

Counselling Implications on the Role of the New Mathematics Teacher in the Teaching and Learning of Mathematics

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Abstract

The many reforms that the mathematics curriculum in Ghana has undergone since independence in 1957 have not yielded the needed results. The teacher is the centre of any teaching and learning process, therefore much attention must be given to the classroom teacher. There is the need for mathematics revolution in Ghana. This paper discusses how this can be achieved by adopting and modifying the Realistic Mathematics Education (RME). The authors also advocate the efficacy of counseling especially the use of cognitive restructuring strategy in the realization of the goals of RME.

Keywords: Realistic Mathematics Education; Cognitive restructuring; Counselling.

Introduction

General Education in Ghana has undergone several transformations since the country gained its political independence from the British Colonial rule in 1957. Fifty years on, Ghana has little to show as far as performance in core subjects (English, Science and Mathematics) at the pre-university education is concerned. This pre-supposes that, something is definitely not being done correctly. The society has now become more aware of the usefulness and indispensable nature of mathematics. This explains why there is a national outcry when students do not perform well in mathematics. Recently the results of the Basic Education Certificate Examination (BECE) and the Senior Secondary School Certificate Examination (SSSCE) published by the West African Examination Council depict overwhelming number of students obtaining low grades or failing entirely in mathematics. The major justification for this paper, therefore, is to examine the importance of adopting the Realistic Mathematics Education; and at the same time show how the counselor can help the new mathematics teacher achieve stated goals.

The Teaching of Mathematics

There is no doubt that the main purpose of teaching is to cause learning to take place, and mathematics is an important factor that contributes to students achievements. Many factors contribute to the poor performance of students in mathematics. Notable amongst them, is the availability of teaching and learning materials, students' socio-economic background, parental and community beliefs and the students' perceived usefulness of mathematics. However, the way mathematics is taught in Ghanaian schools is the most significant factor in any task of identifying or analyzing the poor performance of mathematics learning in Ghana. In other words, mathematics teachers' competencies and attitudes are important factors that determine the performance of students in mathematics.

As rightly put by Eshun (2000), "the teaching and learning of mathematics in the pre-tertiary institutions is influenced by both militating and facilitating determinants such as attitudes, intellectual capacity, maturity, learning style and the teacher's competence in Mathematics". According to Ahia and Fredua-Kwarteng (2004), the mode of mathematics instruction in Ghanaian schools follows a certain pattern which has become the national culture of mathematics teaching. Some of these valid observations are:

1. Mathematics teachers normally appear before their classes, give a definition of a mathematical concept, work a few examples from the mathematics text on the chalkboard and at the end of the instruction assign students some exercises to do. In other words, mathematics teachers act before a passive audience that is supposed to absorb the knowledge transmitted.
2. Mathematics teachers are mostly interested in answers or solutions to mathematical questions or problems rather than the process or methods used to obtain the answers or solutions. Teachers simply give answers or solutions to their students without first having the students work for those solutions.
3. Mathematical concepts are taught as objective, discrete facts without linking them together. For example, primary and secondary school teachers do not demonstrate to their students that there is an affinity between decimal, ratio, rate, fractions, percentage and proportion.
4. Students are hardly encouraged to ask questions, make comments or suggestions about what is being taught. Student's primary responsibility is simply to listen passively to the teacher, take notes when necessary.
5. Teachers hardly connect mathematical concepts that they are teaching to the live of their students or cultural practices in the community.
6. Mathematics teachers simply give formulas or algorithms to their students to use in doing mathematics. Normally, the underlying logic or philosophy of the formulas or algorithms is not explained to the students.
7. Most mathematics topics especially at the senior secondary school level are taught without using any other material except chalk and the chalkboard.

It's time this old fashioned way of mathematics teaching gave way to new trends. To teach all students according to current standards, teachers need to have an indepth mastery of the

subject matter because this will enable them to help students create useful cognitive maps, relate one idea to another, and address misconceptions. Teachers need to understand how ideas connect across fields and to everyday life. The rationale for this type of understanding is to provide a foundation for pedagogical content knowledge that enables teachers to make ideas accessible to others (Shulman, 1987).

The Learning of Mathematics

Ahia and Fredua-Kwarteng (2004) have observed that, the culture of mathematics learning in Ghana's educational institutions are the direct consequences of both mathematics teaching culture and student's perception about the nature of mathematics and its importance in formal education. Some observations of the culture of learning mathematics according to Ahia and Fredua-Kwarteng (2004) are:

1. Students learn mathematics by listening to their teacher and copying from the chalkboard rather than asking questions for clarification, justification and discussion.
2. Students learn mathematics mainly during class hours when teaching is in progress or for quizzes, class tests and examinations.
3. Students hardly read their mathematics textbooks. Even where students read the prescribed textbooks, they read them mainly to do their homework or assignments or solve problems towards examinations or tests but not for discussing mathematical concepts that were taught in the classrooms.
4. Our culture of learning mathematics is by repeating facts, theorems or formulas without analyzing them; probing for meaning and understanding of mathematical concepts. That is, students hardly ask the logic or theory underlying those mathematical principles, facts, or formulas.
5. The teacher in the Ghanaian classroom is the sole authority of mathematical knowledge in the classroom, while the students are mere receptors of mathematical facts, principles, formulas and theorems. Thus, students accept whatever the teacher teaches them.
6. Most students do mathematics homework and exercises not as a way of learning mathematics, but as a way of satisfying or pleasing the teacher. That is, mathematics homework or assignments are not constructed as an instrument for learning mathematics.
7. Most students have internalized the false believe that mathematics learning is for brilliant students only.
8. Students go to mathematics classes with the sole aim to do mathematical calculation. Therefore, if the classes do not involve calculations students do not think that they are learning mathematics. So students learn mathematics with the goal to attain computational fluency, not conceptual understanding or meaning.

Realistic Mathematics Education

Realistic Mathematics Education (RME) is a teaching and learning theory in mathematics education that was first introduced and developed by the Freudenthal Institute in the Netherlands. This theory has been adopted by many countries such as England, USA, Germany, Japan, Denmark, Spain, Portugal, South Africa, Brazil, and Malaysia (de Lange, 1996).

The present form of RME is mostly determined by Freudenthal's view on mathematics (Freudenthal, 1991). Two of his important points of views are: mathematics must be connected to reality and mathematics as human activity. First, mathematics must be close to children and be relevant to everyday life situations. However, the word 'realistic' refers not just to the connection with the real-world, but also refers to problem situations which are real in students mind. For the problems to be presented to the students this means that the context can be a real-world but this is not always necessary. De Lange (1996) stated that problem situations can also be seen as applications or modeling. Second, the idea of mathematics as a human activity is emphasized. Mathematics teaching and learning is organized as a process of guided reinvention, where students can experience a similar process compared to the process by which mathematics was invented.

Treffers (1987) identifies two types of mathematization which were formulated explicitly in an education context. These are horizontal and vertical mathematization. Freudenthal (1991) stated that "horizontal mathematization involves going from the world of life into the world of symbols, while vertical mathematization means moving within the world of symbols." In horizontal mathematization, the students come up with mathematical tools which can help to organize and solve a problem located in a real-life situation. According to Freudenthal (1991), the following activities are examples of horizontal mathematization: Identifying or describing the specific mathematics in a general context, schematizing, formulating and visualizing a problem in different ways, discovering relations, discovering regularities, transferring a real world problem to a mathematical problem. On the other hand, vertical mathematization is the process of reorganization within the mathematical system itself. The following activities are example of vertical mathematization: representing a relation in a formula, proving regularities, refining and adjusting models, using different models, combining and integrating models, formulating a mathematical model and generalization.

Treffers (1987) classifies mathematics education into four types with regard to horizontal and vertical mathematization. These classifications are described clearly by Freudenthal (1991):

- **Mechanistic, or 'traditional approach'**, is based on drill-practice and patterns, which treat the student like a computer or a machine. It means the activities of students in this approach are based on memorizing a pattern or an algorithm. Learners therefore find it difficult if they are faced with other problems that are different from the one they have memorized. In this approach, both horizontal and vertical mathematization is not used.
- **Empiristic approach.** In this approach, students are provided with materials from their living world. This means that students are faced with the situations in which they have to do horizontal mathematization activities. However, they are not prompted to the extended situation in order to come up with a formula or a model. Treffers (1991) pointed out that this approach, in general, is one that is not taught.

- **Structuralist approach.** This approach is based on set theory, flowchart and games that are kinds of horizontal mathematization but they are stated from an 'ad hoc' created world, which had nothing in common with the learner's living world.
- **Realistic approach.** In this approach, a real-world situation or a context problem is taken as the starting point of learning mathematics. And then it is explored by horizontal mathematization activities. This means students organize the problem, try to identify the mathematical aspects of the problem, and discover regularities and relations. Then, by using vertical mathematization students develop mathematical concepts.

According to Van Hiele (cited in de Lange, 1998), RME has five characteristics: (1) use real-life contexts as a starting point for learning; (2) use models as a bridge between abstract and real, that help students learn mathematics at different levels of abstractions; (3) use students own production or strategy as a result of their doing mathematics; (4) interaction is essential for learning mathematics between teacher and students, and among students and (5) connection to other disciplines and to meaningful problems in the real world.

The roles of the RME teacher in the classroom are as a facilitator, an organizer, a guide and an evaluator (de Lange, 1996; Gravenmeijer, 1994). Based on the process of progressive mathematization, generally one can conclude that the role of the teacher on the steps of the teaching-learning process based on realistic approach are:

- (1) Give the students a contextual problem that relates to the topic as the starting point;
- (2) During interaction activity, give the students a clue, guide the students individually or in a small group in case they need help;
- (3) Stimulates the students to compare their solutions in a class discussion; Let the students find their own solution. It means the students are free to make discoveries at their own level, to build on their own experimental knowledge;
- (4) Give another problem in the same context.

On the other hand, the role of students in RME is mostly that they work individually or in a group, they should be more self-reliant, they can not turn to the teacher for validation of their answers or for directions for a standard solution procedure and they are asked to make contributions in class.

The New Mathematics Educator and Counselling Needs

The traditional way of teaching and learning mathematics enumerated above has not helped the growth of mathematics in the country and the performance of students is not really improving. Students are not able to think critically and their analyses of mathematical phenomena are quite discouraging. For a conceptual understanding requires students to think critically and act flexibly with what they know. Students are fond of asking, "How do you calculate that?" instead of asking "why do you calculate it in that way?" It's time to move away from the traditional way of teaching and learning mathematics to **Realistic**

Mathematics Education. In realistic mathematics education, both the teacher and the learner are always paying attention to their environment and looking for any event around to “mathematize” them. This means that both the teacher and the learner are all the time thinking mathematically and doing mathematics anywhere they find themselves. The new Mathematics educator must therefore be that teacher who believes in and practices RME.

From the discussion thus far the role of the counselor in ensuring the adoption of the RME approach cannot be overemphasized. The Report of the President’s Committee on the Review of Education Reforms in Ghana (2002) had acknowledged the importance of Guidance and Counselling.

The Report asserts that:

Guidance and Counselling provides the opportunity for individuals to better understand themselves, their potentials and their relationship to the world in which they live. It assists students/pupils in the making of choices, plans and decisions or adjustments to situations in order to develop positive behaviour.

The Report went further to recommend among others that:

- a. Guidance and Counselling units should be set up in all second cycle schools and cluster of schools at the basic level.
- b. GES should ensure that at the pre-tertiary level, periodic group counseling is offered on relevant social and academic issues.

It is against this background that it is advocated that the counselor must help both the teacher and the students in coming to terms with the challenges of RME. The counselor through the process of group counseling need to bring to the knowledge of the teacher the concept of cognitive restructuring. The key issue is that the teachers are meant to jettison the traditional methods of teaching mathematics and adopt the RME. Therefore, through cognitive restructuring this can be achieved. Cognitive restructuring is the process of identifying and evaluating one’s cognitions, understanding the negative behavioural impact of certain thoughts and learning to replace these cognitions with more realistic and appropriate thoughts (Corey, 1990).

The counselor will have to help them to understand how to differentiate between self-defeating and self-enhancing statements. Self-defeating thoughts can cause emotional distress and can actually interfere with performance but constructive self-statements oftentimes lead to improved performance. The attention of the teacher must be drawn to the fact that he/she has the ability and competence to adopt and practice RME.

Furthermore, the counselor must help the teachers to realize and appreciate the important role they have to play in adequately motivating their students to learn. Therefore, the teachers should be encouraged by the counselor to adopt the following strategies in motivating their students to learn:

1. Be a competent model who is motivated to learn. The attitudes the teacher convey about learning ,effort and achievement are important factors in determining whether students will develop positive attitudes toward the same issues.
2. Create an atmosphere of challenge and high expectations. Every student should be challenged to do their best.
3. Communicate the expectations that the students will achieve and provide the necessary academic and emotional support.
4. Encourage students' intrinsic motivation to learn. Students should be encouraged to resolve that they are going to succeed and at the same time make a commitment to that success.
5. Work with students to help them set goals, plan and monitor their progress.
6. Select learning tasks that stimulate interest and curiosity.

Above all, the counsellor should make the teachers realize that motivating the students is not enough but keeping them motivated is more important (Santrock, 2001).

Conclusion

The teaching and learning of mathematics should be real, practical and interesting. Mathematics is around us all the time, and it depends on the teacher to market this concept through innovations of his/her teaching. Situations and environment of mathematics teaching and learning differs from place to place, from country to country and from culture to culture. However, in any situation the mathematics teacher can do something positive to market this beautiful animal (mathematics).

RME has produced positive results in many advanced countries and adopting it in Ghana as a national policy will be a step in the right direction. For instance, in the USA, RME is adopted in the "Mathematics in context" textbooks for grades 5-8. After the books were used by students in several school districts from different states, a preliminary research report showed that the students' achievements on the national test increased tremendously (Romberg and de Lange, 1998). In the Netherlands where RME was originated, the results of the Third International Mathematics and Science Study (TIMSS) show that students in the Netherlands gained high achievements in mathematics education (Mullis et al, 1997).

Considering the utilitarian nature of mathematics, the realistic approach is the one which should be emphasized in our schools, since it is friendlier and allows students to approach mathematical problem from their own perspective. Realistic Mathematics Education stresses the idea that mathematics is a human activity and mathematics must be connected to reality, real to the learner using real-world context as a source of concept development and as an area application, through processes of mathematization both horizontal and vertical.

Finally, collaboration between the counsellor and the teacher will go a long way in enhancing the adoption and practice of RME in Ghanaian schools.

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