wide variety of methods claim to be based on constructivist learning theory. Below is a diagrammatic structure that describes an effective learning structure according the Constructivist theory of learning. Constructivist learning theory says that all knowledge is constructed from a base of prior knowledge. Children are not a blank slate and knowledge cannot be imparted without the child making sense of it according to his or her current conception. Therefore children learn best when they are allowed to construct a personal understanding based on experiencing things and reflecting on those experiences.

One of the primary goals of using constructivist teaching is that students learn how to learn by giving them the training to take initiative for their own learning experiences.

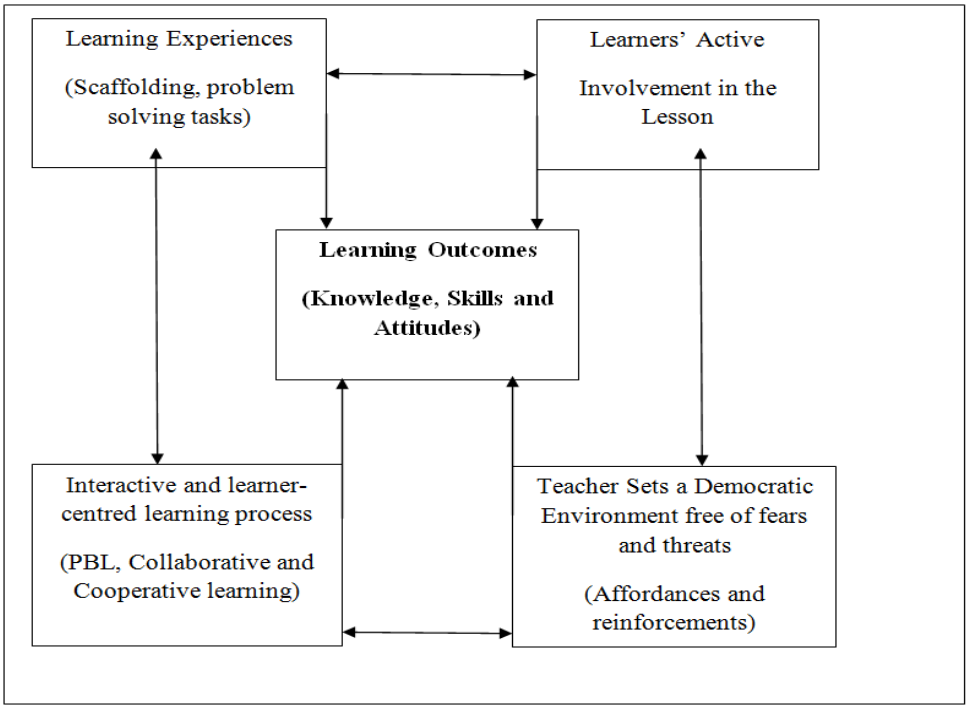

Figure 1: Effective Learning Structure

From the figure above, the independent variables include the classroom practices comprising: the learning experiences/tasks through problem based learning, collaborative learning and cooperative learning environment, the conducive democratic environment and the interactive and leaner-centred environment. The dependent variable is the learning experiences and outcomes. The intervening variables include the teacher's fluency, organization and competence in the classroom.

This theory was suitable for the study because it guided the design of the study and the selection of the variables for focus. In the constructivist class, learners need an environment where they work together on a task, sharing feelings, ideas, opinions and experiences out of which they construct meaning from the learning tasks. The role of the teachers is to structure the learning tasks (scaffolding) in a manner that stimulates learning and an overall learning environment that encourages free interaction and student participation

1.3 Purpose of the Study and Objectives

The purpose of this study was to investigate the effect of using problem solving strategy on secondary school students' achievement in mathematics. The study established that classroom practices and activities commonly employed by mathematics teachers do not empower the students to be independent problem solvers. The study also found out that there are significant differences in students' coping mechanism in mathematics classrooms between those exposed to problem solving and those not exposed.

1.4 Research Hypotheses

The following two hypotheses were used to test the achievement of the above objectives at an alpha level of 0.05 significance:

HO_1: There is no consistency in the classroom practices and activities employed by mathematics teachers.

HO_4: There are no particular students' coping mechanisms in the learning of mathematics using conventional approaches.

1.5 The Study Area

The study was carried out in Emuhaya district of Vihiga County, Kenya. The district was chosen as a study area for various reasons. First, there is very little known classroom research particularly on the area of problem-solving in mathematics which has been done in the District. Secondly, performance in mathematics in the district has been poor having recorded an average of D (plain) in the last three years KNEC (2009). Thirdly, the nature of the study which involved live classroom instruction and long visits within the limited time and finances, the researcher found it appropriate to confine the study to this area. Fourthly, the district was found to have a higher number of secondary schools of all the three types, District, Provincial and National schools.

The formidable problem currently facing the teaching and learning of mathematics is the dire need to improve students' mathematics performance. The dominant mode of instruction within the district is the conventional (didactic) approach, hence the need to employ problem solving and other learner-centred methods.

1.6 Sample and sampling procedures

The study was carried out in four public secondary schools within the district. These included one girls' school, one boys' school and two mixed schools. Eight trained practicing mathematics teachers, two from each of the four schools were involved in the study. The student sample population was 160, with each school producing 40 students. One of the teachers was trained for the control group and the other one for the experimental group. In total, four teachers were trained to teach the study groups.

The study employed multi-stage sampling techniques. Stratified sampling was used to identify one boys' school and one girls' school. Simple random sampling was used to identify the two mixed schools from the available thirty schools. In each of the selected schools, simple random sampling was used to get the two mathematics teachers. The Form Three class was purposively selected because it is at this class that the aspects of circle geometry; circles, chords, tangents and their properties are taught. Simple random sampling was used to select each stream in the Form Three class. Since the students were admitted in form one on merit, their entry behavior was assumed to be the same. A short test of 20 marks was administered to the students and the results used to pick the best 40 students for the study.

The four schools formed the four groups to meet the Solomon (1949) Four- Fold Group design's requirement. From a total of 1376 Form Three students' enrolment in the district, this sample constituted 30.06%. Of the four secondary schools, two were provincial schools while two were district schools. The district and provincial categories provided a platform for comparisons in performance and achievement according to school type.

2. Research Design and methodology

This study adopted an experimental design, which involved collection of quantitative and qualitative data in an attempt to answer the research questions. The experimental design chosen for the present study is Solomon Four-Fold design, which is considered rigorous enough for experimental and quasi-experimental studies (Ogunniyi; 1992; Ary et. al, 1982; Cook & Campbell, 1979). Solomon Four-Fold design is believed to be robust in

eliminating variations that might arise due to differences of experiences and contaminate the internal validity of the study (Ogunniyi, 1992; Tuckman, 1988). The design helps avoid some of the difficulties associated with the pretest-posttest designs. It is a factorial design that randomly assigns participants to four groups. It is a standard pretest-posttest only group design and the posttest only control design. In this design, the study population was divided into four groups. Two served as Experimental groups while the other two were control groups.

In the experimental groups, one group was pre-tested, treated then post-tested while the other one was only treated then post-tested. In the control groups, one group was pre-tested and then later post-tested while the other group was only post-tested. The various combinations of tested and untested groups with treatment and control groups allow the researcher to ensure that confounding variables and extraneous factors do not influence the results. The two control groups act as controls for their respective pretested and non-pretested treatment groups.

2.1.1 Instrumentation.

Questionnaires, Mathematics Achievement Test and an interview schedule were used to collect information from the subjects. The scores were used to compare the groups taught using the problem solving strategy and those taught conventionally.

2.1.2 Data analysis

The data obtained from the study were analyzed in terms of quantitative and qualitative descriptions. Descriptive statistics consisted of percentages, means and standard deviations. Inferential statistics used here included analysis of variances (ANOVA), t-test which were employed to determine the significance of the differences in students' achievement, interests and attitudes during mathematics lessons.

3. 1 Results

The first objective was to establish the classroom practices and activities commonly employed by mathematics teachers. The items of the interview referred to their lesson reviews, concept development, concept application, their approach during solving problems and the types of activities used in their lessons. The results are shown in Table 2.

Table 2: Differences in Classroom Practices between different Teachers

Classroom Practices	**Most maths teachers (Over 60%)**	**The minority teachers (Less than 40%)**
Reviewing previous lesson	Recall of definitions and formula	Students were asked to give real life examples Teachers gave examples from real life experiences
Concept development	Teacher explained procedure and thereafter solved sample examples and gave practice examples	Students given tasks to explore and understand concepts
Applying concepts	Activity was focused on algorithm Students were engaged in computations	Students engaged in discussions and computations
Teachers approach during solving problems	Teacher encouraged students to follow set down procedures	Teacher allowed students to spend more time and consult, among themselves Students encouraged to explore variety of ways on how to solve problems
Types of activity prepared for fixing skills	Emphasis was on execution of mathematical operations and computation with speed	Teacher explanations followed by justification of generalization on concepts

The results in Table 2 above shows that most mathematics teachers prefer using teacher friendly activities like concentrating on early syllabus coverage at the expense of the slow learners, use of one particular textbook, moving ahead with faster learners at the expense of slow learners, giving too much assignments and not marking all of them or providing their answers and being biased in allocation of questions in class to only a few bright students. The results are also consistent with Brosnan & Erickson (1996) who found that teachers give more importance to student's answers rather than their problem solving solutions. However, the results are in contrast to a number of studies which indicate that teachers hold constructivist beliefs about mathematical problem solving. For instance Brown (2003) found that teachers highly support the idea that students should spend time on problems and try to understand why a solution works.

Other items of investigation by the questionnaire regarding the commonly used classroom practices and activities included class size involvement in the lesson and the individual student participation in class. The responses from a sample of 80 students revealed that most teachers preferred whole class instruction as opposed

to small group instruction. The results of the chart in Figure 1show that very few students asked questions in class especially in wanting to understand a concept they had missed. Majority of these would ask their peers who could also be in the same dilemma. This was common in classes characterized by conventional approaches of teaching. Majority of the teachers therefore employed practices and activities convenient to them as opposed to the learner friendly approaches.

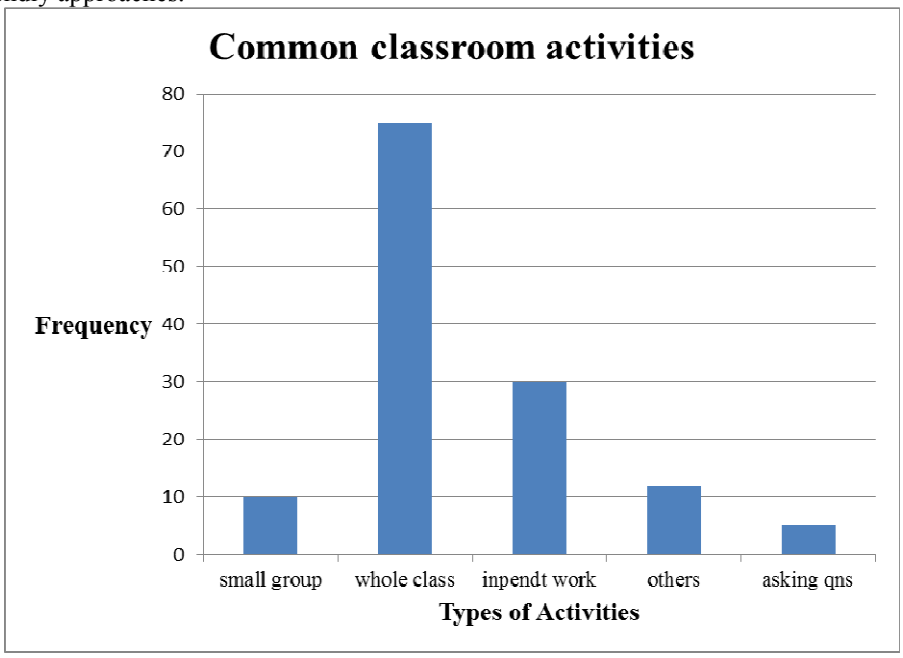

Figure 2: Some classroom activities employed by the teachers

The results in Figure 2 above revealed that independent work by students, students posing own questions, and small group work were infrequently used by teachers. The results indicated that teachers seemed to rely more on whole class instructions where the main objective is for students to master the skills needed in Mathematics. Majority of teachers were observed to dominate class activities through explanations and overemphasis on the formal presentation of Mathematics as a collection of facts and procedures and students algorithm. This shows that the teachers relied more on the teacher-centred activities. This showed a difference between strategies recommended by the syllabus and those preferred by teachers.

The second objective sought to determine students' coping mechanisms in the learning of mathematics using conventional approaches. The general behavior of students in relation to solving challenging problems gave an indication of their preparedness and attitude towards mathematics. This eventually had an impact on their overall achievement in mathematics. A set of 40 students in the control group were interviewed regarding their classroom behavior and preparation for mathematics examinations. When asked what they usually do whenever a question was challenging or seemed difficult, 45% of the students said they promptly sought the teacher's help, 35% asked their peers and 20% did nothing. This sample of students was later given a test marked out of 100 marks; to investigate the effect of their coping mechanism. The test item had application and non-routine questions. Of those who sought the teachers help, 66.67% scored below 50 marks out of 100 and 33.33% scored above the average mark. Of those who asked their peers, 21.43% scored below average and 78.57% scored above the average mark. 75% of those who did nothing scored below average and 25% scored above average.

It was therefore found out that most students who were ill-equipped mathematically tended to look for the teacher at the slightest level of difficulty and challenge in mathematical problems. They showed over-reliance on others rather than persist in looking for alternative methods of solving the same question. They were somewhat reluctant to attempt to solve the problem if the method was not perfectly obvious or if the problem was one that was unfamiliar. This implies the onset of negative attitude about the problem and eventually performs poorly. Those who had the interest and enthusiasm to face the questions head-on ended up doing well.

Other students said that they often resort to group discussion with their peers so as to find solutions to the tasks given to them. Others seek immediate help from the teacher after the lessons since the lesson time is not sufficient for that. The group of students who had fear for the teacher consulted their colleagues who are much better than them in the concepts taught. Other students admitted to cheating by copying their friends' answers for the assignments.

Firstly, the study also found that most mathematics teachers prefer using teacher friendly activities like concentrating on early syllabus coverage at the expense of the slow learners, use of one particular textbook,

moving ahead with faster learners at the expense of slow learners, giving too much assignments and not marking all of them or providing their answers and being biased in allocation of questions in class to only a few bright students. However, the results are in contrast to a number of studies which indicate that teachers hold constructivist beliefs about mathematical problem solving. For instance Brown (2003) found that teachers highly support the idea that students should spend time on problems and try to understand why a solution works. Secondly, this study showed that most students under the conventional approaches of learning avoided questions requiring high order thinking skills. They relied on the teacher and to a lesser extent the higher achievers. A good number of students would do nothing at all, meaning their competence and attitude were not matching the expectations. Most students in this category avoided application and non-routine questions. A good number of students under the conventional learning approach would quickly resort to cramming formulae and procedures and others would copy from their friends.

3.2 Conclusion

The role of the teacher is to encourage student-centred learning where he is merely a facilitator or guide to the learning process. In all active learning processes the learners learn according to their own needs and pace. Wenglinsky (2000, 2002) uses multi-level structural equation modeling to analyze the impact of different teaching methods employed by the teacher on students' test scores in mathematics and sciences. He finds that the use of hands-on learning activities like solving real world problems and working with objects, an emphasis on thinking skills and frequent testing, more individualized assessment through projects are positively related to student test scores, taking into account student backgrounds and prior performance. Teachers as facilitators of learning need to establish the classroom as a safe and secure learning environment in which students expect warmth and acceptance. The environment should be free of tensions, worries and threats.

On the basis of the findings in this study, the following conclusions were drawn:

(i) The characteristics of problem solving method are learner-centred and hence enhance their team work, peer interactions and raises their learning interests. Therefore the students' attitudes towards mathematics are positive when taught using problem solving approaches. On the other hand, they are negative when taught using conventional approaches.

(ii) The classroom practices and activities commonly employed by mathematics teachers are teacher-centred as opposed to the accepted instructional guidelines of student-centred activities.

(iii) The students' interest, understanding and collaboration in mathematics classrooms highly depend on the practices initiated by the teacher during instruction and students' involvement and advancement in class.

(iv) Classroom practices that promote dialogue amongst students and the teacher provide an enabling environment for meaningful learning and achievement. They create a fear-free learning environment, enhance teamwork and facilitate active participation in class.

3.3 Recommendations

The findings of this study are considered as invaluable contributions to the teaching and learning of mathematics. On the basis of these findings, the following recommendations are hereby suggested:

(i) Teachers of mathematics should be encouraged to embrace classroom practices and activities that are learner centred and those that improve their problem solving skills so that they can be better problem solvers in more challenging circumstances.

(ii) Extensive and results oriented training programmes, seminars and workshops on circle geometry and other challenging topics should be organized for mathematics teachers in secondary schools.

(iii) Teachers of mathematics should embrace innovation in their teaching to make learning more interesting to the learner. They should adopt the modern 21st Century skills (guided discovery, ICT integration, problem-based learning, etc) that are in tandem with the advancing technology.

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