Constructivist Approach in Mathematics

Pushpendra Singh[1]
Dr. Anil Kumar[2]

Abstract:

Developing children's abilities for mathematisation (ability to think logically, formulates and handles abstractions) rather than knowledge of mathematics (formal and mechanical procedures), is the main goal of mathematics education (NCF-2005 P.127). but there is a general feeling that mathematics is a very dry subject among many students and parents. The present system of mathematics education and the mathematics classroom fails to facilitate the development of competence of divergent thinking and logical reasoning among students and thus they fails to apply their knowledge in real life situations. Many students complain that learning of mathematics is not at all interesting and attractive to them. Various studies show that the main reason for their complaint lies in faulty methodological approaches and pedagogy adopted by mathematics teacher. To achieve the goal and overcome the complaint, progressive new ideas on teaching and learning, many strategies in mathematics are constantly emerging one of these strategies is the constructivist based approach which views learners as active participants in learning process. This paper focuses the various dimensions, guidelines and efforts that may help in incorporation of constructivist approach in mathematics' classroom.

Keywords: *constructivism, Mathematisation, NCF (National Curriculum Framework), Curriculum, Brain storming, Logical thinking, Objectivist Paradigm, Strategies, metacongnitive abilities.*

I. INTRODUCTION

The modern mathematics views has been shifted from seeing mathematics as a large collection of concepts and skills to be mastered in a strict, lopsided order, to seeing mathematics as something people do. Knowing as 'doing' implies that a person gather, discovers or creates knowledge in the course of doing purposeful activity. Students, are more likely to be successful if they learn mathematics in the context of problematic situation, in this case students learn to formulate problems, develop and apply strategies to solve them. They learn to verify of different context. In doing so, they apply mathematical modeling and become confident in their abilities to address problem situations in the real world. Students develop the ability of making and evaluating conjectures and of constructing, and validating agreements. Since 1970s mathematics learning is being conceptualized as involving the construction of meaning and understanding based on the modeling of reality. During the same period several important shifts also occurred in conceptual and methodological approaches to mathematics teaching and learning. These include shifts from a focus on the general domain to domain specific processes, from concentration on the individual to concern for social and cultural factors; from the laboratory to the classroom as the primary setting for research; and from quantitative experimental approach to a more diversified methodological repertoire, including qualitative and quantitative interpretive techniques (Corts, Vershaffes Green 1994).

International literature shows that students in school are not equipped with the necessary knowledge, skills, belief and motivation to approach new mathematical problems and learning tasks in an efficient and successful way (Decoite, 1992). This is because of the prevailing learning activities in schools which consist mostly of listening, watching and initiating the teacher and the textbook (Greeno, 1991). Romberg and Carpenter (1986), point out that the dominant approach of teaching in mathematics classroom is still the information – transmission model; in the approach students acquire mathematical knowledge independent from the social and physical context from which it would derive its meaning and usefulness. Subsequent researches theorists in the fields of education, mathematics and psychology conceptualized learning as an ongoing activity and not as an achievement.

The recent view is the constructivist approach which perceives the learner as a builder of his or her own ideas. Traditionally learning was seen as transfer of knowledge for the teacher to the learner, with the learner merely making his own copy of their transmitted knowledge. In contrast constructivists suggest that mathematics leaning is a process involving highly personalized construction of knowledge, based upon prior knowledge as well one's personal belief system consisting of metacongnitive abilities, notions interests and attitudes.

Constructivism is a relatively new paradigm which takes into account the subjective, contextual and pluralistic nature of knowledge. According to constructivists, learners construct knowledge in the social and cultural context in which they are embedded. The knowledge can be expressed in a number of language and symbol forms, a problem can have a number of viable solutions. The constructivist thinking has been

[1] Research scholar, Mewar university Chittorgarh, Rajasthan
[2] Research guide

considered important to achieve the objectives of learning to live together, learning to learn, learning to know and learning to be (Delor's Commission, 1996).

The national curriculum Framework (NCF-2005) also recommends the curriculum should help learners to become constructors of knowledge and emphasized the active role of teachers in relation to the process of knowledge construction, learners knowledge while engaged in the process of learning and the teacher's role is to engage them in the process of learning through well chosen tasks and questions. "Active engagement involves enquiry, exploration, questioning, debates, application and reflection leading to theory building and creation of ideas/positions schools must provide opportunities to question, enquire, debate, reflect and arrive at a concepts or create new ideas."

Thus constructivists believe that learners construct new knowledge in the particular context in which the cognizing individual is operating. Learners are active participants into construction of knowledge. Learning is thus not a passive receptive process and knowledge cannot be transmitted to passive learners. Learning is an active meaning- making process where learners reformulate the new information, restructure their existing knowledge and reorganize their prior conceptual schemes.

II. GOALS OF CONSTRUCTIVISM

Although it has many different interpretations, where constructivism is concern there are some goals for mathematics instruction. Here I intend to fix some major goals in mathematics teaching through constructivist approach. First, students should develop their mathematical structures that are more complex, abstract, and powerful than the ones they currently possess so that gradually they will be able to solve a wide variety of meaningful problems.

Second, students should become autonomous and self-motivated in their mathematical activity. Students' should believe that mathematics is a way of thinking and thinking is the only way to solve mathematical problems. Their believe will be change so that they don't get mathematical knowledge from their teacher so much as from their own exploration, divergent thinking, participation in discussion, observation and experimentation.

Also another important goal of the constructivist approach in mathematics is assessment, measurement and evaluation what should be a natural part of the learning process rather than an activity completed at the end of the learning process. Additionally, students should be involved in making judgments of learning and these judgments should be combined with judgments of teachers or other experts or peers regarding their constructing knowledge or understanding of mathematics. So the goals of constructivism approach are to boost up the confidence level of the students.

III. STRATEGIES FOR CONSTRUCTIVIST LEARNING IN MATHEMATICS

Some specific strategies that can be used for constructivist learning in mathematics have been discussed below:

I) Mathematical games and puzzles

All children like games and puzzles. Games and puzzles energize and refresh mind by facilitating creative thinking. Mathematical games and puzzles help in developing a positive attitude and in making connections between mathematics and everyday thinking. Apart from computational skills, stress must be laid on identifying, expressing and explaining patterns, on estimation and approximation in solving problems, on making connections, and on the development of skills of language in communication and reasoning students get the first test of the power of mathematics through the application of powerful abstract concepts that compress previous learning and experience. This enables them to revisit and consolidate basic concepts and skills learnt at the primary stage, which is essential for the point of view of achieving universal mathematical literacy solving problems and in generalization, to the systematic study of space and shapes, and for consolidating their knowledge of measurement. Data handling, representation form a significant part of the ability of dealing with information in general, which is an essential 'life skill.' The learning at this stage also offers an opportunity to enrich students' spatial reasoning and visualization skills. Games and puzzles will do a lot in this direction.

II) Provide Opportunities for Recreation through Mathematics:

Keates has remarked that "Truth is Beauty." Thus whenever learners discover something new and true, with the help of mathematical laws, facts, theorems and principles, a sense of joy is developed in their mind. (Does the present day mathematics learning facilitate such joyful experiences among learners is a very crucial and pertinent question. Many times the teachers fail in fulfilling this task.) Mathematics provides enough opportunities for recreation. Once the learners test the delight of mental activity, he/ she is able to exercise the mental power on their own account for the mere pleasure of doing the same. This helps them in their future life to easily diffuse the problem due to stress and strain.

III) Developing problem solving abilities:

The ultimate goal of school mathematics at all times is to develop in our students the ability to solve problems. The children should learn to enjoy mathematics rather than fear it. They should pose and solve meaningful problems, the teacher should engage every child in the class by facilitating to solve meaningful and life-related realistic problems. When the classroom discusses the problems faced by the learners in their society, it becomes problem pausing education as suggested by Paulo Friere (1967).

IV) Making mathematics meaningful and life oriented: knowledge of the subject gained in school is to be linked with the child's everyday experiences. Activities and exercises are such that they reflect thinking and reasoning. Learning should be shifted away from 'rote method' to 'learning by doing' and creation of knowledge.

V) Linking mathematics with nature:

Nature provides wonderful resources to learning, we have to indentify the elements in nature that can be linked with

mathematics. Patterns, shapes etc. in nature can be easily brought to mathematics class and thereby we can blend mathematics with nature.

VI) Developing reasoning and logical thinking through learning mathematics:

One of the major purposes or value of learning mathematics is to develop reasoning and logical thinking abilities among learners. But the mechanical nature of teaching mathematics does not endure this. Teachers have to facilitate the development of reasoning and logical thinking through learning of mathematics from the primary stage itself so that the learners can enjoy the mental happiness and can use the logical thinking and reasoning power in dealing with their day to day experiences and issues.

VII)Using of Appropriate Mathematical Tasks:

Teachers have to select and use appropriate mathematical tasks in the classroom. Different types of mathematical tasks are give below:

- *Brain Storming:* challenging and unfamiliar problems that can be solved by using and after learning a particular mathematical topic such as arithmetic topic like whole numbers, fraction, with arithmetic operations such as addition, multiplication, or division, but it requires higher-order analytical thinking skills and it enhance creativity.
- *Programmed learning material:* 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.
- *Computer 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), Television can be used to show some good mathematics education show.
- *Open-ended Problems:* open-ended activities for students to explore and extend a piece of pure mathematics for its own sake. The activities may develop in different ways for different students to provide them to develop their own system of generating results from exploration, tabulation of data to look for patterns making conjectures and testing them, and justify and generalize their findings; these kinds of problem are used to develop deeper understanding of mathematical ideas and communication in students. Open-ended tasks require high-cognitive thinking such as:
  - Making own assumptions about missing data,
  - Accessing relevant knowledge,
  - Displaying number sense and equal grouping patterns,
  - Communicating argument using multiple modes of representation, and
  - Displaying creativity in as many strategies and solutions as possible
- *Activities:* Activities here include all such work where in students play an active role, has 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	Values of mathematics, Mathematics is everywhere etc.
Role play	Arithmetical concepts like place value, face value etc.
Seminars	Shortcuts through Vedic Mathematics, Application of mathematics in other disciplines.
Discussion	Properties of 'Zero', perimeter and area.
Mathematics club	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, ration shop, shopping malls ,tailor and carpenter shops etc.

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 behavior, availability of resources acceptance of constructivist approach and positive attitude of teachers towards it, is an important factor for the selection of method and pedagogic resource. There are researches which shows that some innovations are carried out in the classroom and has shown the positive effect on teaching learning process.

IV. CONSTRUCTIVISM AND ASSESSMENT OF MATHEMATICAL UNDERSTANDING

Constructivism requires a re-examination of the classroom evaluation practices. Traditional teachers emphasize too much on marks/grades and the position secured by a student in the class. They depend on standardized tests and test scores for determining the success of a student in the prescribed course. These practices, however, have come under fire for a multitude of problems. The problem raised by teachers themselves is that this system has resulted in teaching how to answer the questions instead of using the tests to know the success of teaching-learning process.

The present practices of evaluation are based on 'objectivist paradigm.' The technology of testing in this paradigm was evolved to determine whether students could reproduce facts and determine correct answers to problems. The test makers are viewed as having the 'correct' answers and student knowledge is judged against the test constructor's knowledge. The present testing practices consist of 'objective' questions to eliminate teacher's subjectivity in scoring. The questions are constructed by the test designer and the wordings are of the test designer. The students are expected to interpret the questions as they were designed by the examiner. Students may frame or interpret a problem differently. They may like to give an answer, which is not one of the suggested answers given by the examiner. In the objectivist paradigm, alternative solutions of alternative understanding of words are not considered in assessing the assessing the answers, although those solutions may be viable. Objective tests, therefore, do not reveal what a student

knows/thinks, but only reveal how well his/her knowledge matches with that of the test maker. From a constructivist perspective, evaluation of student learning should not be judged only on the specifics of the knowledge, but should be judged on whether students can solve the problems posed with a viable solution.

Techniques which attempt to reveal the individual's construction of knowledge are being explored and tried out. In the constructivist paradigm uniform standards of evolution cannot be used for all students. Self evaluation against own's previous knowledge may be used. A 'criterion-based' evaluation must be used. For assessing conceptual change different tools and techniques can be used such as concept mapping and diagrams, performance-based tests, portfolios, team-projects etc. are some of the techniques which can be used in the constructivist paradigm.

The focus of the constructivist assessment would be to :-

- Find what learners bring to the class in terms of their interests, prior knowledge and ideas, alternative conceptions and likely questions.
- Get and indication of how their new knowledge and their prior knowledge are interacting.
- Find what the learners are thinking rather than their overt responses, that is their constructed meanings, rather than whether they have the 'right 'answer.
- Measure understanding rather than training, for example measure the ability to use simple ideas in unfamiliar situations rather than the ability to recall facts or use procedures in set and familiar situations.

In mathematics, assessment should be free from traditional memory based, we can provide open ended questions or we can motivate the students to generate the different ways to solve a problem and if a student solve a problem in more than one way then teacher should encourage such students by awarding extra marks/grades etc.

V. CONSTRUCTIVIST APPROACH AND TEACHER

Classroom processes, particularly teaching-learning strategies, have been considered important for improving the quality of education in our schools. There has been increasing shift from 'teacher cantered' to 'learner centred' approaches of teaching. The NCF-2005 developed by NCERT emphasized the use of learner centered approaches. Learner centered approaches take into account learner's capabilities, capacities, learning styles, context and culture. They are supported by philosophical assumption and have strong psychological bases. These are based on constructivist philosophy that views knowledge as subjective and contextual.

In the constructivist classroom, the role of teacher changes from 'transmitter' of knowledge to 'facilitator' of knowledge construction. Teacher must know the pre-concepts and misconceptions of children. Teacher's activities may be such that help the children in clarifying ideas, providing rational explanations, challenging misconceptions, guiding experimentation, predicting results and drawing inferences. Teachers should ask questions which test students' ideas and provide feedback to them. They should be encouraged to debate ideas and also comment on answers and explanations provided by other students. Teachers may ask students to use evidence to explain ideas, to apply their conceptions to phenomenon, to summaries result and to present them symbolically. Teachers should encourage students to think independently, provide logical explanations, test hypothesis etc.

The new role of teachers also places new demands on teachers. Teacher should have flexible subject matter knowledge. That is, the teacher must not only have good understandings of the principles but should also have the ability to explore these principles in a variety of ways. In mathematics most of the problems have one 'correct answer' but students may reach this answer through different processes. Teacher has to examine how the students make use of the problem solving approach. Teacher should have awareness of disciplinary 'truths' and the viability of various ways of knowing the 'truth'.

In addition to good knowledge of subject-matter, teachers should have good knowledge of 'pedagogical skills'. Designing instructions based on 'constructivism' is not as straightforward as it appears. Teachers and teacher educators struggle with how specific instructional techniques (for example, lecture, discussion, cooperative learning, problem-based learning, inquiry learning) fit in the constructivist model of instruction. Regardless of the particular techniques used in instruction, students will always construct and reorganize knowledge rather than simply assimilate information from teachers or textbooks. The question is not whether to use lecture or discussion or discovery methods but how to use these to nurture students' thinking. Constructivist principle suggests that students should experience the idea, phenomenon and artifacts of a discipline before being exposed to their formal, theoretical explanations.

Following guidelines may be followed by mathematics teacher for incorporation constructivist approach:

- 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.
- The immediate environment of the learner both natural and human should be used when and where possible for making learning concrete and meaningful.
- Involve the students in the process of learning by taking them beyond the process of listening to that of thinking, reasoning and doing.
- In order to promote self-study skills use of library and resource centers needs to be encouraged.
- 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.

- Mathematics-teachers' organizations at different levels should be formed where sharing of ideas and experiences, developing resources in a collaborative 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.
- Properly instruct and guide the students for carrying out different activities and precautionary measures should be taken so that students are not misguided.
- Study journals of mathematics 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, demonstration, 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/she will be able to use these ideas again in 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.

VI. CONCLUSION

Since the central idea of constructivist approach is construction of knowledge by the learners based upon their previous knowledge, and a well determined enthusiastic and creative teacher can enhance the creative thinking among learners meaningfully and effectively by adopting various types of strategies of generating knowledge and assessment so that mathematics can be learn joyfully with active participation of all students with greater emphasis on development of skill of mathematisation.

VII. REFERENCES

- Areekkuzhiyil santosh, (2016); Joyful learning of Mathematics: EDUTRACK vol.15 No.10 Neelkamal Publication Pvt. Ltd. Hyderabad.
- Bhowmik Monoranjan,(2014); Constructivist Approach in Mathematics Teaching and Assessment of Mathematical Understanding : Basic Research Journal and review.www.basicresearchjournal.org.
- George E Hein (1991) Constructivist Learning Theory : CECA Conference (International Committee of Museum Educators) Jerusalem Israel.
- Martin A Simon (1995); Reconstructing Mathematics Pedagogy From Constructivist Perspective :Journal for Research in Mathematics Education, Vol.26 No.2 University Park PA16802.
- NCERT (2005); National Curriculum Framework, New Delhi.
- Sasikumar.P.(2009) ;Constructivism and Evaluation; EDUTRACK Vol.9 No.1, Neelkamal Publication Pvt. Ltd. Hyderabad.
- Siddhu.K.S. (1999); Teaching of Mathematics :Sterling Publishers Pvt. Ltd. Delhi.
- Sinclair Parvin (2000);Approaches to Learning (LMT-01):IGNOU Delhi.
- Sharma Santosh.(2006); Constructivism, Learner Centered Approach: Constructivist Approach to Teaching and Learning: NCERT Delhi.
- Woolfolk Anita (2004); Education Psychology :Pearson Education Singapore.