



# Paradigm Shift in Pedagogical Practices in Mathematics Classroom: NEP 2020

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## Abstract

The National Achievement Survey (2017) reported gradual deterioration in performance in mathematics with increasing order of grades across the nation. It is also evident that most of the students loosen their interest in mathematics up to secondary level (NCF, 2005). Curriculum and pedagogy contribute a lot to develop positive or negative attitude towards the subject. Generally, teachers adopt such teaching approaches, strategies and methods in mathematics classroom which focus on procedural knowledge rather than conceptual clarity. Many students struggle with subject and become disaffected as they continually face the obstacle in engagement due to pedagogical practices. NEP (2020) proposed revamping in curriculum and pedagogy and recommend the paradigm shift from content based to experience based learning. This article highlighted paradigm shift in pedagogy to engage the learner and make learning joyful.

*Keywords: Pedagogical practices, Mathematics, NEP (2020).*

## Introduction

Mathematics is an important subject of curriculum at every stage of school education due to its numerous applications in all walks of life. The importance of mathematics is recognized by each commission and policy after independence of India. The National Policy on Education (NPE, 1986) stated that “Mathematics should be visualized as the vehicle to train a child to think, reason, analyze and to articulate logically”. Similarly, proposed National Education Policy (NEP, 2020) recognized importance of mathematics and mathematical thinking in upcoming research-oriented fields such as artificial intelligence, machine learning and data science.

Mathematics is considered as a science of numeracy and calculation which is surrounded by tyranny of one right answer whereas in broader sense it is a subject of assumptions that produce logical conclusion. It is the study of abstract system built of abstract elements. Mathematics, therefore, is not only ‘number work’ or ‘computation’, but is more about forming generalizations, seeing relationships,

and developing logical thinking and reasoning. Many students struggle with it and become disaffected as they continually face the obstacle in engagement (Anthony & Walshaw, 2009). National Focus Group on Teaching of Mathematics pointed out the problems of mathematics education and provided some recommendations in year 2005 with reference to curriculum, pedagogy and classroom environment. Although paradigm shift in all important aspects of teaching- learning process has been recommended in 2005, still the performance in mathematics is deteriorating (National Achievement Survey, 2017) across the nation.

The National Achievement Survey (2017) was conducted throughout the country in November 2017 for third, fifth and eighth grade in government and government aided schools. The percentage of correct response in mathematics at national level was found 63% in third grade, 53 % in fifth grade and 43 % in eighth grade. A gradual deterioration in performance is reported with increasing order of grades. It is also evident that most of the students loosen their interest in mathematics up to secondary level and opted a stream deliberately without mathematics. There exist many factors such as poor mathematical base, irregular study habits, parental non-involvement etc. behind this negative attitude of students towards mathematics (Vijyana, 2014). Apart from these factors, teaching approaches, methods, strategies and classroom environment also contribute to develop positive or negative attitude towards the subject.

Generally, teachers adopt such teaching approaches, strategies and methods in mathematics classroom which focus on procedural knowledge rather than conceptual clarity. Verbal & verbal cum explanatory methods that give all importance to speech and text, are used by teachers in mathematics classroom (Khongji & Nongbsap, 2013). These methods are content centred in which students are supposed to memorise the mathematical rules presented before without engagement (Khongji & Nongbsap, 2013). Engagement with the content and association of new experiences to previous one is very much needed to make learning meaningful (NEP, 2020). Paradigm shift in pedagogical practices is promoted in NCF, 2005 to remove the sense of fear and failure towards the subject. It should be designed to make this subject enjoyable rather burden. It should be more interactive and involve collaborative and exploratory activities that will create fun rather than fear. NEP (2020) proposed a paradigm shift from content-based learning to experience based learning to make learning meaningful and interesting. This article highlighted such approaches, strategies and methods of teaching mathematics that may helpful to bring innovations in mathematics classroom.

**Constructivist Approach:** Position paper national focus group on teaching of mathematics, recommended an approach in 2005 that facilitate learning of students i.e., Constructivist approach. Majority of school teachers are unaware about this approach till now. NEP (2020) also emphasized on such approach which promotes higher order thinking instead of rote memorization. Constructivist approach radically changes the process of teaching and learning mathematics, connecting it with daily life, rather than teaching only abstract formulas and using a creative approach to mathematical tasks solving (Vinetere, 2018). It is a learner centred approach in which learner is the constructor of knowledge rather mere receiver. Teacher acts as a facilitator and provides students such experiences that allow

them to hypothesize, predict and manipulate mathematical facts. Under this approach, actions such as research, investigate, imagine, invent and pose questions are performed by the learner (Gray, 1997). Student's own intuitive mathematical thinking gradually becomes more abstract and powerful through interaction with mathematical tasks and other students (Clements & Battista, 2009, cited in Vintere, 2018). Constructivist approach-based classroom is distinguished from a conventional classroom by a number of identifiable qualities like learner activeness, democratic environment, interactive and student-centred activities. In the constructivist classroom, students are encouraged to construct their own ideas on the basis of their prior knowledge and experiences. This approach has positive impact on achievement in mathematics of students as well as helpful to develop a positive attitude towards mathematics (Clarke, 1997 and Simon & Schifter, 1997). There are various strategies of teaching that follow the principles of constructivist approach such as Inquiry-based learning, problem-based learning, experiential learning etc. These strategies must be utilised by the teachers to bring innovations in classroom.

**Inquiry-Based Learning:** Inquiry-based learning involves students' centred activities that develop confidence and ability to do mathematics on their own. It starts by posing questions rather than simply presenting established facts or portraying a smooth path to knowledge. It allows students to develop and practice critical thinking skills by providing the opportunity to explore the situation presented before them. It improved mathematical creativity of the students and develop problem solving ability among students. Problem posing and problem solving and modelling activities are core areas in inquiry based teaching. Prior knowledge is used to start the communication that helps students to develop their own strategies. When using an inquiry-based teaching approach in mathematics, some mathematical content is more obvious than others, and students benefit from engaging in different mathematical tasks. There are two popular models viz. 5 E instructional model and 7 E instructional Model which follows the principles of constructivism and comes under inquiry-based learning. Originally these models are practiced in science subjects but many research studies have been conducted to see the effectiveness of these models on achievement in mathematics. It is evident that these models are better than conventional method in mathematics classrooms (Baser, 2008; Hiccan, 2008; Ozdal, Unlu, Catak, & Sari, 2006; Boddy, Watson & Aubusson, 2003 cited in Walia, 2016). There are five phases in 5 E Instructional model viz, engagement, exploration, explanation, elaboration and evaluation. Two additional phases i.e., elicit and extend in 7 E instructional model make it more comprehensive and effective. Bevevino, Dengel & Adams (1999) stated that using this instructional model, teacher can create a series of activities that are meaningful for students and give opportunities to students to practice critical thinking skills.

**Experiential Learning:** NEP, 2020 proposed the adoption of experiential learning for all stages of school education. Experiential learning is the practice of learning through doing. It encourages the students to have firsthand experiences with the materials, rather than learning through someone's else experience in textbook and lectures. Experiential learning focuses on individual' learning. It is defined as learning through reflection on doing. It involves one more step i.e., reflection if compare with other strategies such as activity based, problem based and discovery learning. Experiential learning may be helpful in subject like mathematics where students are involve in their own understanding of mathematical concepts and practices.

Introducing experiential learning activities in mathematics classroom is the way to create classroom environment innovative that help students to overcome their math anxiety. Teachers need to associate activities with the concept so that students may involved and reflect on their actions e.g., in primary school if teacher want to teach the duration and timing of rising and setting of sun. He should ask them to prepare a chart on rising and setting of sun for few days that will provide a deep understanding of duration of a day instead of telling them directly. Similarly, in middle school an activity related to selling the self-made edible items involving purchasing, measuring the ingredients and they can reflect on the process they adopted for all the activities involved. In secondary school concept of probability may be teach through experiential learning involving concrete item such as coins, cards, dices related activities.

**Problem based learning** is another learner centred strategy that begin with the problems. Problem drives the learning when it is taken from real world. Problem based learning environment helps students for constructing a deep understanding of mathematical ideas and process by engaging them. Problems are solved by creating, conjecturing, exploring, testing and verifying the mathematical situations (Lester et.al., 1994 cited in Benjamin, E., 2011). Traditionally, math textbooks often just provide fixed examples without providing rich experiences in problem solving. Problems should be presented before the students so it can arouse students' interest and they become motivated to solve it. In this approach, teacher provide meaningful instructions and learners work on these instructions by following steps such as identifying the problem, devise a plan to solve a problem, implementing and reflecting on the plan. It stimulates critical and creative thinking among students that help to develop problem solving skills that will be helpful in their life as well.

**Technology Enabled Learning:** Technology reduces the effort of human being and increase the efficiency in all sphere of life. Education is not the exception where technology entered and contributing in increasing the efficiency of teaching learning process. There are various type of technology enabled learning strategies which can be categorised on the basis of hardware, software and utility purpose. Web quest learning, m-learning and blended learning are few of them that must be practiced in mathematics classrooms to make learning interesting and joyful.

**WebQuest Learning:** WebQuest learning is the outcome in the form of construction of knowledge with the help of internet resources. A WebQuest is an inquiry-oriented activity/lesson in which all or most of the information that learners use comes from resources on the Internet. It is designed to ensure meaningful learning by combining technology with a constructivist approach in classroom (Yenmez, Ozpinar & Gokce, 2017). Teacher can create Webquest using different programs, but the most common and simple form is to create a word processing document that includes links to websites. "WebQuests were created by Dodge in 1995, during the early stages of widespread Internet access. It includes group work, prior knowledge and cooperative learning.

**Blended Learning:** Blended learning is the combination of e-learning and face to face learning environment. It combines online educational material and opportunities for interaction online with traditional classroom methods. Thousands of videos on trigonometry, statistics, algebra and arithmetic are available freely on Khan academy and youtube. This online material is frequently used by the teachers for blended learning environment. Lin, Tseng and Chiang (2016) conducted an experimental study to see the

effectiveness of blended learning on high school mathematics students in Taiwan. They found not only positive effect on learning outcome but also attitudinal change towards mathematics. Awodeyi, Akpan & Udo (2014) & Abramovitz, Berezina (2012) found the result in favor of blended learning in mathematics classroom with reference to achievement and attitude. Generally, Moodle Learning platform is utilized for such learning environment. Teacher can conduct interactive activities for online group discussion, examination and assessment. This strategy provides flexibility in context of time and space.

**M-Learning:** M-Learning is the technique where learning occurs in multiple contexts, through technological, social and content interactions. M-Learning Technologies are available by using personal electronic devices such as handheld computers, notebooks, mobile phones and tablets. Supandi et.al. (2017) and Etcuban & Pantinople (2018) found that mathematics teaching supported by mobile phone application improves school student's achievement. Apart from web-based learning, many mobile applications such as Socratic, Photo Math, 'My script Calculator Two' etc are used commonly by the students. 'Socratic' is a photo based free software which provides step by step solution of math problem. 'My script Calculator Two' is an app which is more than a calculator. It converts the handwriting into text and then solve the problem. The app includes support for basic operations like addition and subtraction, powers, roots, exponents, trigonometry, logarithms, constants (like pi), and more. Apart from that various learning management software such as Google classroom, Moodle, EDMODO are popular now a days to connect with students anytime anywhere.

Apart from paradigm shift in approach and strategies of teaching some innovations may be bring in real classroom teaching by merging two methods such as Inducto-Deductive Method and Analytico-Synthetic Method. Inducto-Deductive method is the combination of inductive and deductive method of teaching in which number of examples are presented and students generalized the things on the basis of observation of example and later use the formula directly to solve the problems. This method promotes construction of knowledge by observation and discourage rote memorisation. Analytico- Synthetic method is the merger of two separate method of teaching mathematics i.e., analytic and synthetic method. This method must be utilised by teachers for proving the results and solving problems. Teacher must start with analytic method and then utilised synthetic method.

Play way method is another useful method which produce joyful learning and help to create interest in the subject for lower grades. Mathematical puzzles, riddles and jigsaw are the ways to teach the students through play. This method is very useful in foundational and preparatory stages of school education (NEP, 2020). NCF (2005) pointed out that making mathematics a part of children's life experience is the best mathematics education. Project Based Method is a way to connect classroom learning to life outside the school. It is ideal to arouse curiosity, promoting creativity and inculcating the spirit of enquiry among the students. Students handle the problems in natural setting. A sense of confidence may be brought though engagement in projects involved mathematical concepts.

Above discussed approaches, strategies and methods are learner centred and facilitate the learning of students in one hand but require flexible curriculum, well trained teachers and resources in other hand. There may be some constraints behind less utilization of these pedagogical practices in real



classrooms such as overcrowded classrooms, overloaded curriculum, lack of proper training of teachers, lack of infrastructure, overburdened teachers and administrative ignorance towards innovation. Curriculum must be reduced to practiced innovative learning strategies in classroom. NEP (2020) proposed the reform in curriculum and pedagogy across all the stages of education system that shift the learning from rote memorisation to deep understanding of concepts. There is a need to train the pre- service and in-service teachers to learn and implement innovative pedagogy in classrooms and make mathematical learning joyful rather than burden.

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