

Mathematics Teaching: New Methods with More Appropriate Understanding

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Abstract

Though mathematics is an important subject and it has occupied a central position since the ancient times, still it has not been the interest of many students which is the main reason for not developing the thinking and logical skills of children. So, while teaching mathematics, teachers should use innovative and creative teaching methods, strategies and pedagogic resources that are much more useful and fruitful in gaining adequate responses from the students than we have ever had in the past. It can be seen that more focus is laid on the higher level of objectives underlying the mathematics subject looking to the aims of teaching mathematics like analytical thinking, critical thinking, decisionmaking, logical reasoning, problemsolving, etc. Such objectives are very difficult to get along only through verbal and mechanical methods that are usually used in the class of mathematics. The verbal methods of instruction give all importance to speech and texts, to the book and to the teacher. This method was used majorly until the end of the 19th century from a historical point of view. Teachers are simply satisfied with giving mathematical rules to their students and having them memorize them. Their task is to transmit the knowledge to their students which has accumulated over the centuries. As per today's requirement of system of education, it is strictly needed to make this teaching-learning process effective by using innovation in it. Innovations in teaching of mathematics can be diversified in terms of mastery learning strategy, pedagogic resources, methods, and various teaching aids used in teaching-learning process. This paper discusses the new understanding about the innovations in teaching.

Keywords: Mathematics, teaching aids, mathematical rules, innovations in teaching

I. GOALS OF TEACHING MATHEMATICS

It is very important to know about the main goal of mathematics education in schools which is the mathematization of the child's thought processes. According to George Polya [1], we can think of two kinds of aims for school education: a good and narrow aim – turning out employable adults who (eventually) contribute to social and economic development – and a higher aim – developing the inner resources of the growing child. In the words of David Wheeler [2], it is “more useful to know how to mathematise than to know a lot of mathematics.” In ancient times, the main focus was laid down on numeracy. Primary schools teach numbers and operations on them, measurement of quantities, fractions, percentages and ratios; all these are important for numeracy. This is also to know “what is the higher aim?” In developing a child's inner resources, the role that mathematics plays is mostly about thinking [3]. Clarity of thought and pursuing assumptions to logical conclusions is central to the mathematical enterprise. There are many ways of thinking and the kind of thinking one learns in mathematics is an ability to handle abstractions. But this is not the end that mathematics offers, even more importantly, it is a way of doing things: to be able to solve mathematical problems, and more generally, to have the right attitude for problem solving and to be able to attack all kinds of problems in a systematic manner [4, 5]. It should be ambitious in the sense that it seeks to achieve the higher aim mentioned above rather than (only) the narrower aim.

To explore the concepts of mathematics and to develop problem-solving skills, knowledge and understanding are the basic fundamentals to studying mathematics. Through these, students develop mathematical reasoning to make deductions and solve various types of problems. Students are expected to use mathematical language in appropriate manner when communicating the mathematical ideas, reasoning and findings – both orally and in writing [6, 7].

By following it, students should be able to:

- Demonstrate understanding of the concepts from the branches of mathematics such as number, algebra, statistics and probability, geometry and trigonometry and discrete mathematics.
- Apply general rules correctly to solve problems including those in real-life contexts as well as to use appropriate mathematical concepts.
- Use appropriate mathematical notations, mathematical symbols and mathematical terminology in both oral and written explanations.

- Use different forms of mathematical representation such as mathematical formulae, mathematical diagrams and figures, tables, charts and graphs.

Students are encouraged to choose and use ICT tools as appropriate and, where available, to enhance communication of their mathematical ideas. ICT tools can include graphic display calculators, screenshots, graphing, spreadsheets, databases, and drawing and word-processing software [8, 9].

In the Indian context, there is a centrality of concern which has an impact on all areas of school education, namely that of universalization of schooling. This has two important implications for the discussion on curriculum [10], especially mathematics. Firstly, schooling is a legal right, and mathematics being a compulsory subject of study, access to quality mathematics education is every child's right.

NEED FOR INNOVATIONS IN TEACHING MATHEMATICS

It can be clearly seen looking at the goals of mathematics education that more focus is laid on the higher level of objectives underlying the mathematics subject, like critical thinking, analytical thinking, logical reasoning, decisionmaking, and problemsolving. However, such objectives are a bit difficult to achieve only through verbal and mechanical methods that are usually used in the class of mathematics. It is well known that the verbal methods of instruction give all importance to speech and texts, to the book and to the teacher. It was majorly used until the end of the nineteenth century [11]. Teachers got simply satisfied with giving the mathematical rules to pupils and having them memorize them using one of these verbal methods. They justified this method by saying that pupils would not understand explanations. Their task was to transmit to their pupils the knowledge which had accumulated over the centuries, to stuff their memory while asking them to work exercises. Few teachers who used other methods that involved enough explanations assumed that the mental structure of the child was same as an adult's. But a developmental stage according to Piaget is a period of years or months during which certain developments take place [12]. Teachers think teaching must imply logic, and logic being linked to language, or at least to verbal thought, verbal teaching is supposed to be sufficient to constitute this logic. This type of attitude of the teachers who believe on these types of methods which are overburdened for a child rather than enjoying and feeling the subject deeply leads the child to the mindset fear which is popularly known as "math phobia" [13]. However, the Education Commission (1964–66) has pointed out, "In the teaching of Mathematics, a teacher is required to put his/her more emphasis on the understanding of basic principles than on the mechanical teaching of mathematical computations to achieve the goal of teaching-learning process of mathematics" [14].

Innovations in Teaching Mathematics

Innovations in teaching mathematics can be diversified in terms of various methods, resources and strategies used in the process of teaching-learning mathematics. B.S. Bloom has developed a strategy "Mastery Learning Strategy." It is a new instructional strategy that is used for developing mastery learning and objectives of curriculum can be realized. Basically, it is a generalized plan for a lesson and includes a specific structure to be followed. It consists of different steps: formulation of objectives related to each unit, division of content into units; teaching and instruction are organized for realizing objectives of each unit; administering unit test to evaluate the mastery level and diagnose the learning difficulties; and remedial instructions are given to remove the difficulties and attain mastery level by every student [15]. This strategy plays an important role for learning of basics and fundamentals, e.g., operations in different number systems – natural numbers, integers, rational numbers, real numbers. Apart from this, it is also necessary about the innovative methods used in teaching-learning mathematics. Method is a style of the presentation of content in classroom. The following are the innovative methods that can be used to make teaching-learning process of mathematics effective and child oriented.

Inducto-Deductive Method

Inducto-deductive method is a combination of inductive and deductive methods. Inductive method is to move from specific examples to generalization and deductive method is to move from generalization to specific examples. It has been observed that usually in the classroom, instructions start directly with the abstract concepts and are being taught in a way that does not bring understanding on the part of majority of the students. Mathematical formulas, theorems, many of the examples, results are derived, proved and used in the problem concerned. But to make this practice innovative, the teacher needs to start with specific examples and concrete things and then move to generalizations and abstract things. After this, the teacher again needs to show how generalization can be derived and it holds true through examples. This method always helps the students to understand better which washes the tendency to cram the things and will have long lasting effect.

Examples of Inductive Method

A) Ask the students to construct a few triangles, measure and sum up the interior angles in each of the triangle. The sum of all the interior angles will be same (180°) in each case. Thus they can conclude that “the sum of the interior angles of a triangle is 180°.” This shows the equality of sum of interior angles of a triangle (180°) in certain number of triangles which leads us to generalize the conclusion.

Thus this is an example of inductive method.

B) Let us study about the principle of mathematical induction and take a mathematical statement, S (n): $1 + 2 + \dots + n = \dots$. It can be proved that if the result holds for $n = 1$, and it is assumed to be true for $n = k$, then it is to be proved true for $n = k + 1$ if above results hold and thus for all natural numbers n. Here, the given result is true for a specific value of $n = 1$ and we prove it to be true for a general value of n which again leads us to the generalization of the conclusion.

Thus it is an example of inductive method.

Examples of Deductive Method

A) We have an axiom that “two distinct lines in a plane are either parallel or intersecting” (general). Based on this axiom, the corresponding theorem is: “Two distinct lines in a plane cannot have more than one point in common” (Specific). Thus this is an example of deductive method.

B) We have a formula for the solution of the linear simultaneous equations as and (general). The students find the solutions of some problems like based on this formula (specific). Thus, this is an example of deductive method.

Analytico-Synthetic Method

It is a combination of analytic and synthetic methods. Analytic is breaking down and moving from unknown to known and synthetic is putting together known bits of information and moving from known to unknown.

Analytic Method

The meaning of the word analysis is to “separate things that are together.” In analytical method, we start from what is to be found or proved. Thorndike says that, “Analysis is the highest intellectual performance of the mind” [16]. In analysis, we proceed from “unknown to known” which means, “breaking up of a given problem, so that it may get connected with what is already known.”

Procedure:

If $a/b = c/d$, prove that $(ac - 2b^2)/b = (c^2 - 2bd)/d$

The unknown part is $(ac - 2b^2)/b = (c^2 - 2bd)/d$ is true,

if $acd - 2b^2d = bc^2 - 2b^2d$ is true,

if $acd = bc^2$ is true,

if $ad = bc$ is true

that is, if $a/b = c/d$ is true,

which is known.

Synthetic Method

The word synthesis simply means, “to place things together or to join separate parts.” In this method, we proceed from “known to unknown.” It is the process of relating known bits of data to a point where the unknown becomes true. It is the method of formulation, recording and presenting concisely the solution without any trial and errors.

Procedure:

The known part is $\frac{a}{b} = \frac{c}{d}$

Subtract $\frac{2b}{c}$ on both sides (but why and how the child should remember to subtract $\frac{2b}{c}$ and not any other quantity)

$$\frac{a}{b} - \frac{2b}{c} = \frac{c}{d} - \frac{2b}{c}$$

$$\text{or, } (ac - 2b^2)/bc = (c^2 - 2bd)/cd$$

$$\text{or, } (ac - 2b^2)/b = (c^2 - 2bd)/d$$

which is unknown.

To sum up, these methods are basically used in proving the results and solving sums. In textbooks, mostly synthetic method is used. To prove something unknown, we start with a certain known thing, but that leaves doubt in the mind of students why we have started with that step and using this particular known thing. So, the teacher has to use the combination in order to explain and relate each step logically.

Pedagogic Resources

Pedagogic resources are the resources that a teacher may integrate in a method for the transaction of a particular content and draw upon to advance the students' learning.

Teaching Aids

Teaching aids are tools that classroom teachers use to help their students learn quickly and thoroughly. A teaching aid can be as simple as a chalkboard or as complex as a computer program. Different teaching aids should be used in teaching mathematics like charts, manipulatives, programmed learning material (PLM), computers and television.

Charts

Charts can be used to display geometrical figures, symbols, and mathematical formulae. Charts can be used for making students familiar to the symbols and for memorization of basic formulae. These can even be used to bring to the students two-dimension geometry and the graphical representation in a better way.

Manipulatives

In mathematics, a manipulative plays an important role for a learner to understand the concepts in a play-way method. It is designed so that a learner can understand some mathematical concept by manipulating it [17]. Manipulatives provide a way for children to learn mathematical concepts in a developmentally suitable, hands-on and experiencing way.

Mathematics is one of the areas of the school curriculum that makes a great demand on teacher's resourcefulness in creating relevant learning situations for formation of concepts in children's minds. We have a number of other innovative activities which a teacher needs to add during teaching in classrooms such as quiz competition, projects, role play, seminars, discussion, mathematics club, assignments, field trips, etc. Activities here include all such work wherein students play an active role and have to interact with different resources and generate knowledge.

II. CONCLUSION

Though mathematics is an important subject and it has occupied a central position since the ancient times, still it has not been the interest of many students which is the main reason for not developing the thinking and logical skills of children. So, while teaching mathematics, teachers should use innovative and creative teaching methods, strategies and pedagogic resources that are much more useful and fruitful in gaining adequate responses from the students than we have ever had in the past. It can be seen that more focus is laid on the higher level of objectives underlying the mathematics subject looking to the aims of teaching mathematics like analytical thinking, critical thinking, decisionmaking, logical reasoning, problemsolving, etc. Such objectives are very difficult to get along only through verbal and mechanical methods that are usually used in the class of mathematics. The verbal methods of instruction give all importance to speech and texts, to the book and to the teacher. This method was used majorly until the end of the 19th century from a historical point of view. Teachers are simply satisfied with giving mathematical rules to their students and having them memorize them. Their task is to transmit the knowledge to their students which has accumulated over the centuries. As per today's requirement of system of education, it is strictly needed to make this teaching-learning process effective by using innovation in it. Innovations in teaching of mathematics can be diversified in terms of mastery learning strategy, pedagogic resources, methods, and various teaching aids used in teaching-learning process. This paper discusses the new understanding about the innovations in teaching.

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