Research & Reviews: Journal of Educational Studies

THE NATURE OF THE GAP BETWEEN THE INTENDED AND THE IMPLEMENTED ORDINARY LEVEL MATHEMATICS CURRICULUM: A CASE STUDY OF MASHONALAND CENTRAL DISTRICT

Pagana J, Nyikahadzoyi M, Mutambara L.H.N, Chagwiza C*

Bindura University of Science Education

Review Article

Received date: 31/08/2015

Accepted date: 15/10/2015

Published date: 22/10/2015

***For Correspondence**

Chagwiza C, Bindura University of Science Education, P Bag 1020, Bindura, Zimbabwe; Tel:+263 2716372-2

E-mail: cjchagwiza@gmail.com

Keywords: Intended curriculum, Implemented curriculum, Gap.

ABSTRACT

An information- and technology based society requires individuals who are able to think critically about complex issues, analyze and adapt to new situations, solve problems of various kinds and communicate their thinking effectively. To learn mathematics in a way that is beneficial to students in their lives, there is need to have classroom experiences that help them develop mathematical understanding, develop skills, procedures and habits, develop the ability to apply mathematics and acquire a positive attitude towards mathematics. The study sought to establish the nature of the gap between the intended and the implemented mathematics at ordinary level in Zimbabwean Secondary Schools. As is typical of ethnography, the focus of the study was mainly on teaching methods, the "O" level intended mathematics curriculum interpretation as well as issues surrounding assessment and classroom discourse in the teaching and learning of "O" level mathematics. A sample of fifteen qualified teachers purposively and randomly selected from sixty qualified mathematics teachers in Mashonaland province was used. A mixed research paradigm was employed and data was collected through document analysis, focus group discussions and lesson observations. However, the curriculum expectations of the "O" level mathematics curriculum do not seem to be reflected in practice in a classroom situation. Measures cited for the successful implementation of the curriculum is through in service training programs, workshops and launching a resource centre.

INTRODUCTION

In an international review of mathematics education, Howson and Wilson comment that what is urged by educators and in official reports in the learning of mathematics is not in line with what can be seen in the classrooms of some outstanding teachers [1]. A typical traditional mathematics lesson relies heavily on the textbook and the traditional teaching pattern of exposition-examples- exercise. A report on mathematics teaching in countries of the SADCC region recommends more active participation of pupils in the learning process.

This study seeks to find out more about the teaching and learning of ordinary level mathematics in Zimbabwe. To improve performance in mathematics, it is important to advocate worthwhile approaches in learning mathematics and implement them effectively [2]. In Zimbabwe, the ordinary level mathematics curriculum (syllabus) advocates certain teaching methodology. If these suggestions are worthwhile, then what exactly is happening in a mathematics lesson in schools in a selected district in Mashonaland central?

There has been a considerable curriculum development in Zimbabwe since 1980. The current "O" level mathematics syllabus has been developed locally in co-operation with the University of Cambridge Local Examination Syndicate, which was first examined in 1991. It suggests that concepts should be taught from the concrete and familiar moving to the abstract. It further suggests that learning should be based on sound understanding of concepts and be learned through activity-based discovery or

guided discovery approach. There is an emphasis on reinforcement of skills taught in other subjects. The syllabus recommends that group work be used regularly during mathematics lessons and that mathematics should build an interest and confidence in tackling problems, in familiar and unfamiliar situations.

The teaching methodology in the Zimbabwe "O" level mathematics syllabus is an educational policy which needs to be reflected in practice. What exactly is happening in the learning of "O" level mathematics in secondary schools in Zimbabwe?

The Problem Statement

Past researches point out that the disparities between the intended and the implemented mathematics curriculum are among the major contributors to the poor performance in the subject. An analysis of the mathematics pass rate in a district in Mashonaland province for the past three years clearly portrays that really there is a high failure rate in the subject. In 2009, the percentage pass rate was 12%, followed by a pass rate of 14% in 2010. In 2011, the pass rate was 11% and this year it was 9%. The curriculum statement on mathematics education is explicit on the goals and objectives to be pursued by mathematics teachers in the teaching process. It is also clear on different methodologies to be employed in learning the subject. Despite these well-articulated objectives of teaching mathematics and clarifications on what to learn and how to learn it, students' poor performance has long been a subject of discussion among parents, teachers, educators, political leaders and students themselves.

It is against this background that this research seeks to explore the nature of the gap between the intended and the implemented mathematics curriculum in Zimbabwe secondary schools. Cobb et al assert that the intended curriculum can become a reality when educators are able to understand the goals learners are expected to achieve; the content learners are to master and the pedagogies that enable learners to understand what they learn. The study is guided by the research question: What is the nature of the gap between the intended and the implemented ordinary level mathematics curriculum in Zimbabwe [3]?

The researchers were interested in the mathematics curriculum as outlined by the curriculum planners and how it is being implemented in the classroom by the classroom practitioners. The researcher is not worried about what the learners will produce at the end (result).

Conceptual Framework

Mathematics is among one of the most important subjects in the school curriculum because of its practical application to various work environment such as biology, engineering, economics and business.

The key teaching approaches recommended in the syllabus are approaches in which Mathematics is seen as a process ("O" level syllabus 4008 page 3). Teaching should develop concepts from the concrete and familiar, moving to the abstract is learned through guided discovery or activity based discovery, inquiry based approach as well as through project work. The syllabus also emphasises the use of group work regularly as well as teaching problem -solving as a skill.

Aims in the "O" level Mathematics curriculum are in line with those outlined by Sidhu. Looking at the aims of teaching Mathematics in the "O" level curriculum, it can be seen that more focus is laid to the higher level of objectives underlying the Mathematics subject, like critical thinking, analytical thinking, logical reasoning, decision making, problem solving, interpretation of mathematical information, appreciation of the beauty of mathematics, cooperation, development of good habits such as neatness and positive attitudes and communication [4].

Thus the "O" level Mathematics curriculum ascribes to the constructivist view of teaching Mathematics.

Aspects of constructivism can be found as far back as 470-320 BC as Socrates, Plato and Aristotle described the formation of knowledge. However, the major development of constructivism as a philosophy is credited to Jean Piaget and Vygotsky [5]. Piaget's constructivist learning model or cognitive constructivism begins with a flow of information from the student's senses into the structure of their mind. Piaget postulated that when the student's expectations do not coincide with their experience or observations, the student is in disequilibrium. When the student is faced with this disequilibrium state, he/she will have three choices to make and these are:

- The students do not believe the observations
- The students do not care in one way or the other
- The students alter understanding so that the observations fit the predictions.

This latter choice is called cognitive restructuring or meaningful learning.

Constructivist View of Learning Mathematics

Constructivists belief that learning occurs as learners are actively involved in a process of meaning and knowledge construction as opposed to passively receiving information. Jaji argues that teachers must move to more constructivist approaches if they are to effectively implement the intent of the syllabus [6].

To the constructivists, learners are the makers of meaning and knowledge and learning is as a result of problem solving.

Problem solving involves finding solutions to real life situations thereby resulting in construction of new knowledge. Problem solving thus is not about learning a mathematical theorem and then use the theorem to solve problems from a textbook. Constructivist teaching fosters critical thinking and creates motivated and independent learners. This theoretical framework holds that learning always builds upon prior knowledge in students. Learning to the constructivists is more effective when students are actively engaged in the learning process rather than receiving knowledge passively. What then is happening in a Mathematics lesson in a district in Mashonaland province?

The constructivism philosophy contends that students actively construct meaning through interaction with prior knowledge and ideas provided by others students and teachers.

Constructivists view students as bringing their own beliefs, ideas, and experiences, to the classroom, which in turn, actively affect how they understand and learn new materials [7]. It is believed that students interact with others to make sense of experiences and phenomena, and then reflect on this process, re-conceptualizing their existing knowledge structures. Learning is thus perceived as a social process in which interaction with others is of prime importance [8]. Through interaction with peers and teachers, students share their personal meanings and, based on this 'negotiation' process, re-conceptualize their initial knowledge structures. The new knowledge's meanings to students depend on its context. Therefore, the social and cultural context of students should be an important part of the teaching and learning process.

Constructivists advocated for the following teaching approaches:

- Problem- solving in mathematics
- Inquiry-based learning in mathematics
- Project- based learning in mathematics education
- Group work in mathematics

The Roles of the Teacher in a Class Based on Constructivism

Many researchers believe that teacher's knowledge, beliefs and actions all influence the success of the learners. Recent researches have documented the positive relationship between student success and teachers' application of pedagogy based on constructivism. Brooks and Brooks believe that the most valuable quality of a teacher is the one who applies pedagogy based on constructivism in his/her teaching [9].

Slavin and Hanley came up with a summary of the different roles of the teacher in a constructivist classroom and these are [10, 11]:

- Teachers should encourage and accept student autonomy and initiative.
- Teachers should allow students responses to drive lessons, shift instructional strategies and alter content.
- Constructivist teachers use raw data and primary sources, along with manipulative, interactive and physical materials.
- When framing tasks, constructivist teachers use cognitive terminology such as "analyze", "predict", "classify" and "create".
- Teachers should seek elaboration of students' initial responses.
- Teachers should inquire about students' understandings of concepts before sharing their own understanding of those concepts.
- Teachers should promote collaboration both with the teacher and with one another.
- Constructivist teachers encourage student inquiry by asking thoughtful, open-ended questions.
- Teachers should encourage students to ask questions.
- Constructivist teachers allow wait time after posing questions.
- Teachers should encourage thoughtful discussion among students.
- Constructivist teachers tolerate wrong answers in order to clarify students' misconceptions.
- Constructivist teachers provide time for students to construct relationships
- Teachers use scaffolding as an approach in their teaching.

It can be noted that the role of the teacher from a constructivist point of view as outlined above is that of a facilitator and stimulator of students' learning. His/ her main duty is that of posing interesting questions and situations for investigation, challenging students to think and helping them to unpack errors in their thinking. It is also the duty of the teacher to support the learner in a systematic way to enhance cognitive development.

Hanley postulates that the teacher should be one of the many resources students should learn from, not the primary source of information tasks. There is also need for the constructivist teacher to encourage and accept student autonomy and initiative as

well as use raw data and primary sources, along with manipulative and interactive physical materials. Hanley further postulates that constructivist teachers should promote student leadership and collaboration in their learning process [11].

RESEARCH METHODOLODY

The study was conducted, making reference to the literature on constructivists' view of learning mathematics which informed the design of the study. The first phase involved collecting information on interpretation of the "O" level intended mathematics curriculum. The second phase of the study was that of classroom observation so as to assess how the intended mathematics curriculum was put into practice by "O" level mathematics teachers from various schools in the same district. The last stage was that of document analysis. The study of the nature of the gap between the intended and the implemented "O" level mathematics curriculum requires observing teachers' and students' activities during a mathematics lesson so that comparisons and conclusions can be made. It also involved assessing curriculum interpretation at school level by various "O" level mathematics teachers. A sample of thirty-six qualified and specialized mathematics teachers holders of either diploma and/or degree from various Tertiary institutions were selected. The 36 teachers were involved in a focus group discussion in which ten questions related to curriculum interpretation were discussed to assess how they interpreted the intended curriculum. The researchers did a documentary analysis on the teachers' schemes of work and pupils' exercise books was done to gain an insight on the mathematics curriculum implementation. Also the teachers were observed to evaluate the amount of constructivist characteristics present in their teaching of "O" level mathematics. The classroom observation checklist of eighteen constructivist characteristics crucial in mathematics education used in this study were adapted from Murphy were categorized into three rankings using a likert scale [12]. All the lesson observations were done during second term of the school calendar in the months of May and June 2014.

DATA ANALYSIS

Teachers' Understanding of the Intended Curriculum

From the discussion held with the thirty-six "O" level mathematics teachers from the district, it emerged that four teachers did not have the current "O" level mathematics syllabus at their schools and relied on the syllabus for the previous years. Thus most mathematics teachers in the district have access to the current "O" level mathematics and are guided in their teaching by the intended curriculum. On the issue of aims and objectives of teaching "O" level mathematics, most teachers pointed out that they copy them as outlined in the syllabus without making any interpretation and fully understanding of them. One of the teachers from the focus group discussion explains: It is a departmental and ministerial requirement those we incorporatea section on aims in the preamble of our schemes of work. Personally, I just extracts them from the syllabus. Otherwise I do not see their essence because rarely do implement them in my teaching of mathematics (Teacher X).

The focus group discussion also revealed that a greater percentage of the teachers from the district are aware of the aims of teaching mathematics as outlined in the intended curriculum. Most of the teachers in the discussion indicated that most of the aims outlined in the intended curriculum can never be addressed in a mathematics lessons, since teachers aim at students' passing the ZIMSEC examinations at the end of the year. One of the teachers explains: Of course there are various aims of teaching mathematics outlined in the syllabus, but let us remember that most of them are never examined. These days all stakeholders in mathematics education are concerned about producing results. So my major aim when teaching "O" level students is to make sure that they pass the ZIMSEC mathematics examination so that I get a better pass rate in the subject (Teacher Y).

5 percent of the teachers raised the point that although they did not understand some of the aims outlined in the syllabus they also aimed at obtaining better pass rates when teaching "O" level mathematics. One of them explains: My teaching is examination oriented. All I need to achieve in my teaching is make sure that a large number of my students pass the ZIMSEC examinations at the end of the year. (Teacher M).

It can be noted from the above discussion that although most mathematics teachers in the district have access to the intended "O" level mathematics curriculum, their practice is in contradiction to the aims of the intended curriculum. This concurs with Jaji findings which confirmed that mathematics teachers' practice contradicts the aims, objectives and methodology of the syllabus [6].

On intended curriculum content coverage most teachers from the focus group indicated that they do not cover all the topics outlined in the intended curriculum as expected. The they do not teach in detail or at times do not teach at all the topics they perceive difficult to teach, for example the topics about transformations, linear programming and probability. One teacher from the focus group explains: It is better to cover the syllabus quickly even if some pupils did not understand and revise the work again or revise the topics which most of the students did not understand in preparation for the examination (Teacher M).

Another teacher explains: This syllabus is too wide. We need not to spend too much time on one topic. We may concentrate on one topic and it may never come on the examination and some students may never understand the topic at all, therefore rush through the syllabus (Teacher R). It can be noted that there is really lack of congruency on content coverage in mathematics teaching in the district.

The discussions revealed that most mathematics teachers in the district derive their lesson objectives from the syllabus with few getting them from the textbooks. It was also noted from the discussion that all lesson objectives were decided by the teachers. One of the teachers explains: When we prepare schemes of work, we will be in actual fact making a plan of what to teach and how to teach it. Therefore lesson objectives should come from the teacher and they should be derived from the syllabus (Teacher Z) **(Table1).**

Table 1. The table below shows the frequency of individual constructivist characteristics occurrence in the forty-five observed lessons.

Constructivist characteristic	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Frequency	42	0	0	12	0	15	0	3	5	8	0	6	12	15	12	0	0	17

It can be noted that the frequency of constructivist characteristic 2, 3,5,7,11,16, and 17 had zeros which indicates that it was never evident in the observed lessons. This is clear indication that teachers in the district derive lesson objectives instead of allowing students to derive their own lesson objectives. Constructivists however advocate that effective learning occurs when students are left to decide on what to learn. This concurs with Jordan et al who assert that students should derive their own goals and objectives for the lesson or that they should negotiate them with the teacher or system [13].

Consistency Of Teaching Approaches In The Intended And Implemented "O" Level Mathematics Curriculum

The most common teaching approaches used by teachers in the focus group discussion were pair work, group discussions, individual work, teacher-class discussions and teacher demonstrations. Fifty-five percent of the teachers in the focus group use teacher demonstrations in their mathematics lessons, twenty percent use teacher-class discussions, seventy-five percent use individual work and thirty percent use group discussions. Only forty percent use pair work when teaching mathematics .The researchers observed the occurrence or absence of the eighteen constructivist characteristics using fifteen "O" level mathematics teachers **(Figure 1).**

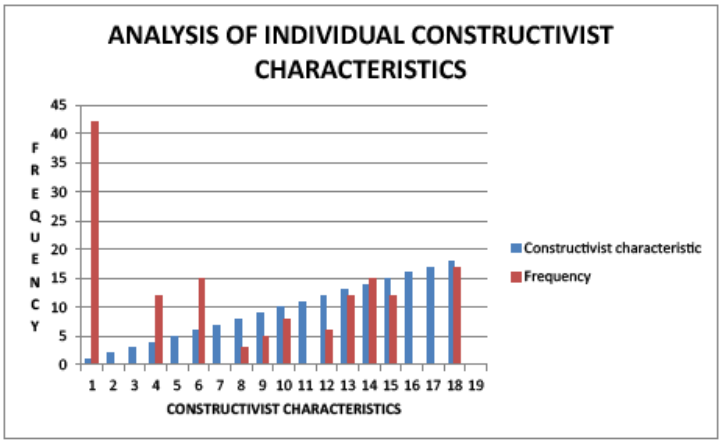


Figure 1. Graph above is showing the frequency of individual constructivist characteristics occurrence.

The graph above reveals that most lessons were characterized by the first constructivist characteristic, which looked at presentation of subject matter from different perspectives or use of various methods by the teacher. Three characteristics which are:

- Activities, tools and environments are provided to encourage meta-cognition, self-analysis-regulation, reflection and awareness.
- Learners are provided with the opportunity for apprenticeship learning for which there is an increasing complexity of tasks, skills and knowledge acquisition with the help of the teacher.
- Collaborative and co-operative learning are favored in order to expose the learner to alternative viewpoints, occurred in the observed teaching twelve times.

In fifteen lessons, the researchers observed that learning situations, environments, skills, content and tasks were relevant, realistic, and authentic and represented the natural complexities of the real-world.

Constructivist characteristic numbered eight was evident in three lessons, characteristic numbered nine was observed in five lessons and the constructivist characteristic numbered ten was observed in eight lessons.

There were six occurrences in which exploration was used as an approach to learning and there were also fifteen occurrences in which collaborative and cooperative learning were used in the teaching process. In seventeen cases, the teachers used primary sources of data to ensure authenticity and real-world complexity. The following constructivist characteristics did not occur in any one of the forty-five observed lessons.

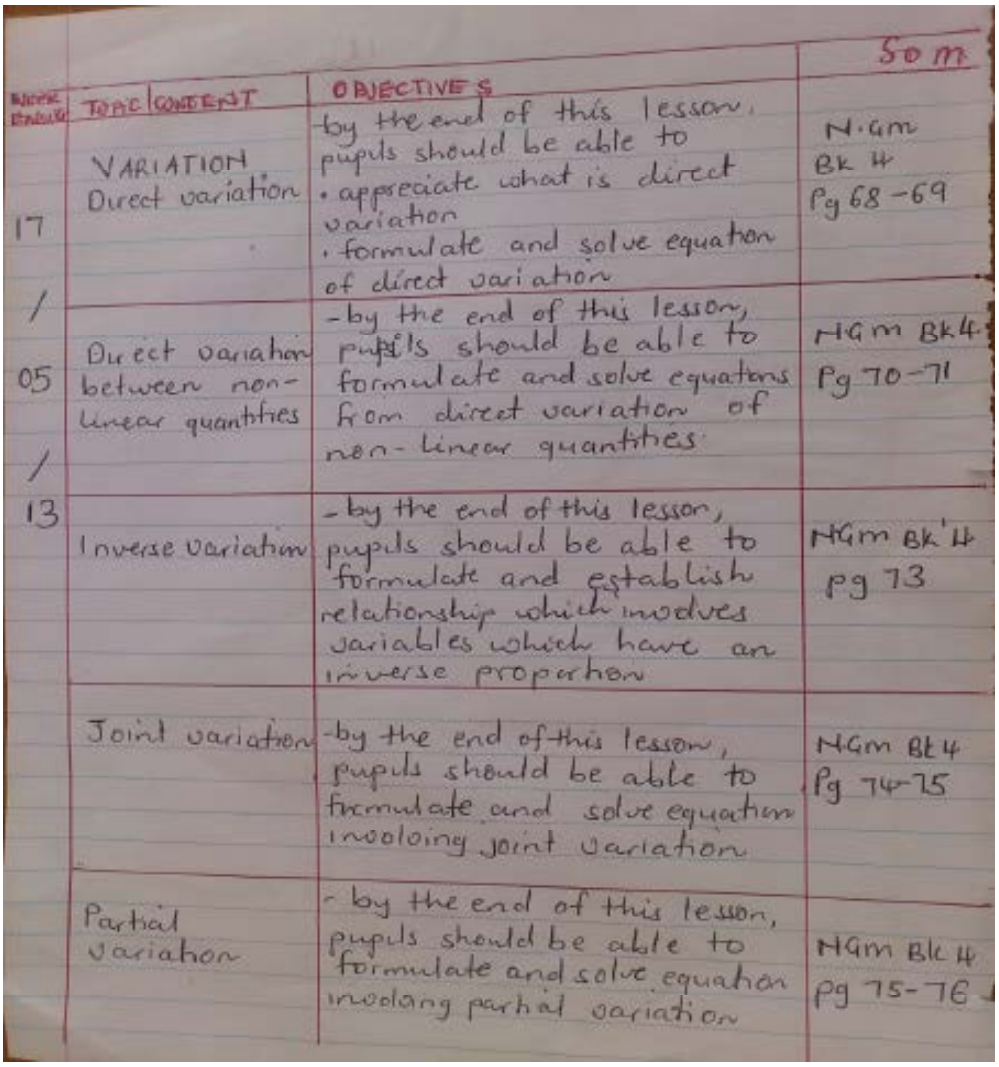
- Goals and objectives are derived by the student or in negotiation with the teacher or system.

- Teachers serve in the role of guides, monitors, coaches, tutors and facilitators.
- The student plays a central role in mediating and controlling learning.
- Knowledge construction not reproduction is emphasized.
- Consideration of errors provides the opportunity for insight into the students' previous knowledge constructions.
- Scaffolding is facilitated to help students perform beyond the limits of their ability
- Assessment is authentic and interwoven with teaching.

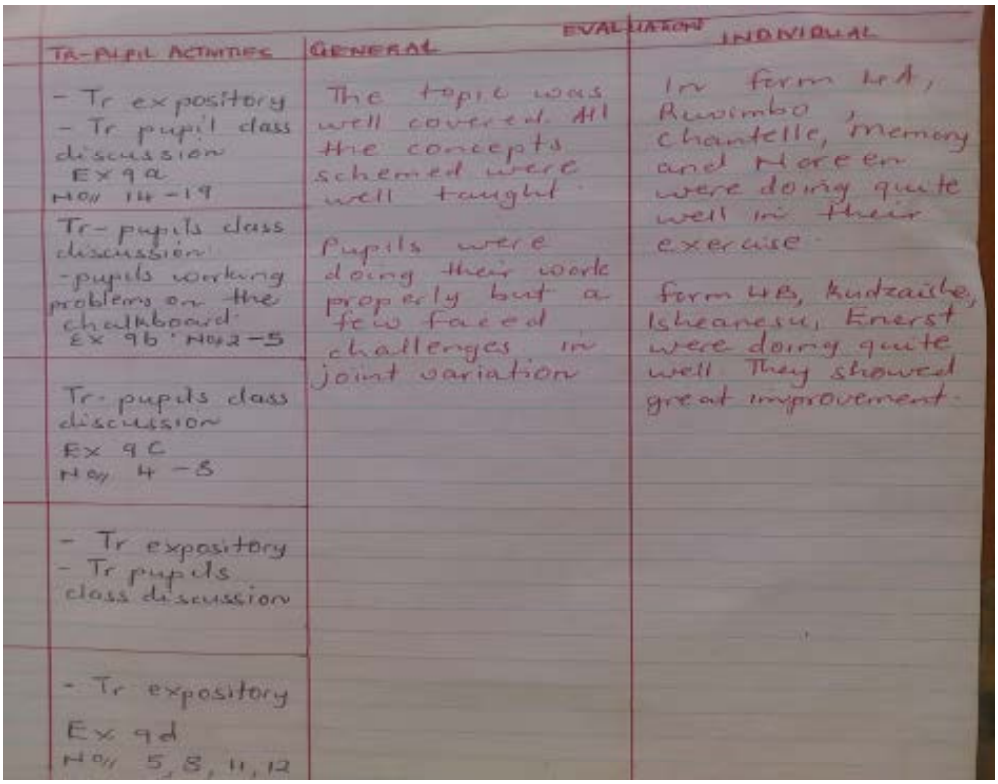
The above findings revealed that teachers in the district need to serve as guides, monitors, coaches, tutors and facilitators. It was also noted that students did not play a central role in controlling their learning. Findings from classroom observation showed that most teachers were biased towards knowledge reproduction and not knowledge construction when teaching "O" level mathematics. This is evidenced by a frequency of zero in the occurrence of constructivist characteristic 7 as in the table above. However, the above characteristics are considered to be vital in the constructivist education which rendered all observed lessons fall short of purely constructivist methodology.

Consistency Of Assessment Techniques In The Intended And Implemented Mathematics Curriculum

Concerning assessment of students in a mathematics lesson, most of teachers in the focus group pointed out that they make use of exercises and tests when assessing their students. This contradicts the constructivist view of assessment whose assertion is that assessment should not be based only on tests and exercises. Constructivists advocate that assessment should be a continuous process which should be interwoven in teaching. However, this was not common among mathematics teachers in the district. Findings from the classroom observation revealed that constructivist characteristic about assessment being authentic and being interwoven with teaching was not evident in any observed lessons. Most teachers from the focus group discussion pointed out that they derived their assessment tasks from textbooks and past exam papers. Findings from document analysis also showed that "O" level mathematics teachers in the district rely on one major textbook (New general Mathematics) when planning their work, and no teaching media was incorporated. Below is an extract from the schemes of work of one of the teachers. Extract 1 showing content to be covered, objectives and the sources of material for the lessons **(Extract a & b).**



	TOPIC/CONTENT	OBJECTIVES	50 m
17 /	VARIATION Direct variation	by the end of this lesson, pupils should be able to • appreciate what is direct variation • formulate and solve equation of direct variation	N.GM Bk 4 Pg 68-69
05 /	Direct variation between non-linear quantities	- by the end of this lesson, pupils should be able to formulate and solve equations from direct variation of non-linear quantities	NGM Bk4 Pg 70-71
13	Inverse variation	- by the end of this lesson, pupils should be able to formulate and establish relationship which involves variables which have an inverse proportion	NGM Bk 4 pg 73
	Joint variation	- by the end of this lesson, pupils should be able to formulate and solve equation involving joint variation	NGM Bk 4 Pg 74-75
	Partial variation	- by the end of this lesson, pupils should be able to formulate and solve equation involving partial variation	NGM Bk 4 pg 75-76



Extract a&b. It was also noted that on evaluation, teachers focus on the higher performers as shown in the extract below.

Thus it can be concluded that most common form of assessment in mathematics education by teachers in the district is through written exercises which according to the constructivists should not be the only form of assessment.

RECOMMENDATIONS

In the view of the research findings stated above, the researchers recommended that:

- Ministry of education should produce or support the production of a variety of resource documents that "O" level mathematics teachers may find helpful as they plan programs based on the expectations outlined in the intended curriculum.
- There is need for the mathematics coordinators in districts to organize the compilation and introduction of a district "O" level syllabus with a breakdown of topics for each term which must be used by all secondary school mathematics teachers in the district when planning their day to day mathematics lessons.
- District to organize workshops and in-service programs on interpretation of the "O" level mathematics curriculum.
- District to organize workshops and in-service programs on how to teach "O" level mathematics topics as a process.
- I encourage mathematics teachers to make use of other forms of assessment instead of resorting to tests and exercises only. These include observations, project work and assessment based on development of good habits such as neatness and thoroughness and development of positive attitudes such as self-reliance, persistence, critical and creative thinking.
- To urge mathematics teachers to develop in students other skills like communication skills, critical thinking, logical reasoning, neatness and thoroughness when teaching mathematics instead of only focusing on knowledge and understanding of mathematical content.

Encourage "O" level mathematics teachers to teach all topics outlined in the intended mathematics curriculum.

REFERENCES

1. Howson A G and Wilson B. Schools Mathematics in the 1990s, Cambridge; Cambridge University Press. 1986.
2. Fullan G and Hargreaves A. What's worth fighting for? Working together for your school. Regional Laboratory for Educational Improvement of the Northeast and Islands, Massachusetts. 1991.
3. Cobb P, Wood T, et al. Assessment of a problem –centered second grade mathematics project. Journal of Research in Mathematics Education. 1991; 22: 3-29.
4. Sidhu K S. The teaching of Mathematics. New Delhi: Sterling Publishers Pvt. Ltd. 1995.
5. Ginsburg A and Opper S. Piaget's theory of intellectual development (2nd Ed). Englewood Cliffs NJ: Pentice-Hall. 1997.

6. Jaji. Curriculum implementation in Mathematics classrooms in Zimbabwean Secondary Schools. Zimbabwean Journal of Educational Research. 1993; 5: 41-42.

7. Borovcnik M, and Peard R. Probability. In A. Bishop, K. Clements, C. Keitel, J. Kilpatric, & C. Laborde (Eds), International Handbook of Mathematics Education. Dordrecht: Kluwer. 1996.

8. Wenger E. Communities of practice: learning, meaning and identity. Cambridge University press. 1998.

9. Brooks J G and Brooks M G. The case for constructivist classrooms. Alexandria, VA: Association for supervision and curriculum development 1993.

10. Slavin R. Cooperative Learning Theory, Research and Practice, Englewood Cliffs, N J: Prentice Hall. 1990.

11. Hanley S. On Constructivism [On-line]. 1994.

12. Murphy E. In Constructivism: From Philosophy to Practice, Summer. 1997.

13. Jordan A, Carlile O, et al. Approaches to learning: A guide for teachers, McGraw Hill, Open University press, Berkshire. 2008.