

Foundations for success in the teaching of O-level mathematics in rural day secondary schools in Masvingo district

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Abstract

The growing failure rate in Mathematics at O-level is cause for concern and warrants an in-depth investigation. This study focused on factors that make the foundation of success in the teaching and learning of Mathematics. The study was qualitative and employed a case study design. Semi-structured interviews were used as data generation tool. The study found out that for effective teaching and learning of mathematics, there is need for competent teachers, teacher availability, teaching experience, marking experience, availability of resources like textbooks, parental involvement, good mathematical background, among others. The study recommends that the Ministry of Primary and Secondary Education holds staff development workshops with both primary and secondary school teachers in order to develop their teaching competencies in the subject.

Key words: foundations, mathematics, teaching and learning, success, failure

1. Background to the study

There is growing concern over low performance in O-level mathematics in Zimbabwean secondary schools as very low pass rate is always the order of the day. Low achievement in mathematics is an issue of great concern to the public, policy makers as well as educators (Slavin, Lake & Groff, 2009). Society believes that secondary school mathematics is directly linked to the nation's competitive strength. To that end, students are expected to compete effectively in the teaching and learning process so that results are of quality. Zimbabwe is in a state of economic recovery and requires people with basic skills in mathematics so as to promote socio-economic transformation. This means that the nation should have students who perform well in mathematics as a necessary grounding for take off to growth.

Prior to the attainment of independence in Zimbabwe, African education was mainly dominated by a watered down curriculum, where subjects like communication skills, gardening, cookery, home-craft, among others, were the mainstay of African curriculum. With the attainment of independence, the curriculum was revamped to meet the needs of society and its students. Mathematics was one of the subjects on which emphasis was put in order to develop a mathematical base and background among the learners. The thrust of the Curriculum policy of 2002 is geared towards the establishment of a strong mathematical base for economic development (Secretary's circular No 3 of 2002). In order to meet this target, mathematics has been made a compulsory subject at O-level in Zimbabwe. The poor performance in mathematics by most students at O-level shows that the country will take long before meeting the Zimbabwean government's target. There is a lot of debate on how to foster greater knowledge of and improved performance in mathematics among many Zimbabwean students.

Mathematics has grown phenomenally beginning in the nineteenth century and even way back. It is now viewed in a new perspective emphasising structural considerations, and new branches of the subject have mushroomed (Howson, Keitel and Kilpatrick, 2008). The development of the mathematics curriculum in schools was seen as useful as far back as 1857 by Tate. The following reasons were advanced for the need to have mathematics in the curriculum for schools:

- Mental arithmetic cultivates the memory and the powers of conception and reasoning. It also especially fosters the habit of promptitude, presence of mind, and mental activity.
- Arithmetic cultivates the reasoning powers and induces habits of exactness and order.
- Mathematics and Natural Philosophy cultivate the reasoning powers chiefly in relation to the acquisition of necessary truths; they also cultivate habits of abstraction (Tate as cited in Howson, Keitel and Kilpatrick, 2008, p. 24).

This underscores the importance of mathematics to all learners in the school system. Deprivation of such a subject would reduce the mental powers and reasoning capabilities of individual students. It is argued that

nations should seriously think about the education they want to provide. In their aims and objectives, Mathematics teaching should be of central importance.

Mathematics and science, closely interlocked, are the basis of the most revolutionary of recent developments in society and in the everyday lives of all young people. Even the slowest pupils are interested in progress and success, and in demonstrating that mathematics can contribute towards success, we may best hope to give all pupils before leaving school some realization of its intrinsic value (Newsom Report as cited in Howson, Keitel and Kilpatrick, 2008, p. 52).

The purpose of any curriculum is to guide in the development of knowledge, skills and attitudes that are important for individual and societal development. Similarly, the mathematics curriculum has to develop the intellect for students that are exposed to it. What is most important is that teachers should have the craft literacy and craft competency to interpret the curriculum and syllabus matter. Teacher preparation is an important area that has to be attended if at all schools aim at improving pass rate in the mathematics. The argument is that if teachers are not familiar with the curriculum they might fail to implement it to the required standard (Thungu, Wandera, Gachie and Alumande, 2008).

2. Statement of the problem

O-level graduates are facing challenges in passing mathematics over the years. Mathematics is a compulsory subject and teachers' colleges, universities and most job opportunities require a pass in mathematics for one to be considered. Against that backdrop, most schools are finding this a challenge to make students pass. A lot of leakages are experienced in O-level mathematics examinations in a bid to get a pass in the subject and students suffer lots of re-writes. Many parents have gone to the extent of employing teachers to provide extra lessons in mathematics because of continued failure in the subject. There are many O-level products who are failing to take up their career choices because they have not passed mathematics at O-level. Teachers' colleges and universities demand

3. Purpose of study

This study explores important contributions to the improvement of mathematics teaching and learning.

4. Research questions

1. To what extent do teachers contribute towards low O-level pass in mathematics?
2. How do textbooks contribute towards low pass rate in O-level mathematics?
3. In which way does lack of parental involvement contribute towards poor pass rate in mathematics?
4. What school conditions affect student performance at O-level in mathematics?

5. Theoretical framework

This research is guided by John Amos Comenius's philosophy sometimes referred to as the father of modern education and teacher of nations. Comenius explored how people learn and how they should be taught from infancy to university and beyond. Comenius believed that human beings were born with a natural craving for knowledge and that schools beat it out of them. He advocated that the curriculum taught in schools should be of relevance to ensure that what is taught can be applied to the everyday experiences of the learner and that it is of immediate practical use to the learner. He further argues that appropriate sequencing of content should cater for the age and ability of individual learners. Progression of learning should also depend on the different stages of growth and development. There is need for teachers to make use of instructional resources and the immediate environment to enhance learning. Teachers have to use activity methods in teaching and learning. Students learn effectively in a safe and stable learning environment. Learning should proceed from the general to the particular or specific and from known to unknown, through experience (Thungu, Wandera, Gachie, and Alumande, 2008).

6. Literature

Poor performance in mathematics is a global phenomenon. Research has shown that even in the United States, principals and teachers are complaining about poor performance in mathematics by most students (Jackson and Wilson, 2012). It is argued that issues that are central to improving mathematics learning and teaching are those of equity, the content of textbooks, and graduate education (Cobb and Jackson, 2008). Textbook availability enhances easy teaching and learning by students. Learners can easily see examples from the texts and can share experiences on their own.

In a study that was carried out on senior secondary teaching success, it was found out that teaching success was a result of developing and sharing programmes, resources and teaching ideas (Ayres, Dinham & Sawyer, 2000). Mathematics teachers who share ideas through workshops, meetings and staff development programmes are likely to be more effective in their teaching practices and thus make a strong foundation for student learning.

In a study carried out by the National Research Council (2004), it was found the content in mathematics textbooks contributes towards pass rate in secondary schools. Mathematics textbooks should have matter that corresponds with current conceptions of appropriate curriculum.

Literature points to a close link between performance of students in a subject and effective classroom management. It is argued that for teachers to achieve positive educational outcomes, they need a critical mass of skills to manage the behaviour of students in the classroom. Good instruction is only possible if the behaviour of the learners is controlled and properly managed because where there is no discipline there is no learning (Oliver, 2007). Teachers should be able to handle disruptive behaviour so that low achieving learners can get assistance through remedial work and special education (Donovan & Cross, 2002). The ultimate goal of the teaching and learning situation is to provide an opportunity for each learner to obtain maximum benefit from the subject content designed by the curriculum designers and build up potential for individual development.

7. Research methodology

The study was qualitative and employed a case study design. Semi-structured interviews were used as a data generation tool.

8. Findings

Teaching experience

- *The number of years that one has taught the subject is cause for concern. If you are a new member in the field, you might not have developed the mechanics of the field*
- *Teachers who have been teaching for a longer period at a school can handle the subject in a better way than newly recruited teachers*
- *Teaching experience affects the way of teaching as this broadens teachers knowledge and their ability to prepare for work*
- *The adage that experience is the best teacher remains valid because such teachers know which points to stress and which areas need emphasis*
- *Experience enables teachers to overcome challenges during the teaching and learning process*
- *More experience means more exposure to the tricks of the subject and to problem solving skills*
- *There are common errors which experienced teachers are aware of and this puts them at an advantage*

Marking experience

- *Experience in marking public examinations provides the teacher with a skill on how to set termly tests, weekly tests and end of year tests. To that end students are given proper practice of likely examination questions*
- *Some teachers have the advantage of marking public examinations where they see topics that continuously appear and how to tackle them.*
- *This is not the case with most rural teachers who are not exposed to marking public examinations*

Availability of resources in the school

- *It is very difficult for students to pass without adequate textbooks in the schools*
- *Some schools lack teaching and learning resources and this affects the quality of teaching mathematics.*
- *Teachers who lack adequate textbooks find it very difficult to plan effectively.*
- *Schools that lack library facilities cause problems to teachers for they cannot develop mastery of concepts to students with limited facilities*
- *Students who have nothing to turn to are badly affected when trying to pursue homework and private study at home*

- *The textbooks that are available today have illustrations, exercises and examples which assist students' understanding so their unavailability pose problems to students' concept formation and development*

It should be noted that the critical issue is not the mere presence or absence of resources but how those resources are actually used in the classroom and what students are learning as they engage in activities. It is argued that textbooks act as a source of content for both the teacher and the pupils during the teaching and learning process (Brunner, 1966). To its credit, the Panel's Task Group on Instructional Practices acknowledges that mathematics teaching is an extraordinarily complex activity involving interactions among teachers, students, and the mathematics to be learned in real classrooms (Brunner, 1966, p. 4-10).

Parental involvement

- *Mathematics is a practical subject and requires parents to purchase all the materials that the student wants to use like graph books, mathematical sets, calculators, among others*
- *Parents who fail to provide mathematical sets put their children at a great disadvantage*
- *Lack of sets results in most students failing to engage in practical activities yet they are the gateway to success*
- *Parents need to supervise homework if they mean serious business*
- *Students need monitoring when they are at home particularly after school and during weekends so that they do their homework and private study. Lack of such close supervision by parents results in students engaging in uncontrolled behaviour, lack of individual practice and promiscuity*
- *Parents have to guard against their children from absenteeism from school because they loose content taught*

Parental involvement has long been identified as a contributory factor in enhancing student success at school in many ways. Various types of parental participation in schools include, among others, communication with child's teachers and by attendance at parent-teacher meetings, attending school presentations by pupils, attending school events or activities related to other altruistic activities in the school and volunteering at school. Parent involvement can also be by way of reading activities at home with child, assisting a child with homework, or communicating with a child about learning experiences at school (John-Akinola and Gabhainn, 2014).

Teachers' use of various pedagogical methods

- *The inadequate use of a variety of teaching methods like models, film strips, chalkboard, among others, leads to poor teaching of the subject. Poor teaching is a recipe for failure by students*
- *Poor teaching methods lead to learners failing to grasp the concepts*
- *If students are poorly taught in mathematics they end up having a general dislike of the subject*
- *Teachers who fail to break down the matter into manageable components results in learners feeling that the subject is a hard nut crack*
- *Group work that is given without thought and that is not monitored to ensure that students do not go astray results in poor answers by students*
- *E-e-e, you know what, if the teacher employs poor teaching methods, students will not grasp the basic concepts*
- *The use of interactive methodologies like discovery method in mathematics enables students to participate in lessons fully so lack of these retards understanding and consequently causes poor performance*

Teachers should not be in the classroom just to ensure presence in the school system. They should have skills of structuring the matter so that it is easily consumed by students. They should have knowledge of the theory of instruction. Bruner (1966) states that a theory of instruction should address four major aspects: (1) predisposition towards learning, (2) the ways in which a body of knowledge can be structured so that it can be most readily grasped by the learner, (3) the most effective sequences in which to present material, and (4) the nature and pacing of rewards and punishments. If teachers have good methods for structuring knowledge, this would result in simplifying, generating new propositions, and increasing the manipulation of information.

Learners' mathematical background

- *Learners who lack a strong foundation of the subject from the primary school suffer most*

- *Most students have a poor mathematical background. They are likely to find it hard to sail through when they get to O-level*
- *It is very difficult to try and build up a concept on top of a poor foundation*
- *Poor background impacts negatively on general understanding of concepts and the teacher is posed with a lot of remediation challenges during the teaching and learning process*
- *A strong base enables students to assimilate knowledge easily and get better chances of performing well*
- *When a teacher is given a secondary school class to teach, the teacher has a stereotype of a secondary school student and begins at that level. Those with missing links are in problems until the teacher notices that, if at all that will be noticed. So effective learning is all about the foundation that has been laid already*

It is argued that the primary school teacher is often lacking in mathematical knowledge; indeed she might well fear or hate the subject (Howson, Keitel and Kilpatrick, 2008). If students lack a good background in Mathematics, they are not likely to do well in their future studies.

The availability of a mathematics teacher

- *Schools that spend a term or so without a teacher put students at a great disadvantage*
- *Without a teacher to initiate the learning process, students are like orphans without a parent to look after and they cannot go anywhere*
- *Syllabus coverage is key to high performance in mathematics because if you fail to cover the syllabus then one cannot expect miracles from students in their examinations*

The presence of the teacher in the classroom is a measure that entails some kind of exposure to the subject by students. Although schools should think about what teachers are doing inside the classroom but their presence is a quality measure for its readiness to be taught. Research argues that careful investigation is needed into what teachers do, how they interact with students, and the effects of this interaction on students' performance in mathematics (Johnson, 1984, p. 150). Teacher competence can also be measured by ensuring that all students attend the lessons and are highly attentive as the lesson progresses. High motivational skills are a good sign of teacher competence and teachers who lack such skills are a recipe for student failure and dislike of the subject.

The need for competent teachers

- *The teaching of mathematics requires the presence of a competent teacher*
- *Mathematics requires a teacher who has knowledge of the subject matter so that explanations, examples and demonstrations are given properly and accurately to avoid confusion among the learners*
- *Competent teachers are highly committed and go an extra mile in their work. If teachers do their work lackadaisically and requiring a push always, mathematics students automatically fail.*
- *Without competent teachers, no meaningful learning takes place*
- *The advantage of competent teachers is that they can go an extra mile and look for current revision and practice books, they attend to individual needs of each learner, they love their work and are really motivators. If a school does not have such characters then one should not expect much from students*
- *In teaching mathematics, the transfer of knowledge requires competence in mixing the assumed knowledge of the learner, the content and in developing the actualization phase. Lack of such competence leads to poor formation of mental pictures in the minds of children*
- *Competent teachers do not teach for examinations but give a broad view of the subject and students can deal with complex questions regardless of the way questions are asked*

The teacher should not be a stranger in front of students showing signs of lack of subject matter. It is important that the teacher demonstrates proficiency in the subject area so that students benefit. The quality of the teachers involved in the teaching and learning process is the key factor in any classroom innovation. Over and above pre-service training, there must be provision for in-service training, for the constant up-dating of professional knowledge (Gagne, 1974).

Attitudes of learners towards mathematics as a subject

- *Some students have developed a negative attitude towards mathematics and this becomes a hindrance towards their effective learning of the subject*
- *Students who develop negative attitudes fail to concentrate and even abscond from the lessons*
- *Some students have a general phobia of mathematics and they think that they will never manage. Such fear results in lack of attentiveness and passiveness during the lessons*
- *Students who have a negative attitude will not participate during the lessons at all and disturb others from fully concentrating, they are really a nuisance for they cause indiscipline problems and disturb the smooth running of the lesson*
- *Mathematics requires learners who have interest in it and who commit themselves to the work. If one does not commit herself or himself fully then problems are likely to arise and they might get very weak passes*

It is argued that learners develop a positive attitude towards a subject when they see the need in doing it (Zimring, 1999). In line with that thinking, Rogers (1969) abstracted a number of principles about learning. Of relevance to this study is the aim which states that significant learning takes place when the subject matter is perceived by the student as having relevance for his/her own purposes, when the individual has a goal he/she wishes to achieve and sees the material presented to him/her as relevant to the goal, learning takes place with great rapidity. Some students feel that the subject is of no relevance to them because they are specialists in the arts.

Lack of in-service training and staff development programmes

- *Some teachers have long been from college and have never attended some kind of in-service training*
- *You know what, brain is like a slate and if not sharpened, it rots and decays totally. So teachers need some kind of sharpening through staff development and in-service training*
- *In-service is a tool that rebuilds teachers and exposes them to new content, new ways of teaching and clears misconceptions on certain concepts*
- *There are areas one might find gloomy and needs some explanations from experts and such exposure enhances and improves the teachers' understanding of the subject and their understanding is the children's understanding of the subject as well*

In-service training might raise the standards of mathematical argumentation by teachers, classroom discourse, preparation, methods of tackling given problems and skills of dealing with students with varying abilities. Students seem to dislike a subject that is haphazardly taught and they develop negative attitudes towards the subject.

9. Conclusions and recommendations

In the light of the above findings, several conclusions and recommendations were made. It has been noted that teachers are not highly competent in teaching mathematics as a subject. This results in their ineffectiveness and hence high failure rate by most students. Schools lack capacity building workshops that might improve the quality of classroom discourse. Staff development programmes that expose teachers to effective pedagogies lack in schools and this renders teachers incompetent to teach the subject in question. Textbooks are not adequately provided for and most students share. Students who share textbooks find individualized instruction extremely difficult. The study concludes that for effective teaching and learning of mathematics, there is need for competent teachers, teacher availability, teaching experience, marking experience, availability of resources like textbooks, parental involvement, solid mathematical background, among others. In the light of these conclusions, the study recommends that the Ministry of Primary and Secondary Education holds staff development workshops with both primary and secondary school teachers in order to develop their teaching competencies in the subject.

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