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Dr. Femila Pangat
Assistant Professor, Miranda College of Education, Indiranagar, Bangalore, Karnataka, India

Correspondence
Dr. Femila Pangat
Assistant Professor, Miranda College of Education, Indiranagar, Bangalore, Karnataka, India

A study on effect of constructivist pedagogy on the academic achievement of secondary school students in mathematics

Dr. Femila Pangat

Abstract
The present study was designed to examine the effect of constructivist approach on the academic achievement of secondary school students in mathematics. A pre-test, post-test Equivalent Group Design with randomized experimental and control groups was used. The sample of the present study consisted of 50 mathematics students.The selection of the school had been done through purposive sampling method. A simple random sampling method was used to divide the students in two groups. A Self-made achievement test of mathematics was administered to all the students. The test was conducted on two occasions as a pre-test and as a post-test. The data collected was analyzed and interpreted using the statistical techniques mean, standard deviation and t-test. It was found that the performance of mathematics students taught with constructivist approach was better than that of group taught by conventional approach. The calculated t-value of 11.26 was more than the table value at.01 level of significance. The study revealed two important results. Firstly, using constructivist learning approach significantly improves students' achievement in mathematics as compared to using a traditional teaching method. Secondly, most of the students were showed remarkable improvement in their abilities of understanding and reflection. Therefore, they indicated that constructivist learning approach which help them to understand, integrate and clarify mathematical concept and also enhance their interest to participate in group in constructivist classroom.

Keywords: Constructivism, Mathematics, Academic Achievement, Secondary Students

Introduction
Schools are expected to transmit knowledge to younger generations. They are, however, also increasingly criticized for distributing so-called inert knowledge, i.e., knowledge that is accessed only in a restricted set of contexts even though it is applicable to a wide variety of domains. The causes of limited knowledge transfer are mostly attributed to the dis-embedded ness of learning situations in schools. Instructional procedures that result in learning in the sense of being able to recall relevant information provide no guarantee that people will spontaneously use it later. "Authentic learning," acquiring knowledge in the contexts that (will) give this knowledge its meaning, is now being presented as an alternative. Underpinning these reform proposals is not only a (growing) concern with efficiency, but is also a new epistemological theory, labelled as constructivism.
Learners actively construct their own knowledge by connecting new ideas to existing ideas on the basis of material/activities presented to them. Hence learning process makes sense from in and around the environment of child. It is the result of an individual's mental construction and approach which holds that "learning is an active constructive process rather than the process of knowledge acquisition". Both the teacher and curriculum must nurture student voice & curiosity by developing skills like questioning; sharing and integration of experience and investigations rather than their ability to reproduce textual experience.
In this way, it is a novel and open-ended approach for school to engage students in exploring, questioning, debating, reflecting and arrive at construction of new concepts and ideas based on their prior knowledge. Totally the teacher's role is prominent in facilitating constructivist environment and also to play a reflection role to decide what child already knows? What child is needed to construct? How it is to be constructed? However, the success and failure of constructive approach greatly lies in the role of teacher.

Obviously, teacher is also called constructivist teacher. Every school is expected to provide constructivist education to nurture the experience of the child.

The three main propositions of this philosophy are as follows

1. Understanding is in our interactions with the environment. This is the core concept of Constructivism. What one understands is a function of the content, the context, the activity of the learner, and the goals of the learner. Cognition is not just within the individual but rather it is a part of the entire context, i.e., cognition is distributed.
2. Cognitive conflict is the stimulus for learning and determines the organization and nature of what is learned. Learner's puzzlement is the stimulus and organizer for learning.
3. Knowledge evolves through social negotiation and through the evaluation of the viability of individual understandings.

Need and Importance of the Study: Class room teaching practice becomes more effective, when it is well informed by an understanding of how students' learn and learning will be more successful if students are given the opportunity to explain or clarify their ideas. So in terms of pedagogy, the development of education now requires teaching strategies that emphasize student involvement in their learning, where focus is on knowledge construction rather knowledge transformation. Researchers have shown that learning strategy in classroom can be very effective in encouraging student interaction and consequently enhanced students' achievement. It is therefore essential that the major implication of learning theory should be reflected in classroom practices in a more child focused manner. Constructivism is an emerging pedagogy among the teaching community across the world and National Curriculum Framework (NCF 2005) confirmed the direction to it in Indian classroom situation.

Mathematics has the ability to confuse, frighten and frustrate learners of all ages. If a child has negative experience in mathematics, that experience would affect his / her achievement as well as attitude towards mathematics during adulthood. The obvious question is whether students' failure to learn mathematics can be ascribed to problems of curriculum, problem of teaching, or the student, or perhaps the combination of these (Carnine, 1997) [3]. There are many possible reasons as to why students fail in mathematics. But most of the reasons are related to curriculum and methods of teaching rather than the students' lack of capacity to learn (Jones, Wilson, and Bhaswani, 1997) [7]. Airasian and Walsh (1997) [1] argue that the existing mode of teaching of mathematics in schools has not fulfilled the needs of the vast majority of our students, and that not nearly enough instructional stress is put on the higher order skills. Traditional method of teaching makes the learner to memorize information, conduct well organized experiments and perform mathematical calculations using a specific algorithm and makes them submissive and rule-bound. The traditional teacher as information giver and the textbook guided classroom have failed to bring about the desired outcomes of producing thinking students. A much heralded alternative is to change the focus of the classroom from teacher dominated to student-centred using a Constructivist Approach.

The traditional notion of mathematics teaching, which intends to make individuals to gain social identity depends on a teacher centered instruction, which grounds the belief that the best teaching occurs in a quiet teaching environment, where the teacher symbolizes the wisdom and the authority. The constructivist theory which plays an important role in the field of education recently arouses the interests of the experts in the field of mathematics teaching in terms of designing a curriculum which enables the students to learn through practicing, problem solving and decision-making. The researcher found out that very limited work has been done in the field of mathematics with regard to constructivist approach. The areas so far been explored in other subjects. The present study was aimed to study the impact of constructivist approach on academic achievement of secondary school students in mathematics.

Objective of the Study

- To examine the effectiveness of constructivist approach in the academic achievement of secondary school students in mathematics.

Hypothesis of the Study

- There exists no significant difference between the pre-test and the post-test mean achievement scores of the secondary school students in mathematics of experimental group.
- There exists no significant difference between the pre-test and the post-test mean achievement scores of the secondary school students in mathematics of control group.
- There exists no significant difference between the pre-test mean achievement scores of the secondary school students in mathematics of experimental group and control group students.
- There exists no significant difference between the post-test mean achievement scores of the secondary school students in mathematics of experimental group and control group students.

Sample of Study

The sample of the present study consisted of 50 mathematics students (Two intact groups – 25 for controlled group; 25 for experimental group) of secondary school. The selection of the school had been done through purposive sampling method and simple random sampling method was used to group the students.

Design and Procedure of the Study

The Pretest- Posttest Equivalent Group Design was selected for the study.

$$G_1\ O_1\ X\ O_2$$
$$G_2\ O_3\ C\ O_4$$

Where G1 = Experimental group, G_2 = Control group, X = Application of experimental treatment, C =Application of control treatment, O_1, O_3 = Pretests, O_2, O_4 = Post tests

In the present study, Constructivist Approach is the independent variable. It has two levels – Constructivist Approach and Conventional Method of Teaching. The dependent variable of the present study is Academic Achievement.

Topics for treatment were selected from the secondary school mathematics syllabus (same syllabus mentioned for methodology paper).

Tools for the Study

The following were the tools used for the study.

1. Lesson Transcript for Constructivist Approach
2. Lesson Transcript for Conventional Method
3. Achievement Test Scale (Dr. Femila Pangat)
4. Verbal Group Test of Intelligence (R. K. Tandon)
5. Raven Standard Progressive Matrices Test (Raven)
6. Socio Economic Status (Rajbir Singh, Radhey Shyam and Satish Kumar.)

Data Analysis and Interpretation.

To find the effectiveness of constructivist approach on the academic achievement of secondary school students in mathematics, t-test was used.

Comparison between the mean scores of Experimental group in Pre –test and Post test

Name of the Test	N	MEAN	SD	t-value
Pre-test	25	42.4	8.42	3.97**
Post-test	25	51.5	7.84	

**Significant at 0.01 level

- The mean values in post-test scores of the experimental group was 51.5 and the mean value of the same group in the pre-test score was 42.4. The calculated t-value of 3.97 was found to be significant at.01 levels. So, there is a significant difference between the pre-test and the post- test mean achievement scores of the secondary school students in mathematics of experimental group.

Comparison between the mean scores of Control group in Pre –test and Post test

Name of the Test	N	Mean	Sd	t-value
Pre-test	25	23.2	6.15	9.23**
Post-test	25	42.4	8.42	

**Significant at 0.01 level

- The mean values in post-test scores of the controlled group was 42.4 and the mean value of the same group in the pre-test score was 23.2. The calculated t-value 9.23 indicated that there is a significant difference in the achievement of the mathematics students in this group at.01 level of significance. So, there is a significant difference between the pre-test and the post-test mean achievement scores of the secondary school students in mathematics of control group.

Pre-Test Scores of Experimental and Control Group

Group	N	MEAN	SD	t-value
Experimental	25	23.2	6.15	1.62*
Control Group	25	20.6	5.25	

*Not significant at 0.05 level

- The mean values in pre-test scores of mathematics students in experimental group and controlled group was found out to be 23.6 and 20.6 respectively. The difference between the means of experimental group and controlled group is 2.6. The calculated t-value 1.62 is less than the tabulated value at.05 levels and at.01 level of significance. Therefore, it is found that there is no significant difference found in the pre-test scores of experimental group and controlled group. Hence, the groups are considered to be equivalent.

Post-Test Scores of Experimental and Control Group

Group	N	MEAN	SD	t-value
Experimental	25	42.4	8.42	11.26**
Control Group	25	20.2	5.21	

**Significant at 0.05 level

- The results revealed that the mean value in post-test scores of controlled group was 20.2 and that of experimental group was 42.4. The calculated t-value of 11.26 indicates that the performance of experimental group was significantly higher than that of controlled group in the post-test. Findings of the experimental and control group comparison showed that the performance of experimental group was better than that of controlled group in the post-test scores.

Implications of constructivism for teaching and learning

For the Child

1. Some children failed to show any understanding of certain concepts necessary for meaningful learning in formal method. Constructivism takes care of student's prior knowledge. So, they can be benefitted.
2. Constructivism provides opportunity to the students for independent learning. So, it is useful to the students.
3. For the Teacher
4. By and large from the same group different individuals appeared to learn by the formal method at different times. So, teacher should be aware, wait and promote necessary actions towards formalization.
5. The capability of students varies. So, teacher should provide the task and environment according to students' ability.
6. Teacher should question and insist the students to explain the answer they give and encourage students to reflect on their answers. For the Institution
7. Since mathematics is a unified subject of different branches constructivism provides integrated approach through which the aim of education, which is preparation for adult life, may be achieved to a great extent.
8. The teacher education institution must incorporate constructivism in the training programme for the pre-service and in-service teachers.

Conclusion

The student is placed in the situation of being or playing the role of a stakeholder in the problem situation, such as being a consultant who is requested to find a solution or course of action for dealing with the problem. It becomes clear that teachers need to change to new ideas and alternate ways of doing things that depend upon their existing beliefs and practices about the teaching learning process. Teachers' responsibilities within this perspective would involve taking into account (and thus acting accordingly), children's prior knowledge/ideas and understanding the nature of the concepts to be learned, and the learning outcomes expected, conceptual demands made on the child and the strategies available to the teacher. Educational authorities should

organize the school management in such a manner that takes into account the incorporation of learner centered approaches, whereby learners learn on their own. The organization of time-table, curriculum, extra-curricular activities, games and sports, etc to be done on the principles of constructivism. New curricula should be designed as per the constructivist problem-based learning principles. It should have provision of group activities like discussions, team-work, collaborative learning etc. the learning material should be in simple language and should incorporate illustrations, pictures, maps, practical knowledge, creative work and further references. Holistic approach in the treatment of learner's development and learning to be catered to. Knowledge should be discovered as an integrated whole. Knowledge should not be divided into different subjects or compartments, but should be discovered as an integrated whole. The present study, thus aimed to help in improving the effectiveness of the teaching-learning process by making it learner-centered. The present study is significant because it facilitated learning through interaction an exchange of views among students themselves and with the teacher. It also enabled the application of theoretical knowledge to real-life problems, thus enhancing students' learning.

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