

*Full Length Research Paper*

## Effectiveness of constructivist approach on academic achievement in science at secondary level

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The present study investigated the effectiveness of constructivist approach on academic achievement in science at secondary level using pre-test, post-test, experimental and control group design, with 58 samples grouped as experimental group (29) and control group (29) on the basis of matching by intelligence test. The investigators conducted this experiment over three weeks by using both traditional and constructivist 7E-model. The self-developed achievement test covering Class IX Textbook of West Bengal Board of Secondary Education, India was used as tool. The study found that the students exposed to the constructivist 7E-model significantly achieved better than traditional method. In addition, students exposed to the 7E-model performed significantly higher than those exposed to the traditional teaching method in respect of their gained scores at every intelligence levels. The constructivist approach strategy is capable of improving student's mastery of content at the higher order levels of cognition. It is therefore recommended that constructivist 7E-model strategy be used in science teaching for the development of student's higher achievement in science at secondary level.

**Key words:** Constructivist 7E-model, science, secondary level.

### INTRODUCTION

Education is a social process that changes society as well as adult's role of society, shifting responsibilities of education from parents to teacher and from family to school. Societies change its effective use of education in designing, developing, producing, implementing and evaluating curriculum. It aids teaching learning process in a classroom situation, increases both learning outcome and students' achievements, reduces students' dropouts and burden, stress, anxieties and frustration. So today's development of new teaching strategies is essential for all-round developments of students. This research aims

to compare the difference between the traditional lecture methods with constructivist approach. Constructivist teaching is based on constructivist learning theory which has emerged as a prominent approach to teaching during this past decade. The work of Dewey, Montessori, Piaget, Brunner and Vygotsky among others provides historical precedents for constructivist learning theory. Constructivism represents a paradigm shift from education based on behaviorism to education based on cognitive theory. Behaviorist epistemology focuses on intelligence, domains of

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objectives levels of knowledge and reinforcement. Formalization of the theory of constructivism is generally attributed to Jean Piaget, who articulated mechanism as that by which knowledge is internalized by the learners. He suggested that through process of 'accommodation' and 'assimilation', individuals construct new knowledge from their experiences.

The Biological Science Curriculum Study (BSCS) team along with its principal investigator Roger Bybee developed an instructional model for constructivism, called the 5Es which was recommended for science teaching. In this model, the process is explained by employing 7 E's. They are Elicit, Engage, Explore, Explain, Elaborate, Evaluate and Expand.

### Rationale of the study

Throughout the world, science is one of the compulsory subjects in schools. Majority of students in schools ignored learning science due to lack of interest and motivation that leads to low academic achievement in science. Majority of teachers generally follow the traditional methods of instruction in schools. The conventional teaching method of teachers as sole information giver to passive students appears outdated. At secondary level, scientific concepts to be taught should comprise everyday experiences.

Apart from simple experiments and hands on experiences, an important pedagogic practice at this stage is to engage the students (in groups) in meaningful investigations; particularly of the problems they perceive to be significant and important. Indian Education Commission (1964 to 1966) criticized that if science is poorly taught and badly learnt, then it will become a burden for the learner's mind. Therefore, appropriate method of curriculum transactions must be to inculcate scientific temper. Science inculcates the value of creativity and logical thinking. Due to limitations of traditional teaching, nowadays some skills such as updating, practicing, criticizing and analyzing of knowledge gain importance. Constructivist theory thus plays an important role in the field of education.

Secondary education is the base for future education and it prepares students for higher education. In secondary level, science knowledge construction is very essential and welcomes constructivist approach (Icon-model/7E-model) of teaching. Lee and Fraser (2000) have reported that science students independently perceived their classroom environment in a more favorable light than students of other stream. Miheso (2002) revealed that girls achievement score is better than boys by using icon model than traditional teaching method. It is also found that other researchers (Jong, 2005; Peter et al., 2010; Nayak, 2010; Cakici and Yvuz, 2010; Enok and Joel, 2011; Saran, 2011) used the constructivist approach in social science subjects; also,

Miheso (2002), Becker and Maunsaayat (2004), Obiekwe (2008), Abu (2008), Hussein (2009), Hijazi (2009), Bimbola and Deniel (2010), Ovute (2014) and Qarareh (2016) studied on science subjects and Daloğlu et al. (2009) studied on language subject and have reported that students taught through constructivist approach scores higher than those taught with traditional method. The existing literature in science education is inconclusive about gender achievement in science; hence, there is a need to examine the role of constructivist 7E model on the performance of male and female students in science. Lin (1998), Panda (2005), Agrawal and Chawla (2005), and Satyaprakasha and Patnaik (2005) have reported that co-operative learning has a significant effect on student's achievement in science and sociability among learners. Kim (2005) have found that constructivist teaching is more efficient than traditional; also, ineffective in relation to self-concept and learning strategy but has some effect on motivation anxiety towards learning and self-monitoring. Dhindsa and Emran (2006), Hijazi (2009), and Qarareh (2016) have reported that there was no gender difference in the mean achievement score for the constructivist group than traditional method. Pritinanda (2007) had found that icon model has no significant effect on achievement of English, but a statistically significant effect on communicative competency like reading, writing and speaking. Folasade and Akinyemi (2009) had concluded that constructivist learning technique is more efficient, and also reported that there was no significant difference between the performance of male and female students taught with constructivist approach. Saran (2011) reported that low achiever students that learnt through constructivist approach had achieved significantly higher score as compared to their counterpart that learnt by traditional method for social science (Geography) subject. NCF-2005 has emphasized following constructivist approach in classroom so that students can construct their own knowledge and understand the concept at grass-root level. Ultimately their achievement will be enhancing. However, many research findings are in favor of it. Based on this, the researcher wants to find out the extent of significant effect constructivist approach has on student achievement in comparison to traditional method; hence it is worthwhile to study the effect of constructivist approach on the achievement of physical science students.

An analysis of all the above studies indicates that the application of constructivist approach during the teaching of science has been widely used. Majority of researchers have found that the constructivist approach of teaching is better than traditional method of teaching in Biology, and in some Social Science subjects it is most significant but it has no significance on English subject. It has been found that the low achievers students highly benefit from the constructivist approach. From the above analysis, no such study has been found on the effect of 7E-Model in

achievement of students in physical science subjects in relation to intelligence and gender. The most important point here is that all the studies have been conducted on the English medium C.B.S.E. curriculum; hence the researcher aims to study the effect of constructivism (7E-Model) on academic achievement of secondary school students in West Bengal Board of Secondary Education (Bengali Medium) on the basis of intelligence.

### Statement of the problem

NCF-2005 has emphasized the following constructivist approach in classroom so that students can construct their own knowledge and understand the concept at grass-root level. At secondary level, science knowledge construction is very essential and can be meaningfully achieved through the use of constructivist approach (Icon-model) of teaching. Thus, the present study is aimed at examining the effectiveness of constructivist approach on academic achievement in science at secondary level.

## METHODOLOGY

### Operational definition of the key terms

#### *Constructivist approach*

- i) This refers to knowledge constructed by connecting new ideas/experience to existing ideas /experience.
- ii) Here, the researcher has taken 7E-Model of constructivism for intervention.

#### *Achievement*

- i) This refers to performance of the students.
- ii) Here, achievement refers to the scores obtained by secondary school students in science before and after using constructivist approach.

#### *Secondary school students*

- i) The students studying in Class V to Class X are considered as secondary school students.
- ii) In this study, the researcher has selected Class IX students only.

### Objectives of the study

1. To study the effect of constructivist approach over traditional method on students' achievement in physical science.
2. To compare the effect of constructivist approach over traditional method on students' achievement in physical science with respect to their intelligence.

### Hypotheses of the study

1. Students taught through constructivist approach gain significantly

high achievement in physical science than traditional method.  
2. There is no significant difference in achievement test score among High, Average, and Low IQ students through constructivist approach over traditional method of teaching in physical science.

### Delimitations

- i) This study was conducted in Bengali medium Dakshineswar Adyapeath Annada Vidyamandir, (Bengali medium) of Kamarhati Municipality, Kolkata, which is affiliated to West Bengal Board of Secondary Education.
- ii) The present study was conducted on 80 Class IX students only.
- iii) This study was limited to physical science subjects only.
- iv) This study is a purposeful study limited to two lessons (from physical science) of Class 9<sup>th</sup> science and other units not covered.

### Study design

The design of study was quasi-experimental Pre-test, Post-test, control group design).

### Population

Class 9<sup>th</sup> students of Dakshineswar Adyapeath Annada Vidyamandir were the population of this research.

### Sample

Purposive sampling was used in selecting Secondary School. 58 students were selected from two sections for the purpose of the study. Section 'A' was regarded as experimental group and Section 'B' as control group.

### Tools and techniques

Two types of tools have been used in this research, viz; i) Instructional and ii) Measuring Tool.

**Instructional tool:** This was in the form of unit-wise lesson plans based on 7E model of teaching. Moreover, other teaching aids like pictures, chart papers, models etc., were also used.

**Measuring tool:** For grouping the students, Ravens Progressive Matrices was used. Measuring tools is in the form of teacher made achievement test questions based on constructivist principles (7E-model).

### Data analysis

The data were analyzed by using appropriate statistical techniques like Mean, SD, SEM, t-test, ANOVA.

## FINDINGS

On the basis of the results and their interpretation, the following major findings were found

- i) There was no significant difference between experimental and control group in pre-test [M1=7.1,

$M_2=6.1$ , 't'-value is 1.042, significance value is 0.306, that is, no significant difference between two group at 0.05 levels]. In the present study, it is found that there exists no significant difference between the mean scores of students in experimental group and control group before intervention. From the above statistical analysis, it is clear that mean of pre-test score of experimental group were slightly higher than the mean score of control group but no significant difference found in students' achievement in between both groups before interventions.

ii) There exists significant difference between the mean scores of students in experimental group and control group in post-test. From the comparison of achievement score of control and experimental group in post test the mean difference between two groups in post test is 4.24 and its 't' value is 5.627 which is significant at 0.01 levels. So from mean difference (4.2) and significance value (0.000), it can be concluded that there is difference between experimental and control groups post-test achievement scores, which arises due to different treatment, that is, by constructivist 7E approach and traditional approach.

iii) Constructivist approach (7E-model) had significant effect on the achievement of class 9<sup>th</sup> students in physical science than traditional method. Experimental group gain score mean is greater than control group gain score mean with 3.24, 't'- value is 4.387, and significance value is 0.000, that is, there is significant difference between gain scores of experimental and control groups at 0.01 levels). From both mean difference and significant difference it can be concluded that there is significant difference between the gain score obtained by experimental and control group. Hence, it can be concluded that there is difference between experimental and control groups post-test achievement scores, which arises due to different treatment, that is, by constructivist 7E approach and traditional approach. From the mean values of experimental (10.38) and control group (7.14), this research found that gain by experimental group is higher than the gain by control group. Hence, it can be concluded that experimental group gain greater achievement (constructivist 7E-approach) than control group (Traditional-approach). Thus, the stated hypothesis is accepted. Finally, it can be concluded that constructivist approach has significantly improved the achievement of students in science at secondary level.

iv) Constructivist approach had significant effect on low and average intelligent students by constructivist 7E-approach with respect to high intelligent students. Mean difference gain score between experimental and control groups by low intelligent students (4.86) is higher than the gain by average intelligence students (3.42), which is also higher than gain by high intelligent students (1.9). For high intelligence level, mean difference in gain score is not significant (0.281) at 0.05 level; for average intelligence level, gain score mean difference is

significant (0.003) at 0.01 level and for low intelligence, gain score mean difference is significant (0.005) at 0.01 levels. Since previous basic knowledge of high intelligence students are comparatively higher with respect to average and low intelligence, high intelligence students scored high with respect to average and low intelligence students in pre-test before interventions. But after intervention, achievement score is more or less similar for all intelligence levels. Thus, the mean difference of gain score (1.9) is lower with respect to average (3.42) and low (4.86).

There is no significant difference in achievement test score among High, Average, and Low IQ students through constructivist approach over traditional method of teaching in physical science. Variance (ANOVA) of experimental post test in relation to intelligence level is as shown in Table 1.

#### **ANOVA of experimental post test in relation to intelligence**

From the ANOVA Table 1, F-value is 1.856 and significance value is 0.176 which proves that there is no significant difference in score among High, Average, and Low intelligence students.

#### **Educational implications**

The study and its findings will be applicable for:

The most outstanding characteristics of any research is that it must contribute something new to the development of the area concerned. The present study was conducted on regional medium students to find the effectiveness of 7E model of teaching in science. The result is useful for teachers, curriculum planner, students, teacher educators, text book writers, researchers, corporate and government organization. 7E model can be used by a teacher as effective teaching methodology for difficult and complex concepts; a model of learning that may also help the learners construct their knowledge in a meaningful way as it gives enough scope for active participation and interaction in classroom with peers and teachers. Through 7E interaction, low intelligent students can get better opportunity to acquire knowledge and comprehend what they are learning. In addition, this model will create a joyful learning environment between teacher and students. The implications can also be categorized as follow:

**i) For learners:** In general constructivist approach and in particular, 7E's model of teaching helps the learners construct their knowledge positively. It gives enough scope for active participation and social interaction in

**Table 1.** Analysis of variance of experimental posttest in relation to intelligence level.

Parameter	Sum Squares	df	Mean Squares	F-value	Significance
Between groups	38.384	2	19.192		
Within groups	268.857	26	10.341	1.856	0.176
Total	307.241	28			

classroom with peers and teachers. Through interaction, students of all intelligent levels can get better opportunity to acquire new knowledge, especially for low intelligent students. They can develop the ability of analysis, divergent thinking, interpretation, ability, critical thinking and scientific attitude towards science education.

**ii) Teachers:** Teacher will benefit greatly by understanding the constructivist approach of teaching which the findings of the present study handles. As such, teachers need to encourage peer interaction, group discussion, experimentation, field visiting etc. 7E's model of learning can provide such situation between teacher and student. This model promotes joyful learning among students in classroom situation by facilitating learning process as a two-way mode of learning between learners and teacher. The ideals of teaching learning process of teacher as a facilitator while students develop their potentialities after getting instructions from teacher is what the study indicated.

**iii) School administration:** School atmosphere plays crucial role in managing the teaching learning process. The administration of school has important role to develop a congenial atmosphere among teachers as well as students. 7E's model may create such situation where a learner can interpret the concepts in many ways and teachers always try to provide them appropriate learning situation. Constructivist approach of learning brings better academic achievement of the students. For successful implementation of this strategy, the school administration should understand how learning need to be supported and provide all required learning resources to the learners.

**iv) Policy makers:** The present study and its finding has shown how the constructivist approach learning in science at secondary level enhance students' achievement and this need is taken into consideration while framing the policies of school education to bring qualitative change. At the same time, curriculum planner may incorporate this strategy in curriculum planning and development and preparation of framework/guidelines for achievements of intended learning outcomes.

### Suggestions for further research

1) The present study was conducted only on secondary

school students. Further studies can be conducted with other group of sample and also study can be conducted on school located at rural area process using constructivist 7E-model.

2) The study was conducted on students' achievement in science at secondary level. Therefore, study can be conducted on the specific branch of science like on Chemistry, Physics and Biology at secondary level and also non science subjects required to be studied.

3) A study can be undertaken to know the effect of constructivist approach on students' self-concept and their learning process.

4) In this study, only 7E's Model has been implemented. Other models of constructivist approach Interpretation Construction model (ICON-model) may be taken up for the purpose of study.

5) Problems and issues regarding assessment through constructivist approach is an emerging topic to investigate for the present situation.

6) The study also can be undertaken by taking larger sample and other context.

### Conclusions

From the whole review, analysis and discussions, the following conclusions can be arrived at:

1) Constructivist approach is an effective learning tool, which has significant effect on the achievement in science concepts among all psychological groups of students.

2) Constructivist approach helps in achieving meaningful learning in science concepts among Class 9<sup>th</sup> students.

3) There is no significant difference in achievement test score among High, Average, and Low IQ students through constructivist approach over traditional method of teaching in physical science.

### CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

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