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RESEARCH ARTICLE

THE CHALLENGES OF IMPLEMENTING STUDENT-CENTERED INSTRUCTION IN THE TEACHING AND LEARNING OF SECONDARY SCHOOL MATHEMATICS IN A SELECTED DISTRICT IN ZIMBABWE

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ABSTRACT

The aim of the study was to find out the factors that hinder the implementation of the student-centered methods in the teaching and learning of mathematics at secondary school level. The study was a descriptive survey, involving questionnaires and interviews with fifteen in service mathematics teachers. Descriptive data were mainly presented in form of tables, graphs and direct quotations from teacher. From the findings the constraints included examination assessment requirement, time factor, resources especially textbooks, language barrier, teachers' subject matter content, and other minor ones such as the size of classes and the heavy planning involved. Teachers regarded the student-centered methods as useful and rewarding teaching and learning strategies. Teachers also showed that they are fully aware that their pupils get highly motivated by being involved in student-centered activities. It was therefore concluded that the implementation of student-centered methods in the teaching and learning of secondary school mathematics was far from being realized in the district under study.

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INTRODUCTION

Mathematics is a subject that we use to solve many problems in our daily life, including problems in the classroom. Steen (1989) has pointed out that mathematical sciences have moved from not only being a requirement for future scientists, but are now an essential ingredient in education for all. According to Sitidiso (1961) in Adeleke (1998) no other subject forms a strong binding force among various branches of science as mathematics. These statements show how important mathematics is. Mathematics is now essential for all pupils up to the age of sixteen, as a requirement of mathematical education in the twenty- first century (Haggarty, 2002). In Zimbabwe mathematics is in the curriculum of both primary and secondary schools and every student who passes through these institutions of learning is supposed to learn the subject compulsorily. Charles and Lester (1982:4) indicated "Despite the importance of mathematics and the potential enjoyment that students can experience in it, it is a fact that the majority of the students grow to dislike mathematics by the time they complete secondary school. Many students are not interested in mathematics, have mathematics phobia, could not relate mathematics to the real world and some suffer from the syndrome of learning mathematics for the sake of passing examinations (Battista, 1999). For most students, school mathematics is an endless sequence of memorization and

forgetting facts and procedures that make little sense to them (Battista, 1999). Much of the failure in school mathematics is due to a tradition of teaching that is inappropriate to the way students learn. Charles and Lester (1982:4) state that "This state of affairs is attributed to the overemphasis on drill and practice, to the general absence of attempts to involve students in real –world applications of mathematics, and to the lack of attempts by teachers and textbooks to engage students in real explorations and in problem-solving activities."

For the past four years the 'O' level mathematics pass rate has been below ten percent, according to the statistics from Better Schools Programme in Zimbabwe (BSPZ), in the district under study,. Although high performance in Zimsec examination does not mean automatic ability to use mathematics in real life, it was a general consensus among the examiners that most pupils lacked the skills to apply mathematical concepts (ZIMSEC, 2001). The Zimbabwean education system has been largely criticized for its inability to produce graduates who can apply their school knowledge in everyday life despite having passed public examinations with flying colors (Nziramasanga, 1999). Mathematics performance and results in schools remain poor, while the skills acquired in the classroom do not seem readily transferable (Nziramasanga, 1999). This indicates that the students' performance on application questions in both examinations and in real life problems that need to be solved in society after leaving the school is very poor. As the cause of poor outcomes, Verspoor

(1989) points the finger at the poor implementation, while Hiebert (1999) in Wenglinsky (2002) blames the teaching. Henderson (1995) in Ntata (1999) reported that low performance in mathematics was a direct consequence of employment of poor outdated teaching methods. The quality of mathematics instruction must be improved. There is need to have pupils become actively involved in the construction of their mathematics knowledge. The secondary school mathematics syllabus (4008/4028) replaces the Cambridge syllabus 4004/4024 in 1997. "In Zimbabwe teachers rely mostly on the syllabus provided by the Zimbabwe Schools Examination Council (ZIMSEC) and the prescribed textbooks in their instructional practices" (Chauraya, 2006:227). The syllabus (4008/4028) highlighted the following in the process of teaching and learning of mathematics:

- a) Group work be organized regularly
- b) A deliberate attempt be made to teach problem-solving as a skill, with pupils being exposed to non-routine problem-solving situations.
- c) Pupils should be taught to identify problems in their environments, put them in a mathematical form and solve them, for example, through project work.

The mathematics syllabus emphasizes that the teaching strategies must be seen as a process and not as a product.

Mathematics curriculum reform in Zimbabwe encourages teachers to adopt constructivist approaches in their teaching because of the potential of these approaches to enable learners to transfer school mathematics to contextualized situations through modeling and problem solving (Nyaumwe and Mtetwa, 2006). In Zimbabwe the 'O' level mathematics syllabus is underpinned by a student-centered philosophy that emphasizes understanding and the application of mathematical concepts. Education must be problem oriented (Gwarinda, 1993). Pupils must be actively involved in tackling new and unpredictable situations on their own. They must be taught to question, to experiment, to reason, to think creatively, to challenge, to argue and to criticize. They must be prepared for the unexpected and they must be given opportunity to cope with it. Their education must equip them to be able to solve problems (Gwarinda, 1993). Mathematically, students exiting the schooling system would need to be knowledgeable in dynamic ways.

The poor performance at 'O' level has been a long outstanding problem in mathematics. Although there are several factors that affect the performance of pupils in mathematics, teachers' practices in the classroom remain the major problem. Ridlon (2006) and Nasser, Patman, Reehan (2003) have written extensively on the need to use student-centered approaches in order to improve on the student performance in mathematics. In addition it has been discovered that student-centered instruction has some constructivist connotations in which students are actively involved which helps them to understand the mathematics concepts. Despite the growing popularity of the constructivist methods, they have not had a substantial impact on classroom practices (Frid, 2000). This study focused on the factors hindering the implementation of the student-centered methods as well as the teaching methods used in the teaching and learning of 'O' level mathematics.

The study focused on the three teaching approaches, that is, problem solving, project method and group work which are considered to be student-centered and these were recommended in the 'O' level mathematics syllabus. The study sought to answer the question: What are the teachers' constraints in implementing the student-centered methods?

Given the emphasis of mathematics as a social practice beyond school, this study is based on the social constructivist theory. Constructivism is a concept based on the premise that pupils construct their own perspectives of the world through individual experiences and schema. Teachers around the world have embraced constructivism and many have supported constructivist views of learning and teaching as avenue by which to design and implement mathematics curricula that bring about learning with understanding (Frid, 2000). "Constructivism focuses on student-centered instruction that might not be new in education" (Brumbaugh and Rock, 2001:26). "Constructivist theories encourage the use of student-centered instructional pedagogies because mathematical knowledge is viewed as context based" (Nyaumwe and Mtetwa, 2006:35). Knowledge is believed to originate from observations, experimentation and abstraction using specific senses and therefore is tentative, intuitive, subjective and dynamic (Nyaumwe, 2004). From the constructivist view, to teach mathematics well is to equip learners with conceptual understanding of the process skills that enable them to individually or collectively develop a range for viable mathematical knowledge (Davis, 1990 in Nyaumwe, 2004). In this study student-centered instruction will be considered as an aspect of constructivism that involves the construction of knowledge through experience. The literature frequently refers to a number of teaching practices that appear to be related to students' active involvement in learning and the transfer of mathematical concepts to real life situations. These include problem solving, group work and project work (Syllabus, 4028/4008, ZIMSEC.)

Drill exercises are likely to dominate classroom mathematics in Zimbabwe as revealed in (Chauraya and Mhlolo, 2008). The Zimbabwean teachers have continued to use teacher-centered methods as reported in the Curriculum Development Unit (1995). The mathematics team: Curriculum Development Unit (1995) report noted that most teachers avoided those teaching methods that were student centered and mainly used demonstration and lecture methods. Fast (2000) observed Zimbabwean classrooms over an eight-year period and indicated that direct instruction was the preferred approach at all levels. This clearly shows that the way mathematics is taught in Zimbabwe is still very traditional.

In Zimbabwe, research on science and mathematics teachers at secondary school level has highlighted the shortcomings of current teaching approaches and strategies. Some of these findings indicated that teaching strategies continue to center on lecturing and part of this problem has to do with teachers' lack of knowledge and skills to change their way of teaching (Jaji, 1990 in Scott, 1997). Teachers are greatly affected by their prior experiences as students. Schoenfeld (2002) in Barrent *etal* (2002) explained that the majority of the mathematics teachers were trained in the traditional way using the traditional mathematics curriculum; many teachers feel that they are forced to deviate from skills-based instruction.

Gregg (1995) in Scott (1997) asserted that teachers are themselves products of the traditional mathematics-as-computation view of teaching in which mathematics was regarded as sets of transmitted facts and products. Bonwell and Eison (1991) state that traditional teaching approaches to student (teachers) learning, in which lecturers talk and students listen, predominates in universities despite repeated calls over the past 15 years for lecturers to actively involve and engage students in their own learning.

Mtetwa and Kwari (2006: 512) observed that “in workshops and seminars some teachers appear to be surprised that they find themselves having to learn some more things about the job of teaching for which they had prepared themselves and that some teachers express a sense of unwillingness to do so, believing that having graduated as fully-fledged teachers from pre-service education they had learned all they had to learn about teaching”. This reaction pointed to the possible existence of a gap between pre-service and in-service learning experiences, needs and expectations (Mtetwa and Kwari, 2006). “In Zimbabwe there is a disjunction between leaning experiences during pre-service curriculum preparation and the learning needs of teachers while in the field” (Mtetwa and Kwari, 2006: 514). They concluded from evidence generated from their study that pre-service education curricular should balance theory building and application in a bi-directional fashion, perhaps with more emphasis on the later. These findings were considered relevant to this study, as they seem to generally indicate the actual situation in schools pertaining to the teaching methods and factors hindering the implementation of student-centered methods.

The traditional skill-drill approach is not working in Zimbabwe and students struggle to make sense of the lesson as reported in Nziramasanga (1999). Teaching mathematics through problem solving is one way to make students make sense of the lessons and it encourages students to think critically and apply problem-solving approaches. The focus should be on teaching mathematical topics through problem-solving contexts and enquiry-oriented environments where teachers can help students construct a deep understanding of mathematical ideas and processes by engaging them in creating, conjecturing, exploring, testing, and verifying. Pupils can also apply thinking skills and understanding to solve content related problem. Problem solving is recommended as a means of developing mathematical thinking for daily living, meaning that problem-solving ability lie “at the heart of mathematics because it is the means by which mathematics can be applied to a variety of unfamiliar situations (Cockcroft, 1982 in Confrey, 1990)”. Problem solving is, however, more than a vehicle for teaching and reinforcing mathematical knowledge and helping to meet everyday challenges. It is also a skill, which can enhance logical reasoning.

In the United States of America research studies on implementation of student-centered education suggest that mathematics teaching in many American schools still closely resembles the traditional model (Kilpatrick, 2001; Schoenfeld, 2002) in (Velupillai and Engelbrecht, 2008). Stigler and Hilbert (1977) observed that in Japanese lessons an attempt was made to enhance student understanding, whilst the common goal in USA was to teach students how to do

something. In Zimbabwe students' procedural knowledge in mathematics was admirable but their conceptual understanding was often limited. Problem solving on ‘O’ level and ‘A’ level mathematics examinations were therefore rather challenging for many students. Developing a better conceptual understanding of the mathematics is as much a necessity in Zimbabwe as it is in America (Fast, 2000).

The benefits of problem solving in mathematics instruction have been highlighted by a number of authors (Akihiko, 2000; Kaino and Yaqiang, 2004; Charles and Lester, 1982 in Chauraya and Mhlolo, 2008). These benefits include students active participation, application of their mathematical knowledge and skills, providing rich experiences for students to have pleasure of discovery, learning of new mathematics with greater understanding, fostering positive attitudes towards mathematics, develop higher order thinking skills, problem solving and cooperative skills and developing flexibility and creativity in the learners. Whilst there are many advantages associated with problem solving in mathematics instruction the implementation of this mode of instruction was not likely to be realized in Zimbabwean classroom soon (Chauraya and Mhlolo, 2008). Observations on the ground in Zimbabwe seem to indicate that very little problem solving (as one kind of the student-centered instruction), if any, is being implemented in mathematics instruction in schools and that instructional practices are predominantly teacher-centered (Mtetwa, 1992). These findings were considered relevant to this study, as they seem to generally allude to a need for understanding mathematics teachers’ conception about problem solving and its role in mathematics instruction.

Project type problems can increase appreciation of the importance of research and creativity in mathematics, hence improving the learners’ attitudes. Projects can be a wonderful motivator for students, especially those who are disinterested in mathematics. Projects can give students the chance to learn about mathematics and engage in mathematical problem solving (Artzt and Armour-Thomas, 2002). The study by Chauraya and Mhlolo (2008) revealed that project type problems were likely to remain relegated to the periphery of mainstream classroom mathematics instruction. The essential element of the project method is the application of knowledge or practical application of research leading to tangible result (Gwarinda, 1993). The project method is based on existence of a real life problem, which needs a solution. In a country such as Zimbabwe where education with production (integrating theory with practice) is paramount as a philosophy of education, the project method is seen to be a valuable tool in development. Students must be given opportunities to carry out the projects or small mathematical investigations. Nyaumwe and Mavhunga (2005) noted the existence of what they referred to as the “crowded ‘O’ level curriculum” which does not allow teachers to allocate a lot of time for student activities like small investigations or projects in Zimbabwe.

In class teachers allow students to work together in groups, thus providing opportunities for them to share their methods of solution. Research results suggest that teachers should concentrate on providing opportunities for students to interact in problem-rich situations (Grouws and Cebulla, 2000). Besides providing appropriate problem-rich situations, teachers must encourage students to find their own solution

methods and give them opportunities to share and compare their solution methods and answers. It creates excellent opportunities for students to engage in problem solving with the help of their group members.

According to Dossey *et al* (2002), working in groups with peers provides students with a less threatening environment to work in, simply because they do not feel the pressure to perform in front of their peers. Group work helps to develop students' problem-solving strategies because the fact that a group contains more knowledge than an individual means that problem-solving can be powerful. As pupils work in groups they will have opportunities to learn from each other. Collaborative group problem-solving activities improve students' higher order thinking skills. Mkhize (1999) in Velupillai and Engelbrecht (2008) conducted a study in two township schools, investigating the views of mathematics teachers on group work. In his study educators indicated that they were unaware that their learners learn better through this approach. He also noted that teachers only value group work for giving slow learners a chance to understand.

The effectiveness of group work in improving students' performance in mathematics has been shown in the studies above. However, the use of group work does bring its own problems; for example, Abiodun (2008) carried out a research on group work in mathematics and noted that the issue of class size was a problem because in a particular class the number of groups was up to fifteen. This made it difficult to cover all the groups in one lesson. He also said that in a situation where teachers are required to cover specific grounds within a given period of time, they find it difficult to pursue lessons to their satisfaction. Shared misconceptions can be reinforced by group work (Good *et al*, 1992 in Stols *et al*, 2008), students might be tempted to engage in off-task social interaction (Good and Galbraith, 1996 in Stols *et al*, 2008), and some students may feel they have little or nothing to contribute to the group, and some may feel that their contributions are not valued and thus they become passive (Reynolds and Muijs, 1999 in Stols *et al*, 2008). In this study group work is considered to be a very important aspect as it can be used to achieve goals in problem solving problems and in project problems.

Pupils are required to check and criticize their own and one another's work, according to (Syllabus 4008/4028). Students should be expected to evaluate each other's ideas and reasoning in ways that are not critical of the sharer. This helps to create an environment in which students feel comfortable sharing ideas and discussing each other's methods and reasoning. Watt (2005) suggested that in Australia the use of peers to assess each other's work has potential for improving learner mastery of mathematical knowledge and skills. Peer assessment promotes deep understanding, enhances learner involvement in the academic life, contributes in the development of reflective skills, increases awareness of broad range of possible solutions to problems, aids in the development of self-reliant and self directed learners, and increases collaboration and social interaction by lessening competition among learners (Sivan in Nyaumwe and Mtetwa, 2006). These studies depict peer involvement in learning as having a positive effect because it enhances understanding of subject matter content.

The interactive nature of learning is extended to the process of assessment. Rather than viewing assessment as a process carried out by one person such as the teacher, it is seen as a two-way process involving interaction between both the teacher and the learner. The role of the assessor becomes one of entering into dialogue with the pupils to find out their current level of performance on any task and sharing with them possible ways in which that performance might be improved on a subsequent occasion. Thus assessment and learning are seen as inextricably linked and not separate processes. Teachers should view assessment as a continuous and interactive process that measures the achievement of the learner and the quality of the learning experience and coursework. Analyzing students' solutions is a useful way to assess problem-solving performance. The feedback created by the assessment process serves as a direct foundation for further development. However, in Zimbabwe the most common assessment style are tests and examinations such as school based examinations (mid and end of year examinations) which still call for rote memorization and emphasize procedural skills. The importance paid to the centralized examination makes teachers teach towards tests that do not really emphasized understanding (Mtetwa, 1992; Nyaumwe and Buzuzi, 2007).

Lichakane (2005) in Chauraya and Mhlolo (2008) notes that the strategies used by teachers will largely be determined by factors such as available resources, experience of educators' background, and quality of learners. Manoucheri and Goodman (1998) conducted an ethnographic research in a study involving middle school teachers and found evidence that teachers experienced problems with lack of sufficient time for planning, lack of conceptual understanding of mathematical concepts, and lack of professional support. These factors impact on how and what students will construct from a given learning episode. The progressives criticized traditional school practices such as the authoritarian teacher, exclusive reliance on bookish methods of instruction, the textbook and passive learning by memorization of factual data (Ornstein and Levine, 1989). Students acquire mathematical skills by imitating demonstrations by teachers and the textbook. They acquire mathematical concepts by absorbing teacher and textbook communications (Battista, 1999). The Ministry of Education Zimbabwe Mathematics Team (1995) observed that mathematics instruction is centered on textbooks. Significant changes were needed in the curriculum especially in design and implementation (Ministry of Education Handbook, 1995). Teachers need to help pupils take a more active role in their own learning, reflecting and organizing and creating mathematics for themselves. Personal involvement will foster imagination and creativity that would be promoted by a student-centered approach. It is useful at this point to consider the extent to which questions from textbooks require pupils to engage in some of the higher order activities. Usually, they rarely go beyond application (level 3) of Blooms taxonomy (Haggarty, 2002). Activities that genuinely extend those in the enrichment group without moving them on to new content learning can be developed using questions types found in levels 4 to 6 of Bloom's Taxonomy (Haggarty, 2002). Considering the fact that textbooks are the main sources that teachers use when constructing their lessons, it is important that teachers assess them carefully. Artzt and Armour-Thomas (2002) found weaknesses in mathematics textbooks. Artzt and

Armour-Thomas (2002) stated that when it comes to sequencing and promoting student discovery the text is really poor, there is no room for student discovery and the text is very hard to read and that there are only three examples and their solutions in the section and two of them are of the same type, while the exercise requires the student to solve at least 5 different types of problems, which the book does not model for them. Artzt and Armour-Thomas (2002) also highlighted that textbooks rarely provide occasions for students to introduce any of their ideas. Not only has the content in the textbooks affected the implementation of the student-centered methods but also the availability of the textbooks.

Mogari (2004) noted that factors such as examinations and the death of collegiality in some schools are some of the factors that pose a threat to some pedagogical initiatives. The presence of external examinations encourages teacher-centered classroom practices as well as preoccupation with preparing students for examinations (Majeed, Aldridge and Fraser, 2001). Zimbabwe has a centralized examination system. As long as there are standardized tests at the end of the each level, teachers would continue to provide drill and practice activities to get good results. The stakeholders such as parents, school authorities, teachers, ministry of education officials and even pupils themselves are happy as long as the pupils score high in standardized examinations. Conceptual understanding or the ability to solve non-routine problems does not bother them.

Clements (2002) found out that Brunei students had a low level of conceptual understanding of mathematical ideas involved and they relied more on procedural approaches or rote memorization. Clements (2002) also commented that the drill and practice routine has generated a situation where most students had to regard mathematical 'understanding' as being the same as being able to answer examinations questions correctly. Examination results, generally the public examinations are used as a yardstick or accountability of school performance. Education ministers, students, and parents everyone is concerned about his or her children's examination performance. As a result it is common for school principals to use students' performance in examinations as a yardstick to evaluate teachers teaching capability. This has resulted in teachers completing the teaching of the whole syllabus earlier so that they would have enough time for revision, where they practice the past- year papers again and again. There is no emphasis on conceptual understanding during these times at all. Time is a major constraint. This can be from two aspects: the students' and teachers activities in the classroom could be time consuming. There is a fixed amount of syllabus to be covered within a limited teaching time (Clements, 2002). Hence, many teachers opt for teacher-centered approaches where the teacher instructs while the students listen. Also teachers find, student based activities demand them to spend much time in planning and searching for resources/ideas. Very often, teachers do not have sufficient time to plan their lessons because they are tied down by heavy workloads. Again, the teacher- centered approach is preferred, as it requires less preparation time. Many teachers tend to believe that giving clear explanation with suitable examples (teacher centered approach) is practical and sufficient to achieve most teaching objectives (Clements, 2002). It is time consuming to allow students to construct

their knowledge through student-based activities. Furthermore, they are not confident that their students have acquired enough knowledge and skills if the students were allowed to explore by themselves. Hence, teachers tend to feel more certain if they can control the teaching and learning pace of their students. These are teachers' common beliefs of 'practice make perfect'. These kinds of beliefs are likely to bring about the drill and practice style of instruction in Zimbabwe (Mtetwa, 1992). One difficulty is that, not enough is yet known about how to change the deeply entrenched beliefs about mathematics learning and teaching that are based largely on our own experiences as students. For example, an unfortunate yet widely held belief about teaching is that the role of the teacher is to transmit mathematical content, demonstrate procedures for solving problems as well the process of solving sample problems. If teachers are to become truly student centered in their teaching they must view themselves as agents in their own learning and development. Teachers must be willing and able to explain, and take responsibility for their actions in the classroom by giving careful consideration to what they intend to do, not only before and during the lesson (Artzt and Armour-Thomas, 2002). The reviewed literature supports the incorporation of student-centered methods in order to improve the teaching of 'O' level mathematics. Although a lot of literature seems to be suggesting the adoption of the student-centered methods in order to improve instruction in schools, little progress has been made towards its integration in Zimbabwean schools. The researcher is interested in investigating the factors affecting the implementation of the student-centered methods in secondary schools in Bindura District.

METHODOLOGY

A survey research design was used in this study mainly because of the descriptive nature of the research problem. In Zimbabwe there are ten provinces. Mashonaland central is one of them. Mashonaland central has ten districts. Bindura District is the largest in terms of population size. There is a total of twenty secondary schools in Bindura District. From the twenty schools two are urban schools (10%) and the rest (90%) are rural. One of the two urban schools is the largest in terms of enrolment; it has got a total of twenty 'O' level mathematics classes. The two urban schools cater for the urban students that are from the high and low-density suburbs, rural students and those from the nearby farming settlements. From the eighteen rural schools one (5%) is a boarding school, four (20%) are satellite schools and twelve (65%) are upper tops. There were four groups of schools from which the participants were drawn and each group is a stratum. The study population was the Form 3 and Form 4 mathematics teachers in Bindura District. Stratified random sampling was used to select a sample of fifteen (15) teachers. In this study there were four strata and the participants were drawn from each stratum. A proportional stratified random sample of fifteen teachers based on the location of the schools participated in the study. The sample of fifteen teachers comprised two (10%) from urban schools, one (5%) from the boarding school, three (20%) satellite schools and nine (65%) upper tops. The purpose of stratified random sampling in this study is to guarantee desired representation of relevant subgroups in this study.

In this study questionnaires (for teachers) as well as interviews were employed as the tools to collect data from the respondents. The questionnaire guarantees confidentiality, which in turn generates more valid and reliable information from the respondents. The questionnaire contained both closed and open-ended items. The closed five point Likert scale of Strongly Agree through to Strongly Disagree was constructed. For instance the respondents could rate each item on a 1-to-5 response scale where: 1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree. In this study a face-to-face interview was conducted. Interviewees were informed about the purposes of the study, the importance of their contributions and given assurance in terms of confidentiality of the information provided. Ten teachers from the nearby schools selected from the fifteen schools in the sample were interviewed. Concerns for validity and reliability arise from the need to ensure that conclusions drawn from the results are credible. In terms of 'what' is measured, content validity was considered. Building some redundancy into the instruments checked internal consistency; items on the same issue were repeated in the questionnaire. This was done to enhance reliability. The questionnaire was piloted with Bachelor of Science Honours degree students. Pilot testing of instruments also helped to reveal whether questions and instructions were clear.

Data Presentation analysis and Discussion

Teachers' views towards the student-centered methods

The frequency table 1 below shows the views of teachers towards the use of student-centered methods in the teaching and learning of mathematics.

Table 1: Teacher's views about student-centered instruction

		N=15				
<i>Key 1= Strongly Agree, 2= Agree, 3= Neutral, 4=Disagree, 5= Strongly Disagree</i>						
Items	1	2	3	4	5	
1 It is difficult to incorporate student -centered instruction because we were not trained to do so at college	0	0	0	7	8	
2 It is time consuming to allow students to construct their knowledge through student based activities.	9	6	0	0	0	
3 Meaningful learning results from the interaction of the learner with the social environment.	7	6	2	0	0	
4 Heavy workloads on teachers which make it difficult to engage in effective teaching and learning of mathematics	8	3	4	0	0	
5 Student-centered activities encourage conceptual understanding in mathematics.	11	4	0	0	0	
6 Student based activities demand teachers to spend more time on planning and searching for resources or ideas.	8	5	2	0	0	
7 Mathematics problems given to students should be solvable quickly in few steps.	2	3	0	10	0	
8 Mathematics knowledge is the result of the learner interpreting and organizing information gained from previous experiences.	9	3	1	2	0	
9 The goal of teaching is to ensure that all students can achieve good results in ZIMSEC examinations.	2	0	2	7	4	

Constraints of using the student-centered methods

Teacher training

From the questionnaires (Table 1), seven teachers disagreed and nine teachers strongly disagreed that they were not trained at the colleges to incorporate the student-centered methods instruction. All the respondents indicated that it is possible to implement the student-centered methods in the teaching and

learning of mathematics since they were trained to do so. These findings are in line with Chauraya and Mholo (2008) who state that the notion of problem solving as a child centered instructional strategy is part of pedagogic component of most pre-service and in-service teacher preparation programmes in Zimbabwe. Teachers are introduced to the theoretical underpinnings of mathematical problems and problem solving during their training programmes. Chauraya and Mholo (2008) also noted that the current teacher preparation programmes seem to have little impact on the actual implementation of mathematical problem solving in instructional situations, which could be an indicator that mathematics teachers are not adequately prepared for the student-centered instructional techniques. Bonwell and Eison (1991) stated that traditional teaching approaches to student learning, in which lectures talk and students listen, predominates in universities despite repeated calls over the past 15 years for lecturers to actively involve and engage students in their own learning. From this statement, it could be possible that the teachers have the theoretical aspects of the student-centered methods, which they could not implement practically.

Time consuming

Nine teachers were of the idea that it is time consuming to allow students to construct their own knowledge through student-based activities. Teachers highlighted that these student-centered methods are time-consuming, compromising the coverage of the syllabus. Teacher A interviewed said, "Pupils take more time constructing their own knowledge.

It will be a waste of time since there is more to be covered. The lessons are only thirty minutes and involving pupils in meaningful learning will be a waste of time." Teacher B said, "The syllabus is just too long; we spent two years trying to cover it. Covering the syllabus is very important as this gives the pupils confidence that if they finish the syllabus they will be able to pass the examinations." These teachers are concerned with covering the syllabus so that they have enough

time for revision. The revision activities usually involve practicing the past examination papers again and again. Covering the syllabus guarantees both the teacher and the pupils that there will be high chances of examinations being passed. The need to cover the syllabus is supported by (Clements, 2000) who said that there is fixed amount of syllabus to be covered within a limited teaching time. The thirty minutes are not adequate to cater for effective teaching, hence it can be concluded that the teacher-centered methods are used, as they are the ones that can speed up the coverage of the syllabus.

Heavy workloads

Teachers believed that it is difficult to engage in effective teaching and learning of mathematics. Teachers indicated that the teaching load is just too much 30 lessons per week, classes are too large and the need for daily exercises even worsens the situation. Teacher C said "Despite teaching I also have other duties to perform at school after the daily teaching. I need to mark, and attend to sporting activities". This shows that teachers have a lot of activities to do that also hinder the implementation of the student-centered methods.

Teachers' subject matter Knowledge

Eight teachers strongly agreed whilst four teachers agreed that student based activities demand them to spend more time on planning and searching for resources or ideas. Teacher D said, "I need more time to research on internet and libraries since we do not have enough resources, and also the problem that we have in mathematics is that we have limited knowledge because mathematics is a Western Subject." This shows that the teachers lack the content knowledge in mathematics. It is well known that subject matter knowledge alone is insufficient for successful teaching; however there are clear indications that the presence or the absence of such knowledge does affect the quality of teaching (Taylor *et al*, 1999 in Rhemtula, 2006). Teachers need to know and understand more of their subject. Teachers' lack of advanced conceptual knowledge in mathematics has proved to be problematic for professional development in many mathematics studies (Barrent *et al*, 2002).

Language barrier

One teacher indicated that English language is a barrier in mathematics implying it is difficult to teach the subject in a foreign language, he was advocating for indigenous language. In Zimbabwe mathematics is taught using English language and all the mathematics textbooks are written in English, yet it is a second language.

However, it is not clear how language impacts on the teaching of mathematics (Sibanda and Sialulenga, 2004; Nziramasanga Commission, 1999). Sibanda and Sialulenga (2004) argue that in real life situations the reasoning capacity of an individual is largely determined by his/ her verbal utterances. Worf quoted in Sibanda and Sialulenga (2004) argue that the way people think is largely determined by the way they speak. This implies that in Bindura District where the majority of the students take English as a second language are likely to have difficulties in the comprehension of the mathematical terms. This is also supported by Peacock (1995) in Mamiala (2006)

who indicated "texts are often too difficult for children... in developing countries where pupils are learning through English as the medium of instruction." Although the aim of teaching students mathematics is for them to develop skills and use them, but the ability to tackle the problems require comprehension and interpretive skills.

Resources

Textbooks

Twelve teachers indicated that they did not have enough textbooks in schools. This is also supported by teacher E who said, "I only have one copy of the 'O' level mathematics textbook, which I use." Effective teaching of mathematics is highly depended on text availability. They give confidence to teachers by serving as a secure base from which content, teaching strategies and techniques are drawn. Shortage of textbooks has negative implications for adoption of child-centered methods in the teaching and learning of mathematics.

Lack of teaching and learning aids

Teacher E said "Pupils do not have materials like the mathematical sets or the graph papers for linear programming, but what is surprising is that the headmasters provide the graphs during the examinations. The school provides graph papers and other necessary examination equipment during the examinations" Resources are provided during the examination period, indicating that the school authorities are also interested in outcomes of the examinations. School authorities are happy as long as pupils score high marks in standardized examinations.

Examination oriented

Seven teachers agreed whilst four teachers strongly disagreed that they teach for examinations as indicated in table 1. Respondents were of the idea that teaching was not meant for examination only. This clearly shows that the teachers are aware of the goals of teaching mathematics in Zimbabwe. However, the data were collected whilst the 'O' level students were about to write their examinations, and the researcher managed to observe one of the female teachers who completed the questionnaire and was delivering an 'O' level lesson. It was observed that the teacher was busy drilling the pupils for the ZIMSEC examinations, revising the past examination papers; hence the researcher concluded that the teacher was concerned about the pupils passing the examinations. How well their students performed in the public examinations measure teachers' performance, hence they spend most of their time drilling pupils for examinations. Although the teachers are aware of the goals of teaching they are usually guided by the summative examination system in Zimbabwe that relies heavily on recall and procedural application of mathematical results (Nyaunwe and Mtetwa, 2006). It emphasizes correct computations at expense of logical reasoning and thinking. As a result teachers in secondary schools do not prioritize non-examinable skills that pupils can develop during their learning. Nine teachers disagreed that mathematics problems given to students should be solvable quickly in a few steps. This observation contradicts also with researchers such as Fast (2000) who noted that in Zimbabwe pupils are very good at procedural skills. More emphasis is given to algorithmic aspects to ensure students ability in answering examination questions and students learn in school

that problems mostly have neat, unique solutions, and methods to solve problems will be provided for them.

Teaching methods being used by the 'O' level mathematics teachers

The frequency table 2 below shows the different teaching methods that the teachers claim they use in their teaching of mathematics.

Table 2: Teaching methods N=15

Problem-based learning	9
Group work	11
Discovery learning	12
Lecture-Discussion	6
Demonstration	3
Project method	3

Teachers claim they use the student-centered methods such as problem solving group work and discovery methods as indicated by the very high values from table 2, problem solving (9) and group work (11) and discovery method (12). They also rated these methods as very effective. These claims are based on the idea that the teachers were theoretically trained and they are fully aware of what constitutes effective learning. Furthermore these were also claims as noted by the poor performance of the 'O' level mathematics students as indicated by Nziramasanga (1999). However, this observation contradicts with a number of researchers such as Mtetwa (1992) who states that instructional practices in Zimbabwe are characterized mainly by teacher demonstrations and pupils' imitations, followed by drill and practice through written work. Drill exercises are likely to dominate classroom mathematics in Zimbabwe as revealed in Chauraya and Mhlolo (2008). The Zimbabwean teachers have continued to use teacher-centered methods as reported in the Curriculum Development Unit (1995). The mathematics team: Curriculum Development Unit (1995) report noted that most teachers avoided those teaching methods that were student centered and mainly used demonstration and lecture methods. Fast (2000) observed Zimbabwean classrooms, over an eight-year period and indicated that direct instruction was the preferred approach at all levels. It seems the teacher-centered methods still dominate in Zimbabwe.

Reasons for not choosing demonstration method

Twelve teachers indicated that it promotes rote learning. However this contradicts with teacher G who said "I always use the demonstration method because it is the most effective one, more concepts are covered in a short period of time, and it also helps to cover the syllabus in a short period of time so that I will have enough periods I will have enough time to revise all the topics in the syllabus." These findings from the interviewee are supported by Mtetwa (1992) who states that instructional practices in Zimbabwe are characterized mainly by teacher demonstrations and pupils' imitations, followed by drill and practice through written work. The teacher-centered methods still dominates in the mathematics classrooms.

Reasons for not choosing the project method

Three teachers claimed that they use the project method in their teaching of mathematics. The majority of the teachers do not use this method and reasons such as the time required for

such activities and examination requirements were highlighted. An aspect on examinations that was raised was the nature of the final assessment. Teacher H said "If the final assessment included a percentage on project work like what they do in 'O' Level Agriculture, then probably teachers would have reasons to do the projects." Teachers indicated that no marks from projects or small investigations contributed towards the final mark; hence there is no need of carrying out such small investigations. Assessment is not carried out as a process but it is carried out, as a product and this could be the reason why teachers do not take project problems seriously. This is supported by Nyamwe and Mavhunga (2005) who noted of the existence of what they referred to as the "crowded O' level curriculum" this does not allow teachers to allocate a lot of time for students activities like small investigations or projects. In schools pupils do not do mathematics only hence there is need to allocate time for the other subjects which results in crowded timetables implying that there no time to carry out the small projects. The small number of teachers seems to agree with the study carried out by Chauraya and Mhlolo (2008) that revealed that in Zimbabwe the project method was likely to remain relegated to the periphery of mainstream in classroom mathematics instruction.

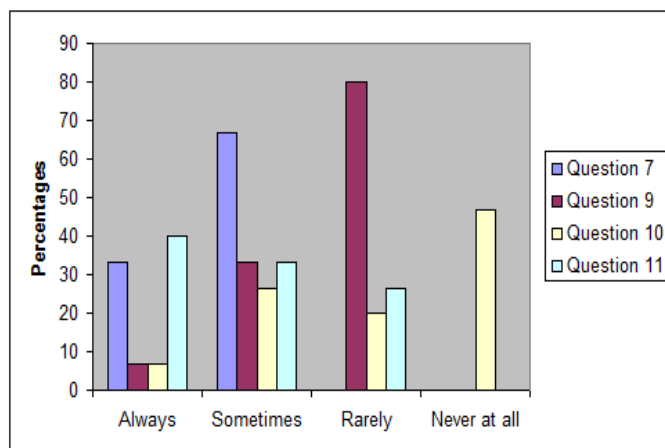


Figure 3: Teachers responses on teaching methods

Teachers' responses on teaching methods

Nine teachers sometimes use group work from table 3 above. Respondents highlighted that the time per lesson, thirty minutes, is too little. The students are too many and we need more time to move around helping each group. This concurred with teacher C who said that classes range from 53-60 pupils. This means that the number of groups in each class is also large and reduces the chances of effectively monitoring all the groups in a class. Respondents also commented that group activities could help learners to catch up with other pupils. Pupils should interact with each other, as this will involve the learners. They also highlighted that pupils tend to choose groups, which comprise pupils of the same caliber and therefore do not benefit much. The problem of large numbers per class was also identified by Abiodun (2008) who carried out a research on group work in mathematics and noted that the issue of class size was a problem because in a particular class the number of groups was up to fifteen. This made it difficult to cover all the groups in one lesson. Abiodun remarked that in a situation where teachers are required to cover specific material within a given period of time, they find it difficult to pursue lessons to their satisfaction.

Conclusions and recommendations

The study was concerned with the factors that hinder the implementation of the student-centered methods. The study sought among other issues to identify the teaching methods that were employed by 'O' level mathematics teachers in their teaching and learning of mathematics. It was observed from the study that the majority of the teachers who participated in the study agreed that student-centered methods benefit in the teaching of 'O' level mathematics concepts. It was also established that several obstacles could hinder the implementation of the student-centered methods, for instance the presence of examinations, time, resources such as textbooks, teacher training that equips teachers with enough skills to implement the student-centered methods, heavy workloads, language barrier and classes. These findings concur with the findings of Clements (2002) and Mtetwa (1992).

The research has also shown that teachers do not refer to the syllabus for their teaching methods, yet the syllabus has a section that recommends on the methodologies that are supposed to be used in the teaching and learning of mathematics. The study also revealed that while teachers are aware of the educational benefits of the student-centered methods, the challenge of incorporating the student-centered methods in the teaching and learning of 'O' level mathematics is within the curriculum structure which places too much emphasis on the examinations. The most daunting impediment is the examination system, which promotes the engineering of resources that are meant to help students pass the examination, but unfortunately this situation promotes memorization and teacher-centered approaches like drilling. The examination system that evaluates pupils' ability to find correct answers to mathematical problems using standard procedures leads teachers to a view that pupils should be coached to recognize mathematical problems in their routine form and should master the procedures to solve problems correctly (Nyaumwe and Buzuzi, 2007). This encourages teachers to use the teacher-centered methods and hinders the implementation of the student-centered methods in this country. It emerged that teachers rarely consult the syllabus when teaching, which major factor that prevents the achievement of the objectives is requiring student-centered methods as stated in the syllabus. All these research findings to a greater extent are in line with prior researches and it has clearly shown that there are not many student-centered methods that are being used in the teaching and learning of mathematics. So it can be concluded that unless the stated constraints are addressed, student-centered methods will ever remain in the archives. The recommendations of this study were mainly focused on the improvements as to the implementation of the student-centered methods in the teaching and learning of mathematics. In order to improve the teaching and learning of 'O' level mathematics it is important that the curriculum planners examine the Zimbabwe mathematics, education system and appreciate that there is indeed a problem as reflected by the poor mathematics results and also as reported in Nziramasanga (1999). There is need to vary the nature of examination from testing pupils on questions requiring procedural skills only to questions that call for higher order thinking skills and problem-solving. Changing the nature of assessment is essential in this context. Analysis carried out in this study showed that there was a class

average of 50 pupils taking mathematics lessons. It is suggested that the schools should be structured so as to reduce the number of pupils in each class to a manageable size with the hope that teaching will become more effective. It is also suggested that further research be carried out on how these mathematics teachers are being trained in the different training institutions.

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