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Research Article

MATHEMATICS EDUCATION: A QUINTESSENTIAL COG FOR HIGHER EDUCATION

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A R T I C L E I N F O

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A B S T R A C T

The National Policy on Education (1986) has portrayed mathematics as the vehicle to train a child to think, to reason out, to analyze and to articulate logically. Apart from being a specific subject, it should be treated as a concomitant to other subject involving analysis and reasoning. The country requires mathematics education that is affordable to every child, and at the same time enjoyable. Development of mathematical literacy in children is increasingly viewed as a potential source of nation's capital and as a means to sustain healthy technological society. Programme for International Student Assessment (PISA) defines mathematical literacy as an individual's capacity to identify and understand the role played by mathematics in the world, to make well-founded judgments and to use and engage mathematics to meet the needs of the individual's life as a constructive, concerned and reflective citizen. The curriculum of mathematics in industrialized nations has been renovated to ensure that children have access to the learning opportunities necessary to attain a high level of mathematical literacy (Hopkins, 2007). The achievement of such high mathematical literacy is possible when there is a prominent change in the teaching of mathematics. The shift to broaden the scope of mathematics teaching is exemplified in the principles and standards for school mathematics proposed by the National Council of Teachers of Mathematics (2000) in the United States. Research has shown that approximately 5 to 8 percent of school-aged children experience difficulty meeting the standards proposed by the NCTM. This paper tries to describe new strategies in rendering the mathematics education to the students. It also points out the areas requiring the changes and introduces the novelty in the teaching of mathematics which leads for students' smooth run with the higher education.

INTRODUCTION

The new Oxford American Dictionary (2001), describes mathematics as the abstract science consisting of number quantity and space. It is the systematic treatment of magnitude that gives the relationships between figures and forms and also relations between quantities that are expressed symbolically (The Random House College Dictionary, 1984). Mathematics is taught in India as a tool for engineering (Singmaster, 2015). The focus is on getting good grades to get into revered institutes of learning. The above were the views portrayed in the words of Manjul Bhargav the winner of the Fields Medal in the year 2014, "In India mathematics has been taught as a robotic subject, where we solve artificial-sounding problems via a sequence of dull memorized steps". The OECD's survey of adult skills shows that poor mathematics skills severely limit people's access to better-paying and rewarding jobs. People with strong skills in mathematics are also more likely to proceed with the social and economic opportunities available to them.

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However, in reality math is a critically important skill for a person to feel competent and capable of interacting with and participating in society.

Mathematics Education

Mathematics education, in its broad view is a scientific discipline considering how people learn and do mathematics, how this learning and doing can be influenced by others in teaching. The foundation of mathematics is whole number arithmetic and place value system. In every grade of the school, the curriculum of mathematics has to be carefully revived. The core aim of mathematics instruction at school is to deepen the mastery over the mathematical skills such as computation, problem solving, and logical reasoning. The students should be taught the mathematics and reasoning skills to succeed in college. Students planning for a Bachelor's degree in a *quantitative discipline* should take a more demanding mathematics track in high school which prepares them to enter college.

Teaching of Mathematics in cognitive perspectives

Mathematics as a school subject, represents a body of conceptual, procedural, and declarative knowledge using the

language of symbols to solve the various problems. Conceptual knowledge refers to the mental structures that underlie children's reasoning with mathematics. These mental structures have various components linked to the previously learned concepts that are contributing to children's deep conceptual understanding. Carpenter and Moser (1984) suggest that the most difficult problems for children to solve are those that cannot be easily associated with an existing mental representation. Procedural knowledge refers to knowledge about the sequence of steps necessary to solve a mathematical problem. Declarative knowledge refers to mathematical ideas that are automatically retrieved from long-term memory. There has been no importance given to the mathematics performance on the bases of conceptual, procedural and declarative knowledge. Mathematics teaching gives stress on memorization and computational skills rather than in the construction of understanding of the mathematical concepts through the real life situations (Montague, Warger, & Morgan, 2000). The major challenge faced by the teachers is to find ways to make the connections between the above bodies of knowledge without emphasizing on one type alone.

Aim of Mathematics Education

Mathematisation of the child's thinking is the main aim of mathematics education. According to David Wheeler (1982) it is more useful to know how to mathematise than to know lot of mathematics. The targets of mathematics education are briefed below.

Teaching the importance of mathematics: Educating the child merely on equating the formulae and mechanical procedures does not develop the child's knowledge on mathematics. Instead, providing the child with the understanding of when and how to use the mathematical technique helps the child to view mathematics as something to talk about, to communicate and to discuss. Making mathematics a part of children's life experience is the best mathematics education possible.

***Developing the skill of problem solving*:** Mathematics inculcates the skill of problem solving. The students learn the various ways to handle a single problem and derive at the solution through different methods. Mathematics also provides an opportunity to make up interesting problems, and create new dialogues thereby.

Perceiving relationships through logical thinking: Students learn to perceive relationships from the abstract concepts. Logical thinking is a great gift that mathematics can offer. Inculcating such habits of thought and communication in children is a principal goal of teaching mathematics.

The blemish of mathematics education

The analysis of mathematics education identifies a range of issues to be changed. The area of concerns are listed below

A sense of fear and failure

Mathematics is a subject that evokes the emotional comment. It has quite become a social norm for adults to probably declare that they could never learn mathematics. On the other hand, the children compelled to pass the mathematics examination often develop fear and anxiety. This fear is closely related with the development of failure. With the universalisation of the Elementary Education in India, a serious attempt was made to examine every aspect that alienates children in school and contribute towards their non-participation leading to dropping out of the system. In the primary level, children become unable to cope with mathematics in grades three and four. At high school level, board exam failures occur mostly in mathematics. The main cause for these failures are due to the collective nature of mathematics. If there is a struggle with decimals, then it would lead to a struggle in percentage. The other principal reason is said to be the predominance of symbolic language.

Sub-standard curriculum

The mathematics curriculum which gives importance to only procedure and knowledge of formulas paves way to anxiety. For those children with minimal level of achievement, the curriculum acts only as a storehouse of mathematical facts borrowed temporarily while preparing for tests. On the other hand, for the gifted children who excel in mathematics, the curriculum is an intense disappointment, as it fails to offer the conceptual depth of the subject. Learning becomes easy but their reasoning capacity is untouched.

Rudimentary assessment

One of the major reasons for failure in mathematics is the undeveloped assessment and evaluation procedures. Tests are conducted to examine the students' knowledge on procedure and memorization of the formulae and facts. Importance is given only to the procedural knowledge than to concept learning. It is always the application of information given to solve a specific set of problems using the formulae. Moreover, the question pattern is the same for all standards. The student of class X gets the same pattern of questions just as the student in class VII. Such a crude assessment would never render any contribution to the field of mathematics.

Inadequate teacher preparation

Mathematics is the only discipline in which the preparation of teachers plays a crucial role in imparting education to the students. The teachers' understanding of mathematics and her pedagogic technique in imparting mathematics education have a great impact on the students. Textbook centred teaching becomes very monotonous. Due to the absence of adequate pedagogic training, the teachers at primary level simply try to reproduce the techniques learnt in their school days. This ends up creating problems across time and space. On the other hand, at the secondary and the higher secondary levels, the syllabi have been completely changed. Due to the absence of continuing education programmes for the teachers, their fundamentals in the concept area are not strong. Hence, they rely on the cheap notes available in the market. The teachers fail to provide the students the adequate knowledge on the particular concepts. The teachers fail to give link of the abstract concepts to formal mathematics and also do give no idea of the various branches of mathematics linked with other disciplines.

Reformative Measures in Mathematics Education leading to Higher Education

Some of the innovative measures in mathematics education have been enlisted

Student centred approach

The student-centred approaches play an essential role in the self construction of knowledge. This approach has its root in the constructivists theory (Roddick, 2001). Over the years, a

number of student-centered pedagogies such as inquiry method, project based learning methods etc have been developed and investigated. Inquiry as an approach to teaching and learning mathematics has seen wide consideration internationally (Berg, 2009). Roddick (2001), in an investigation, reported that students who follow an inquiry based method of learning mathematics course tend to follow a conceptual approach in solving problems, while students who follow traditional teaching tend to follow a procedural approach in problem solving. It has been found that project based learning encourages students to search for information stimulates thinking (Mokhtar *et al*., 2010). The use of student-centred methods in mathematics instruction has been reported to increase students' interest in the subject (Mokhtar *et al*., 2010), increases students' appreciation of the role of mathematics in life (Ward *et al*., 2010), and motivates to learn mathematics and realise its applicability (Mokhtar *et al*., 2010; Chang, 2011). Student-centred approaches in mathematics instruction give better exam scores (Roddick, 2001)

Teaching Mathematics using real-world examples

Majority of students have difficulties in connecting mathematics to real world applications and this could be a reason for failure in mathematics (Chang, 2011). Making mathematics relevant to the real world has been stressed in a number of studies (Chang, 2011). Using real-world examples is essential in student-centered approaches (Mokhtar *et al*., 2010). Real-time data were used in a problem based learning approach to calculus (Niu & Shing, 2010). Chang (2011) utilised image processing examples from computer science to contextualise abstract ideas from linear algebra in a mathematics course for mathematics specialists. Contextualising mathematics has been reported frequently to enhance students' experience (Chang, 2011).

Bridging the gap in previous mathematical knowledge

Many higher education students enter universities with gaps in necessary prerequisite knowledge of mathematical topics. This ultimately hinders the introduction of new mathematical ideas through novel approaches. Turner (2009) designed a model of a program of three stages of predictor-corrector-refinement for supporting first year transition in a calculus course. However, it was not fully successful due to gaps in students' knowledge. Passive lectures are criticised for many factors; for instance, Chang (2011) proposed a framework of mathematics teaching and learning in lectures that encourages lecturers to stimulate discourse in the classroom via asking thought-provoking questions.

Technology as an enabler of innovative mathematics instruction

The use of technology for mathematics teaching and learning can be classified in two dimensions: the use of domain-specific mathematical analysis computer software packages and general use of learning technologies and online tools. It is argued that technology evolution has been a driver for reform in mathematics teaching and learning (Roddick, 2001; Chang, 2011). Domain-specific mathematical analysis computer software such as Mathematica, together with an IBL approach, played an essential role in reforming calculus courses in the US (Roddick, 2001). Matlab has been used for in-class activities that demonstrate linear algebra concepts (Chang, 2011). Potocka (2010) implemented an online mathematics course that could be followed entirely without a need for an instructor. Students who followed the course have achieved similar or better exam scores than their counterparts who attended traditional lectures.

Change in school mathematics

The school mathematics should give emphasis on the factual knowledge, procedural fluency and conceptual understanding. The conceptual elements pave way for the creation of new knowledge. Procedural fluency should be developed with the stress on conceptual understanding and the construction of knowledge. Creating problem solving environments would invite the participation of the children and offer a sense of success. High priority should be given for bringing changes in the mathematics curricula that paves the way for the transformation.

Mathematics for everyone

Each child has a different mathematical taste. The mathematical taste of every child can be satisfied by the systematic mechanism followed in the textbooks. The textbook should provide a variety of content for the children. Importance should be given in identifying and nurturing the mathematical talents of the children at the very early age. Strengthening of such talents leads the children to a higher level in mathematics. Multiple mode of assessment is required than the unique test pattern for assessing students according to their mathematical talent and skill.

Adequacy of the teacher

The teacher's perception plays a crucial role in imparting mathematics education to the students. Offering proper training and material to the teachers enriches their understanding about the subject both conceptually and historically. This helps them to innovate new methods of teaching such as teaching mathematics using technology, teaching concepts from the real world problem, asking students to surf through the math articles in journals, assigning them with projects and so on. The school teachers can be helped by providing them with the channels of communication with the teachers of the colleges and universities. This linkage of the school teachers with the universities strengthens their pedagogic competence. The students also can share their thoughts about the subject with the subject experts.

Educational implications

The mathematics education has to remove the anxiety of the students towards mathematics. The innovative methods of teaching mathematics would guide the students in finding new ways in solving the problems. The students learn to correlate the basic mathematics with the abstract concepts in the higher education. There would be budding of new innovations as a result of students understanding the influence of mathematics with other subjects. When students are nurtured according to their interest and talents in mathematics, there would be more chances for them to pursue higher education in their own field of interest. There would be the birth of prominent research works in the related areas of mathematics. Mathematics education should nurture the ability of the student to think mathematically providing the students with rich mathematical experiences. The students should imbibe the mastery to interpret and communicate the mathematical findings clearly and effectively and evaluate in different situations.

CONCLUSION

The main purpose of the current school mathematics has to be changed from ensuring the students entry into the renowned colleges of the society. Instead, it should take step to develop the intellectual capabilities of the student, promoting them to be the better thinkers and effective problem solvers. Mathematics taught at school should sow the seed for developing the research attitude in students which forms the base of higher education.

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