

Pedagogy of Mathematics

Innovative Practices in School Mathematics

ABSTRACT

*Instead of teaching kids , love the math they hate,
Let us make math that , kids will love to learn .*

The proposed Research Paper will reflect about the effective & concrete learning of mathematics by the use of self devised innovative activities, worksheets, projects, experiments & teaching aids. The research will be to show if maximum participation of students is ensured either in the mathematics laboratory activities or class room interactive questioning sessions like that of quiz, a joyful learning of the subject takes place.

“Learning by doing” is very effective methodology in teaching learning process as the experience gained meticulously, remains permanently affixed in the minds of the children .So innovative teaching aids & projects of math’s laboratory plays a vital role in the conceptualization process as recommended by NCF 2005 also.

As the NCF 2005 emphasizes that children’s experience of school education must be linked with the life outside the school ,so that learning experience is joyful. Having had this in mind, several opportunities are provided to students to construct their systematic knowledge by engaging them in activities, experiment, projects field visits, discussion with peers & teachers, group work, brain storming sessions, collecting information from different sources, enquiring, listening , thinking etc.

The students are provoked & allowed to share & explain their ideas & to ask, raise, pose & frame questions. Appropriate innovative tools & techniques are applied depending upon the situation & requirement of the underlying concepts.

The research for this paper has been carried out at K.V. Moradabad. The innovative Math-lab activities, Teaching-aids, & projects designed by the teacher are used for the research work. The students of the classes VI, VIII.IX & X are the respondents. The evidences of the wonderful improvement in the subjects are recorded. It is observed that the students learn better without stress and fear.

The resource persons are Principal & vice Principal of KV Moradabad. The eminent educationists like Deputy Commissioner Assistant Commissioner at regional office KVS Dehradun are the guiding stars & source of inspiration & motivation."It is truly said that one has to grow into a junior scientist before one can blossom into a junior Mathematician ".

It concludes that the main goal of Mathematics education is the development of children's ability of mathematization of their prior existing ideas & this can successfully be achieved by the use of innovative activities/projects & experiments.

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SOME OF THE INNOVATIVE PRACTICES FOLLOWED BY SWARN LATA SHARMA , TGT (MATHS) K.V. MORADABAD (U.p):

- 1. Self composed poems for important concepts.*
- 2. Mathematical stories to create interest in the Subject.*
- 3. Use of innovative teaching aids in classroom.*
- 4. Self-framed worksheets from simple to complex to reteach the difficult concepts for slow learners.*
- 5. Some interesting games and puzzles designed to motivate the students to love mathematics.*
- 6. Some innovative techniques used in class-room teaching-learning process to remove math-phobia.*
- 7. Self-written hand-outs are provided to students to remove common misconceptions .*
- 8. Innovative Remedial Measures are adopted according to the type of errors committed by the students in their Formative Assessments.*

For example:

- 1. For computational errors :- drill work is practiced.*
- 2. For language comprehensive errors: - suitable questions with solutions are provided & explained in detail.*

3. *For careless errors:- common misconcepts are listed out from the past experience so that students recall them while solving questions.*
4. *For incorrect formulae error: handouts with correct formulae & figures are provided and wherever possible explained through activities . 9.Suitable innovative and interesting activities are carried out in the class room*
10. *With the help of Mathematics Kits maintained by every child from class VI to class X , suitable and appropriate activities are carried out by the students under the guidance of the teacher. The activities end up with a number of questions so that the aim of the activity is clearly understood by each and every child in the class.
The students perform some of the activities in groups too, for example while playing mathematical games a lot of peer learning takes place.*
11. *Instead of giving the exact or accurate solution for the problems many times open-ended questions are preferred which ensures a wider scope for thinking and reasoning .*
12. *Thorough reading of NCERT text book in the class-room is followed to emphasize on the concepts.*
13. *Special attention is given to the solved examples of NCERT which simplify the concepts.*
14. *For homework or assignment questions are picked up from NCERT exemplar
Problems for classes VI, IX & X.*

PAPER PRESENTATION
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Introduction

Teaching of mathematics in the class is not only concerned with the computational knowledge of the subject but is also concerned with the selection of the mathematical content and communication leading to its understanding and application. So while teaching mathematics one should use the teaching methods, strategies and pedagogic resources that are much more fruitful in gaining adequate responses from the students than we have ever had in the past. We know that the teaching and learning of mathematics is a complex activity and many factors determine the success of this activity. The nature and quality of instructional material, the presentation of content, the pedagogic skills of the teacher, the learning environment, the motivation of the students are all important and must be kept in view in any effort to ensure quality in teaching-learning of mathematics.

In this paper I discuss the efforts, I made for innovations and innovative practices in teaching mathematics, under teaching methods, strategies and pedagogic resources to make a joyful learning .

Aims of Teaching Mathematics in the School.

1. To develop the mathematical skills like speed, accuracy, neatness, brevity, estimation, etc among the students.
2. To develop their logical thinking, reasoning power, analytical thinking, critical-thinking.
3. To develop their power of decision-making.
4. To develop the technique of problem solving.
5. To recognize the adequacy or inadequacy of given data in relation to any problem on individual basis.
6. To develop their scientific attitude i.e. to estimate, find and verify results.
7. To develop their ability to analyze, to draw inferences and to generalize from the collected data and evidences.
8. To develop their heuristic attitude and to discover solutions and proofs with their own independent efforts.
9. To develop their mathematical perspective and outlook for observing the realm of nature and society.

Need for Innovative practices in Teaching Mathematics :

In view of the foregoing aims of teaching mathematics I realize that more focus should be laid in class room to the higher level of objectives underlying the mathematics subject, like critical thinking, analytical thinking, logical reasoning, decision-making, problem-solving. Such objectives are difficult to be achieved only through verbal and mechanical methods that are usually used in the class of mathematics. As one of the verbal methods of instruction give all importance to speech and texts, to the book and to the teacher who used to be simply satisfied with giving the mathematical rules to pupils and having them memorize it, e.g. The rule of signs and formulas in algebra, students memorize this and remember it! Another verbal method involves explanation. Teachers who use this method assume that the mental structure of the child is same as the adult's. This method leads to series of explanations and students at the initial steps of logical explanations trying to understand and grasp but slowly the gap is created between the explanations transmitted by teacher and received by students which lead to the poor understanding on part of students and they develop a fear of the subject- **Math phobia**.

The Education Commission (1964-66) points out that "In the teaching of Mathematics emphasis should be more on the understanding of basic principles than on the mechanical teaching of mathematical computations". .

Innovations in Teaching Mathematics

Innovations in teaching of mathematics can be diversified in terms of Methods, Pedagogic Resources and Mastery Learning Strategy used in teaching-learning process.

1. Mastery Learning Strategy

Teaching Strategy is a generalized plan for a lesson and includes a specific structure to be followed. B.S. Bloom has developed Mastery Learning Strategy. It consists of different steps: division of content into units, formulation of objectives related to each unit, teaching and instruction are organized for realizing objectives of each unit, administering unit test to evaluate the mastery level and diagnose the learning difficulties, remedial instructions are given to remove the difficulties and attain mastery level by every student. 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.

2. Methods

Method is a style of the presentation of content in classroom. The following are the innovative methods that I used to make teaching-learning process of Mathematics effective.

Inducto -Deductive Method

(Inductive method is to move from specific examples to generalization and deductive method is to move from generalization to specific examples). In classroom usually the instructions directly start with the abstract concepts and are being taught in a way that does not bring understanding on the part of majority of the students. Formulas, theorems, examples, results are derived, proved and used. But I start with specific examples and concrete things and then move to generalizations and abstract things. Then I show how generalization can be derived and it holds true through specific examples. This method helps students for better understanding, students don't have to cram the things and will have long lasting effect. Example: Pythagoras Theorem - In a right-angle D ABC right angled at B, $AB^2 + BC^2 = AC^2$ (Considering right angle triangles of different measurement leading to generalization and then establishing it through the theoretical proof).

Analytico-Synthetic Method

(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.) 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 mind of students why we have started with that step and using this particular known thing. we use combination in order to explain and relate each step logically.

Synthetic Method	Analytic Method
$a/b=d/c$ $\therefore b/a- 2a =d/c- 2a$ (Why??)* $\therefore d(a-2ab) = b(c-2ad)$ *the doubt raised in students mind is being solved with the help of analytic method	$d(a-2ab) = b(c-2ad)$ $\Leftrightarrow (a - 2ab)/b=(c - 2ad)/d$ $\Leftrightarrow b/a- 2a =d/c- 2a$ $\Leftrightarrow b/a=d/c$

Problem-Solving Method

This method aims at presenting the knowledge to be learnt in the form of a problem. It begins with a problematic situation and consists of continuous meaningful well-integrated activity. I choose a problem and give it to my students and engage them without spending time in going over the things. As they struggle with the problem to get solution, meanwhile it helps them in developing divergent thinking.

Example: There is a problem of finding the amount of water in a given container instead of deriving the formula of volume (cylinder filled with water).

Play-Way Method

I try to use the activities that include a sort of fun or play and give joy to the students in my class room teaching. As the students don't realize that they are learning but in a way they are gaining knowledge through participating in different activities. This way helps to develop interest in mathematics, motivates them to learn more and reduces the abstract nature of the subject to some extent inherently.

Example: Mathematical games and puzzles.

Laboratory Method

I practice the teaching in class through the way of "learning by doing" and "learning by observation" and proceeding from concrete to abstract. All students do not just listen to the information given but do something practically also. They learn through hands on experience. This way leads them to discover mathematical facts. After discovering something by their own efforts, they start taking pride in his achievement, it gives them in return happiness, mental satisfaction and encourages them towards further achievements.

Example: Making and observing models, paper folding, paper cutting, construction work in geometry.

3. Pedagogic Resources

I use pedagogic resources in teaching practice to integrate in a method for the transaction of a particular content and draw upon to advance the students' learning.

Teaching Aids

I am confirmed of the view that Teaching aids are the materials used for effective teaching and enhancing the learning of students. It can be anything ready-made or made by the teacher or made by students. Different teaching aids are used by me in teaching mathematics like Charts, Manipulatives , Programmed Learning Material (PLM), computers etc.

a. Charts – are used in class to display formulae, symbols, mathematical and geometrical figures. Charts are used for making students familiar to the symbols and for memorization of basic formulae. Even it is used to bring to the students two-dimension geometry and the graphical representation in a better way.

b. Manipulatives – are such objects or materials that involve mathematics concepts, appealing to several senses, that can be touched and moved around by the students (not demonstrations of materials by the teacher). Each student needs material to manipulate independently. With students actively involved in manipulating materials, interest in mathematics will be aroused. Canny (1984) has shown that mathematics instruction and students' mathematics understanding will be more effective if manipulative materials are used. Models can be used to make things concrete like three dimension figures in geometry.

c. Programmed Learning Material (PLM) – It is a self-learning material in which learner can proceed at his own pace. It has the characteristics of all sequential steps, learner's response, self-pacing, immediate feedback, reinforcement and self-evaluation. It is helpful in acquisition of concepts like fractions, number systems, etc. and can be used as a remedy for slow learners for a specific content.

d. Computers and Television – Computer can be used for multimedia presentation for the concepts that requires visualization and imagination. Computer can also be used for providing Computer Assisted Instruction (CAI), it is similar to PLM i.e. it is a computerized PLM. Television can be used to show some good mathematics education show.

e.Activities

Activities here include all such work where in students play an active role, Have to interact with different resources and generate knowledge. It includes Quiz competition, Projects, Role play, Seminars, Discussion, Mathematics club, Assignment, Field trips, etc.

Name of the Activity	Examples/Situations where Activity can be used
Quiz Competition	Logic, Properties of Numbers, Mathematical Rules and Results
Projects	Contribution by Different Mathematicians
Role Play	Arithmetical concepts like Profit & Loss, Simple & Compound Interest
Seminars	Shortcuts through Vedic Mathematics, Application of Mathematics in other Disciplines
Discussion	Properties of 'Zero', Difference between Rational and Irrational Numbers, Relating Different Concepts in Mathematics
Mathematics Clubs	Application of the concept studied, Preparing Models, Paper Folding (Origami)
Assignment	Self-Study, Extension of Knowledge
Field Trips	Experiencing the Functional use of Mathematics in Bank, Insurance Company

In any curriculum, content and presentation of content are the two most important and inseparable components. It is difficult to say anything definitely about which method and pedagogic resource is going to be most effective for presentation of a particular type of content. Selection of method and pedagogic resource depends on many factors like type of content, objectives to be achieved, level of the students, entry behaviour, availability of resources. Also acceptance of innovative methods and positive attitude of teachers towards it, is an important factor for the selection of method and pedagogic resource. The things included under innovations are existing in books, also there are researches which shows that some innovations are carried out in the classroom and has shown the positive effect on teaching learning process but their practical usage and implementation in classroom is not seen to the expected level.

Guidelines for a Teacher in Incorporating Innovations in Teaching Mathematics

1. For effective transaction of the curriculum and achievement of curricular objectives appropriate method and pedagogic resources should be used in providing learning experiences to the students.
2. A number of factors need to be considered while making use of a particular method and pedagogic resource: learners' capabilities, availability of resources, entry behavior, school environment, objectives to be achieved, the nature of content and the teacher's own preparation and mastery.
3. Decide on and plan in advance the innovative idea that the teacher would be incorporating to transact a particular concept so that loss of instructional time is prevented or minimized.
4. The immediate environment of the learner both natural and human should be used when and where possible for making learning concrete and meaningful.
5. Involve the students in the process of learning by taking them beyond the process of listening to that of thinking, reasoning and doing.
6. In order to promote self-study skills use of library and resource center needs to be encouraged.
7. Receiving regular feedback for teaching and learning should be an inbuilt component of teaching-learning process. Continuous and comprehensive evaluation has to be ensured as it plays an important role for the required modification in teaching-learning process.
8. Mathematics-teachers' organizations at different levels should be formed where sharing of ideas and experiences, developing resources in a collaborative manner and the mechanisms that enable teachers to carry out innovations is being discussed. Mathematics-teachers' organizations can be instrumental in establishing a climate of confidence in carrying out innovations and a positive attitude to new approaches in teaching mathematics.
9. Properly instruct and guide the students for carrying out different activities and precautionary measures should be taken so that students are not misguided.
10. Study mathematical journals and modern books of professional interest. Any facilities of in-service training should be availed of for improving teaching of mathematics.

The teacher can always ask himself two questions:

1. 'Is there some new way in which I can present this material in order to make it more meaningful and more interesting?'

2. 'What activities, demonstrations, teaching aids, etc. would enrich the classroom presentation and direct attention of students to the important elements?' Once the teacher discovers innovative ways to arouse interest and enthusiasm in the class, he will be able to use these ideas again the following year, since those will be new and fascinating to a different class. But teacher should keep in mind that as time passes, the world undergoes a change, the environment surrounding students changes and their needs also changes, so one has to continuously go on modifying and discovering new ways of teaching which proves him a better teacher.

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