# Finding Scientific Learning Approaches in School Mathematics Class

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## Abstract

Aim of present school mathematics curriculum is the use of scientific approaches to learning, including deductive, mathematical modeling and other scientific approaches. There are still many Mathematics teachers who have difficulties in carrying out scientific approaches in the secondary school classes. This study describes several scientific learning approaches that are effective in school mathematics classes. The study discusses several things that need to be done to ensure the realization of the scientific disposition in school mathematics learning. The researchers propose a mindset change that needs to be done by the teacher to be able to apply the scientific approach in mathematics class. The researchers are additionally portraying a well ordered scientific methodology in school curriculum of mathematics. At the end of this paper, the writers explain on a case of learning mathematics with a scientific methodology.

**KEYWORDS:** Mathematics Class, Scientific Learning Approaches, Secondary School, Teacher Mindset.

## INTRODUCTION

In India, after National Policy on Education (NPE) 1986 and Programme of Action (POA) 1992 noteworthy reorganization in school learning was endeavored in regard to Mathematics. The educational programs was made an overwhelming and modernized at elementary and secondary level. Document submitted by Yash Pal committee in 1993 suggests approach to reduce scholastic stain on school going students. The committee emphasized on competency accomplishment, reduction of course load, increasing of activity anchored teaching, learner focus approach and joyful learning. The NPE-1986 stated that "*Mathematics should be visualized as the vehicle to train a child to think, reason, analyze and to articulate logically. Apart from being a specific subject, it should be treated as a concomitant to any subject involving analysis and reasoning*". National Curriculum Framework for School Education (NCFSE)-2000 stated that a primary aim of teaching mathematics is to "*inculcate the skill of quantification of experiences around the learners*." According to The NCFSE (2000), at the high school Stage, the educating and learning of mathematics has to provide two complementary goals. Firstly, target learners ought to be able to further increase the ability to employ mathematics in solving their problems in their daily lives. Secondly, as a discipline, a systematic study of mathematics should be started here and should be continued further. It emphasizes the fact that studying mathematics must be done through activities from the beginning of school education, i.e. the use of solid materials, prototypes, patterns, mathematical charts, pictures and posters, simple innovative games from the primary stage. During instruction, teachers may involve learners in puzzles and experiments.

National Curriculum Framework (NCF)-2005 repeats the values established in our Constitution, reduces the burden of curriculum on children, issues quality education for everyone and makes systematic changes in the way of

curriculum reform. It recognizes the priorities of children's experiences, their voices and their active participation in the educational process. Learning in school should be such that children can build knowledge from experience and environment. NCF-2005 has set out some critical focuses as a vision for making successful learning condition in school mathematics.

**VISIONS OF MATHEMATICS LEARNING IN SCHOOL IN INDIA:**

The flight of this very days' mathematics education in elementary and secondary school level in India is based on two main "premises", all school going student can acquire mathematical knowledge and all pupils need to be accustomed with mathematical concepts (NCERT, 2006). Vision of mathematics at school, trying to portray the main areas of concern and offer recommendations that address concerns based on these twin points of view. In India, learning school mathematics happens in a circumstance where:

i) School going students '*learn to enjoy mathematics*' instead fearing it.
ii) School going students '*learn important mathematics*'. Mathematics is above equations, formulas and mechanical endeavors.
iii) School going students look mathematics as an issue to discuss, to express through, to contend among themselves, to tackle mathematical issues together.
iv) School going students compose and solve weighty problems.
v) School students use abstract notions to recognize relation-ships, to understand structures, to distinguish true false of statements.
vi) Understanding the basic arithmetic, algebraic concepts, plane geometry, mensuration, trigonometry and other substance areas of school Mathematics.
vii) Every student in class can learn mathematics.

The above vision points indicate that learning ought to be an enjoyable demonstration where kids should feel that they are esteemed and their voices are heard. Constructive and useful learning must be a piece of the educational modules. Circumstances and openings must be generated for learners to make learners familiar with difficult situations, stimulate creative skills in young minds and energetic involvement for students. Learners must be urged to associate with companions, instructors and more established individuals which would open up numerous more rich learning opportunities. Matters related to the competencies needed in the future for effective mathematics learning. The most important competencies needed for future learning are:

i) Ability to communicate
ii) Ability to think clearly and critically
iii) Ability to consider the moral aspects of a problem
iv) Ability to become a responsible citizen
v) Ability to try to understand and tolerate different views
vi) Life skills in globalized societies
vii) Have broad interests in life
viii) Have the readiness to work
ix) Have intelligence according to the talents / interests
x) Have responsibility for the environment

In connection with this, in addition to the development and rearrangement of standard competencies and basic competencies in the school mathematics curriculum, the learning process to achieve their competencies ought to be adjusted. Concerning the standard of the learning process which contains the following learning principles:

i) Learning by doing and learning from various sources.

ii) Strengthening the use of scientific approaches in the process of teaching learning.
iii) Shifting from content-based learning to competency-based learning
iv) Changing from single domain learning to the multi-dimensional learning.
v) Balancing between physical skills and mental skills.
vi) Learning that prioritizes civilization and empowerment of students as lifelong learners
vii) Learning that values by giving real example, building willingness for learning, and develop students' creativity in the learning process.
viii) Learning takes place not only at schools but also at home and in the community and at other suitable places.
ix) Application of information and communication technology to improve the efficiency and effectiveness of learning.
x) Recognition of students' individual differences and socioeconomic background of students.

**TEACHERS' MINTELITY CHANGING**:

According to Stronge (2007), the role and duties of the classroom educators are, in all probability arranging instructions, conveying instructions, surveying learners' learning, and dealing with the classroom environment. Viewpoints on instructing and learning have been changed in this 21st century. It is currently important to open another window for contemplating how 21st-century abilities and benchmarks affect these conventional educating roles. The objective is to make these jobs pertinent to the present advancing learning requirements. To have the capacity to do the learning standards as depicted before, a few changes in mentality that educators need to do. These changing in way of thinking include,

(1) **Changing Resource Centre:** The teacher must change his/her view of his position in relation to student learning resources. The teacher must be sincere that the teacher is no longer regarded as the only source of information in learning. The teacher must change to become the provider of learning experience. In today's modern world, information can be said to be very abundant. With internet technology, what happens in other parts of the continent, we can immediately find out. One of the impacts is books and teaching materials. In the past, books often only belonged to teachers, and teachers could learn one day ahead of their students, so now, students can search and download books from everywhere. In fact, when a student has the ability to speak English or other international languages, the mathematics textbooks that the student has can be of higher quality than the books owned by the teacher. The explanation contained in the book the student owns can be better and easier for him to understand. This provides opportunities for students to not be too dependent on the teacher's explanation.

(2) **Provider of Learning Experiences**: The teacher should change from the beginning to being an active person, being motivator for taking information for children, processing it and processing it. In the current era, the learning paradigm has shifted from the behavioral paradigm to constructivism paradigm. With the change in learning paradigm, the paradigm of learning also changes. Learning is no longer guided as a process of transfer of knowledge to students. Learning is seen as a process of helping students interpret their interaction experiences with learning resources Thus, the teacher does not have to explain the materials elaborately anymore. Presently, the main task of the teacher changes and become more important as a provider of learning experiences. The teacher must encourage students who actively

interact with learning resources, interpret information obtained from these interactions, and draw conclusions. The experience of interpreting the results of this interaction will certainly provide opportunities for students to discover about learning itself. The knowledge that is acquired from finding out about learning will be a valuable learning experience to make students as the lifelong learner.

(3) **Learning outside the Classroom**: Teachers must change their perception that learning can be done anywhere, at any time. Learning is no longer limited in the classroom. That is, even though the child does not seem to study in class, it is very possible that they learn outside the classroom. They learn independently, and take place in the atmosphere they like most. With the abundance of information available in this information age, the implications of learning are no longer demanding classrooms. Learning can take place in an open space, at home, in the cafeteria, and can take place in the morning, during the day, in the evening, at night. Learning can take place while relaxing, while working on something, etc. That way, the teacher must look at learning in fashion as one of the many other types of learning activities. Learning can take place outside the school and classroom, so that the learning design should not be limited in the classroom.

(4) **Developing Thinking Skills**: The teacher must change his perception that he/she learns not to accumulate knowledge. Learning must be seen as an effort to develop students' self regulative, creative, and critical thinking skills. In the current information age, even in the future, increasing information over time follows exponential growth. The growth acceleration was so high that the truth of information takes place only in a very short period of time. Information considered right now may be replaced by the next newest information. Therefore, what is more important in this regard is the ability to think critically, creatively, and self regulative. By thinking critically, a student can choose the right information that is needed and that suits needs. By thinking creatively, a learner can be expected to associate information with one another, and produce new information that is more useful.

5**. Encourage to Formulate Problem**: The teacher should change from the learning that emphasizes speed and accuracy, and should adopt learning that develops the ability to formulate problems. At present, works that are mechanistic are done by machines or robots. Computers are very fast and can solve any type of mathematical calculations with highest accuracy. Numbers of software are available in the market for solving complex mathematical problems. Therefore, teachers do not need to focus too much on their learning to help students regarding calculation speed and accuracy with robots or machines. Teachers must prioritize learning to help children to localize problems and identify instruments that can be best useful to solve them. The teacher must help students develop their thinking ability to become designers of problem solving activities, instead of just making their students like robots with a high level of automatic control. Teachers must encourage students to have the ability to formulate real life problems.

6. **Cooperate and Collaborative Learning**: The teacher must change from emphasizing individualistic learning, to learning that supports the growth of willingness and ability to cooperate. In the modern era where existing jobs tend to be specific and unique, the ability to work together is a very important prerequisite for working. One worker must be willing and able to work together in teams for the benefit of the system. Therefore, teachers need to prepare so that their students have the potential to work together. Classical learning that tends to develop individual abilities must be reduced. Learning with a cooperative approach seems to have to be done more.

(7) **Shifting teaching domination:** The teacher must change his perception that the teaching work is no longer his domination, but must accept the fact that anyone can become a teacher. With abundant information now, the latest information no longer belongs to the teacher. It is very possible for students to master something that their teacher does not have. Therefore, it could happen that the teacher must study with his students. Thus, the teacher may no longer claim that he alone is entitled to become a teacher. Teachers must dare to accept the fact that they may learn from their students. Teachers must also change their mindset that students can learn from others. Learners don't have to wait for their teacher to learn something.

**SCIENTIFIC LEARNING APPROACHES IN MATHEMATICS:**

From the above study, it has been realized that there is a greater opportunity to develop and implement scientific educational approaches that emphasize self learning, creative, and critical thinking skills. In the subject mathematics, scientific methodology stages comprise of gathering the mathematical model in the diverse representative frame, and reflection (Beckmann et al, 2009). In Indonesia, the 2013 curriculum utilizes the Scientific Approach as this viewpoint is judged suitable for advancing learners' attitudes, understanding, and skills. Rohini et al. (2017) conducted a study on the effects of Scientific Approach on students' mathematics problem solving skill. The result of the study revealed that there exists a significant difference in the skill to solve mathematical questions between learners adopting learning with Scientific Approach and the students utilizing Direct approach. The educationists trust that scientific approach is characterized as the learning strategy planned systematically with the end goal to get students who can develop the basic idea through five logical scientific steps. These five sequential steps are Observation, Questioning, Digging Information, Connecting and Communicating.

**Observation:** Observation is basically an activity of paying attention to something carefully. Observing is not only done with the eye, but also with other senses. In learning mathematics, the object of observation can be a mathematical phenomenon and can also be a mathematical object. Two examples are:

i) Observation of drawing geometrical figures.
ii) Observation of mathematical phenomenon in real life activities such as calculation of profit and lost in the market place.

Understanding the basic concept of a topic in curriculum is the first step to start observation. Therefore, understanding basic competencies is the main and first requirement to develop observing activities. Without it, observing activities will not be directed, and achievement of basic competencies will not be guaranteed.

**Questioning:** It is the second step in scientific approaches of learning activities. Educators think that the concept of scientific learning is not on the basis questions provided by the teacher to the learner but the questions asked by the learners. This willingness and ability to ask questions will encourage learners to ask question in mathematics class as well as in real life situations. The questioning movement will energize the holding of investigation and research that will probably create a beneficial work. Subsequently, in this questioning stage, the individuals who need to make questions are students, not instructors.

**Digging of Information**: Exploring information is a key skill in the information age now. The availability of information is abundant, requiring someone to be able to find the source of information, sort and select the information needed, process and analyze it, and draw conclusions, and follow it up appropriately. Therefore, practicing information gathering is something that needs to get emphasis in learning.

**Connecting:** Associating or connecting is the third stage. Students are expected to associate or connect one fact with another, especially the results of extracting the information, and finding patterns and conclusions. The teacher must train students to be able to associate this. Modeling is a best way linking several facts. Students can see and learn how to interlink information with one another. Student knows how to connect tables, diagrams, graphs and others to find a correct answer of a problem. One important thing that needs to be emphasized here is that the results of this association are expected learning outcomes. Therefore, this association is basically the answer to the question that arises at the questioning stage.

**Communicating:** Communicating and sharing results and experience with peer and other is the last step of scientific learning approach. Students must share their results and experiences with others so that all members of the community are aware of their position in the knowledge of mathematics. These findings may be immediately accepted but can also get criticism and suggestions. With criticism and suggestions, findings can be known for their strengths and weaknesses, and new ideas of inquiry can be obtained strengthening the quality of these findings. Therefore, the teacher must encourage students to share ideas, experiences, the results of their work to be observed, commented on, criticized by their peers. The experience of criticizing and defending the ideas communicated indirectly will strengthen their cognitive schemes and provide inspiration for further investigation. That way, this communicating activity must be made in a serious atmosphere even though it must also remain in a relaxed and pleasant environment.

Mathematics teachers believe that scientific approaches of learning have two main characteristics: learners' active learning and teachers' act as provider and motivator.

There are many other things that teachers still have to learn in order to be able to apply the Scientific Approach, especially mathematics teachers and other non-science teachers, which is said to be the nature of teaching materials that differ greatly from science teaching materials. The contradiction in the nature of deductive mathematics and the scientific approach that emphasizes inductive logic requires the mathematics teacher to learn to adapt harder. Learning with the scientific method has the following characteristics:

a) Student-centered.
b) Involving science process skills in constructing concepts, laws or principles.
c) Involves potential cognitive processes in stimulating the development of the intellect, especially the high-level thinking skills of students.
d) Can develop student character.

**THE ROLE OF TEACHERS IN THE SCIENTIFIC APPROACH**

In Scientific Approach, instructors not just enable learners to secure or build their very own knowledge, for example, helping students as a facilitator, organizing or coordinating learning exercises, giving input, giving clarifications, give affirmation, and so on. The job of the educator in learning with the Scientific Approaches is as per the following:

a) In the Observation step, the teacher helps learners to find or enlist what they expect or need to perceive so they can work or construct something.
b) In Asking step, the duty of educator to help students to compose problems dependent on a rundown of things that need or need to be known with the end goal to have the capacity to do or make something.
c) In Digging Data step, the teacher helps in the learner's plan and in getting information to answer the problem that has been figured.

d) Connecting or Associating is the step in which the teacher help students in handling collected information. The teacher also helps students in drawing the conclusion.
e) In the Communicating step, the teacher helps and encourages students to share results and experiences with peers and others.

**SOME LEARNING MODELS WITH SCIENTIFIC APPROACH:**

One of the essential points of instructing mathematics in schools is to teach the expertise of evaluation of encounters around the students. Toward this, completing investigations with numbers and types of geometry, encircling speculations and confirming these with further perceptions shape inalienable piece of arithmetic learning. It would likewise incorporate summing up these discoveries with verification and creating capability to manage issues. Science helps during the time spent basic leadership through its application to genuine circumstances in natural and in addition non-recognizable circumstances. It contributes in the advancement of exactness, discerning and explanatory reasoning, thinking, uplifting states of mind and tasteful sense. Aside from being an unmistakable zone of learning, it helps immensely in the advancement of different orders which include examination, thinking and measurement of thoughts. Investigation of science likewise gives plentiful chances to making guesses, testing and building contentions about their legitimacy and furthermore in making new inquiries. Comprehension of the essential structure of science prompts a greatly improved energy about the extension and intensity of arithmetic. The arithmetic educational module must build up a thankfulness and comprehension of the commitment of Indian mathematicians alongside that of others. This would build up a feeling of confidence and fearlessness among the students. The learning model is a frame of application of an approach, method, and learning technique. There are many learning models and some suggested in the 2013 curriculum include

a) Inquiry Based Learning,
b) Discovery Based Learning,
*c)* Project Based Learning,
d) Problem Based Learning.

**CONSTRAINTS FACED WHEN USING THE SCIENTIFIC APPROACH:**

a) **Time:** Time is very important in terms of learning, with learning time can be maximal and also not optimal. Thing it can affect the approach used. Teacher inside the implementation of the scientific approach, this is the problem. Time per subject is only one hour or 45 minutes, while time is needed at least two hours per subject because they will make observations.

b) **Students are less active**: Which became constraints during the learning process using the approach scientific where when a teacher finds students who are less active, do not want to ask, lazy and lack of response to learning.

c) **Instructional Media**: Media procurement is also an obstacle in terms of implementation

Scientific approach, where not all learning media can be carried going to school, like rice fields, mountains and forests, it can't be a teacher bring it to school. Whereas in terms of scientific approach, the fact is students are faced with real things. So to overcome all

that, students and teachers do learning outside class hours, such as days holiday, go on an excursion to the place he has learned while the teacher introduce to students. Whereas to take students out it requires a lot of money, for this it is also an obstacle in terms of implementing the scientific approach.

d) **Non Availability of Solutions**: Based on the results of conversations with students when finished learning, students feel difficulties where when working on assignments or practice, because not all the answers on the given reading sheet exist, but some are there. This is an obstacle felt by students in terms of learning with a scientific approach.

e) **Teacher role as facilitators**: Most of the teacher struggle in between their role of facilitator or leader.

**CONCLUSION:**

For the course, students now need to adopt a scientific approach for examining living things. The objective of mathematics curriculum is to develop two types of understanding between students, first of all, conceptual understanding and procedural understanding. Perceptual understanding refers to students' knowledge of the biological and physical aspects of students. Procedural comprehension alludes refers to the understanding of students of scientific processes. These two forms of understanding cannot prosper in independent manner. A transparent understanding of scientific processes is necessary for ongoing growth of conceptual understanding. Scientific methods of teaching modern mathematics are very important. That is why investigation on the modern mathematical teaching method is a very useful and important research topic for mathematics education researchers.

Students should be taught gradually and suitably how to dissect, synthesize, summarize, motivate, generalize, and specialize and conformity, even if they are involved in mathematics seriously in the later stages.

By choosing a proper issue and by the adaption of logical learning technique an educator unique imaginative thought can plan learners for work, which is like the exploration work, crafted by a researcher. Heaps of math instructing materials can go through this sort of utilization and along these lines can finish science hypothesis in its range.

Rather than the typical procurement of content, this is a larger amount of mathematical instruction. A mathematical state of mind is a valuable win of scientific mathematical training, relevant in numerous different exercises. The words progressive and fitting are underscored. On the off chance that scientific strategies are fittingly and accurately connected, with an important inclination for the difficulty of mathematics content and scientific state of mind, contemplating mathematical capacities of every student, it very well may be normal that math training will be effective.

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