DEVELOPING MATHEMATICAL PROBLEM SOLVING ABILITY: A PANACEA FOR A SUSTAINABLE DEVELOPMENT IN THE 21ST CENTURY

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ABSTRACT

Mathematics has been tremendously useful in every aspect of human endeavor. It is an essential ingredient in the preparation of individuals for future challenges. This paper gave an overview of mathematics education for a sustainable development in the 21st century. The demands of the new century (21st century) require that all students acquire an understanding of concepts, proficiency with skills and a positive attitude in mathematics if they are to be successful. This paper reviewed the place of mathematics in solving everyday problem and sustaining development in the 21st century, reviewed the aims of mathematics education in schools and gave the five inter- related components namely: concepts, skills, processes, attitudes and metacognition needed to be considered and emphasized by teachers in developing mathematical problem solving ability in students for an effective mathematics program applicable to all levels from the primary to A-levels. Teachers were encouraged to be more student-centered in their curriculum, teaching methods and assessment. Recommendations were made to improve students' connection to the content of mathematics by: selecting mathematical tasks to engage student's interest and intellect: providing opportunities to deepen their understanding of the mathematics being studied and its application: and orchestrating classroom discourse in ways that promote the investigation and growth of mathematical ideas. This paper concluded that mathematics teachers should always endeavor to emphasize the five inter-related components given in this paper in mathematics class in order to develop problem solving ability in students which will help them in solving everyday problem and maintaining a sustainable development in the 21st century.

Keywords: Mathematics, sustainable development.

INTRODUCTION

Mathematics is an excellent vehicle for the development of a person's intellectual competence in logical reasoning, spatial visualization, analysis and abstract thought. Students develop numeracy, reasoning, thinking skills and problem solving skills through the learning and application of Mathematics. These are valued not only in science and technology but also in everyday living and in the workplace. The development of a highly skilled scientifically- and technologically- based manpower requires a strong grounding in Mathematics (Ministry of Education, Singapore, 2006). Many people believed that mathematics is too difficult for them to master or apply in their lives. In truth, mathematics is a tool and a language for solving problem_ big and small. Mathematics reasoning is needed for everyday problems such as budgeting and saving, financing a house or car, calculating a tip at a restaurant and estimating distances and gas mileage. Mathematics is the tool we use to solve these problems (Leonard, Steve & Art, 2004).

Mathematics knowledge and skill provide a key for entry into a rapidly changing technological world (Leonard, et al, 2004). Ukeje (1997) in Lawrence & kolawole (2007) while acknowledging the importance and contribution of mathematics to the modern culture of science and technology stated that "without mathematics there is no science, without science there is no modern technology and without modern technology there is no modern society".

Since the introduction of formal education in Nigeria, mathematics education has gone through several development; from the era of formal Arithmetic, Algebra, Geometry and the likes through the period of traditional mathematics and the modern mathematics controversy to the present everyday general mathematics. These changes have always been necessitated by the realization of the role mathematics should play in the nation's scientific and technological development as well as responses to societal needs and demands (Lawrence & Kolawole, 2007). They further said that the world today is aptly regarded as a global village, characterized by computer and information technology. This age has brought with it lots of sophistication in mathematics to be able to sustain these developments.

Mathematics can therefore be said to be a key to sustainable development. Sustainable development is a development which meets the needs of the present without compromising the ability of the future generations to meet their own needs. The utilitarian value of mathematics as an important pivot in the development of technology has placed it at an advantage position for sustainable development in the 21st century (Odumosu & Eguntola, 2010).

Many changes in technology have shaped our lives in ways unimaginable. No one knows what mathematical skills will be needed in technology, business, and everyday life as the world continues to change. But mathematics will be central for both the consumers and developers of new technologies and their applications. Whether in daily situations or complex ones, mathematical concepts and processes are needed to understand, solve and communicate solutions to problems (Leonard, et al, 2004). They went on to posit that; Since mathematical problem solving (which involves the acquisition and application of mathematics concepts and skills in a wide range of situations, including non- routine, open- ended and real- world problems) is central to mathematics learning; mathematics teachers have a great challenge to guide students' learning of mathematics so that students develop the skills and attitudes needed to solve problems in the 21st century (Leonard, et al, 2004).

This paper therefore reviewed the aims of mathematics education in schools, gave five inter-related components needed in developing mathematical problem solving ability in students and gave recommendations for teachers to improve students' connection to the content of mathematics.

AIMS OF MATHEMATICS EDUCATION IN SCHOOLS

Mathematics education aims to enable students to:

1. Acquire the necessary mathematical concepts and skills for everyday life and for continuous learning in mathematics and related disciplines.
2. Develop the necessary process skills for the acquisition and application of mathematical concepts and skills.

3. Develop the mathematical thinking and problem solving skills and apply these skills to formulate and solve problems.
4. Recognize and use connections among mathematical ideas and between mathematics and other disciplines.
5. Develop positive attitudes towards mathematics.
6. Make effective use of a variety of mathematical tools (including information and communication technology tools) in learning and application of mathematics.
7. Produce imaginative and creative work arising from mathematical ideas.
8. Develop the abilities to reason logically, communicate mathematically and learn cooperatively and independently (Mathematics Syllabus Primary, 2006)

In developing mathematical problem solving ability in students, the following five inter- related components namely: concepts, skills, processes, attitudes and metacognition as put forward by Ministry of education; Singapore (Mathematics Syllabus Primary, 2006) should be considered and emphasized by teachers for an effective mathematics program which is applicable to all levels, from the primary to A- levels.

CONCEPTS

Mathematical concepts cover numerical, algebraic, geometrical, statistical, probalistics and analytical concepts.

Students should develop and explore the mathematics ideas in depth, and see that mathematics is an integrated whole not merely isolated piece of knowledge.

They should be given a variety of learning experiences to help them develop a deep understanding of mathematical concepts, and to make sense of various mathematical ideas, as well as their connections and applications, in order to participate actively in learning mathematics and to become more confident in exploring and applying mathematics. The use of manipulatives (concrete materials), practical work, and use of technological aids should be part of the learning experiences of the students.

SKILLS

Mathematical skills include procedural skills for numerical calculation, algebraic manipulation, spatial visualization, data analysis, measurement, use of mathematical tools and estimation. The development of skill proficiencies in students is essential in the learning and application of mathematics. Although students should become competent in the various mathematical skills, over-emphasizing procedural skills without understanding the underlying mathematical principles should be avoided.

Skill proficiencies include the ability to use technology confidently, where appropriate for exploration and problem solving. It is important also to incorporate the use of thinking skills and heuristics in the process of developing skill proficiencies.

PROCESSES

Mathematical processes refer to the knowledge, skills (or process skills) involved in the process of acquiring and applying mathematical knowledge. This includes reasoning, communication and connections thinking skills and heuristics, and application and modeling.

Reasoning, communication and connection

Mathematical reasoning refers to the ability to analyze mathematical situations and construct logical arguments. It is a habit of mind that can be developed through the applications of mathematics in different contexts.

Communication refers to the ability to use mathematical language to express mathematical ideas and arguments precisely, concisely and logically. It helps students develop their own understanding of mathematics and sharpen their mathematical thinking.

Connections refer to the ability to see and make linkages among mathematical ideas, between mathematics and other subjects and between mathematics and everyday life. This helps students make sense of what they learn in mathematics.

Mathematics reasoning, communication and connections should pervade all levels of mathematics learning, from the primary to A- levels.

Thinking skills and heuristics

Students should use various thinking skills and heuristics to help them solve mathematical problems. Thinking skills are skills that can be used in a thinking process, such as: classifying, comparing, sequencing, analyzing parts and wholes, identifying patterns and relationships, induction, deduction, and spatial visualization. Some examples of heuristics are listed below are grouped in four categories according to how they are used.

- To give a representation,
  e.g. draw a diagram, make a list, use equations
- To make a calculated guess,
  e.g. guess and check, look for patterns, make suppositions.
- To go through the process,
  e.g act it out, work backwards, before- after.
- To change the problem,
  e.g. restate the problem, simplify the problem, solve part of the problem.

Application and modeling

Application and modeling play a vital role in the development of mathematical understanding and competencies. It is important that students apply mathematical problem solving skills and reasoning skills to tackle a variety of problems, including real-world problems.

Mathematical modeling is the process of formulating and improving a mathematical model to represent and solve real- world problems. Through mathematical modeling, students learn to use a

variety of representations of data, and to select and apply appropriate mathematical methods and tools in solving real- world problems. The opportunity to deal with empirical data and use mathematical tools for data analysis should be part of the learning at all levels.

ATTITUDES

Attitudes refer to the affective aspects of mathematics learning such as:

- Beliefs about mathematics and its usefulness
- Interest and enjoyment in learning mathematics
- Appreciation of the beauty and power of mathematics
- Confidence in using mathematics
- Perseverance in solving a problem

Students' attitudes towards mathematics are shaped by their learning experiences. Making the learning of mathematics fun, meaningful and relevant goes a long way to inculcating positive attitudes towards the subject. Care and attention should be given to the design of the learning activities, to build confidence in and develop appreciation for the subject.

METACOGNITION

Metacognition, "or thinking about thinking", refers to the awareness of, and the ability to control one's thinking processes, in particular the selection and use of problem solving strategies. It includes monitoring of one's own thinking and self regulation of learning.

The provision of metacognitive experience is necessary to help students develop their problem solving abilities. The following activities may be used to develop the metacognitive awareness of students and to enrich their metacognitive experiences.

- Expose students to general problem solving skills, thinking skills and heuristics, and how these skills can be applied to solve problems.
- Encourage students to think aloud the strategies and methods they use to solve particular problems.
- Provide students with problems that require planning (before solving) and evaluation (after solving).
- Encourage students to seek alternative ways of solving the same problem and to check the appropriateness and reasonableness of the answer.
- Allow students to discuss how to solve a particular problem and to explain the different methods that they use for solving the problem.

Considering the above explained inter- related components needed in developing mathematical problem solving ability in students, teachers of mathematics are therefore encouraged to be more student centered in their curriculum, teaching methods and assessment to achieve a sustainable development in the 21st century.

RECOMMENDATIONS TO IMPROVE STUDENTS CONNECTION TO THE CONTENT OF MATHEMATICS

The following are recommendations for teachers to improve students' connection to the content of mathematics by:

- ✓ Selecting mathematical tasks to engage students' interest and intellect.
- ✓ Providing opportunities to deepen their understanding of the mathematics being studied and its application.
- ✓ Orchestrating classroom discourse in ways that promote the investigation and growth of mathematical ideas.
- ✓ Using, and helping students use technology and other tools to pursue mathematical investigations.
- ✓ Seeking and helping students seek connections to previous and developing knowledge.
- ✓ Guiding individual, small-group and whole-class work (Leonard, et al, 2004).

CONCLUSION

This paper reviewed the place of mathematics education in solving everyday problem and sustaining development in the 21st century. It reviewed the aims of education in schools and gave five inter-related components namely: concepts, skills, processes, attitudes and metacognition. Efforts should be made by teachers in emphasizing the five inter-related components given in this paper to develop problem solving ability in students which will help them in solving everyday problem. It is desirable that these five components discussed in this paper be emphasized and stressed in mathematics curriculum by curriculum planners for schools right from the elementary level. Government should also provide incentives, attractive remunerations and better conditions of service to boost the morale of teachers. This will go a long way in motivating teachers to put their best in teaching and developing mathematical problem solving ability in students which will help maintain a sustainable development in the 21st century.

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