

Effectiveness of 5E-Model in Teaching Physical Science at Secondary School Level

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ABSTRACT

The purpose of this study is to ascertain the effects of 5E model of teaching physical science on the academic achievements of the students at secondary level. The research study followed quasi-experimental non-equivalent control group design. A sample of 20 students of 9th grade was taken from a government high school in Balasore district of Odisha. The lessons were delivered to the students by two discrete lesson plans following traditional and 5E approaches. A unit test was conducted to assess the achievement level of the students. The data were analysed with t-test. The findings of the study revealed that the achievement of the experimental group of students exposed to 5E model of teaching have high achievement scores in learning Physical science than the control group of students exposed to Lecture method of teaching. So, 5E teaching-learning model is more effective than the lecture method of teaching in Physical science. The result of the study also shows that the students could discover and learn the main concepts of the content on their own. The findings also revealed that students are more engaged and motivated to learn while teaching in 5E method. The classroom environment became more interesting, collaborative and cooperative which resulted in better achievements.

Keywords: Effectiveness, Constructivist approach, 5E model of Teaching, Achievement

Backdrop

Constructivism as a theory emphasises that individual learners are capable of constructing their own understanding and knowledge of the world by experiencing things and reflecting on those experiences. When someone starts to learn something new, it needs to be accommodated with what he/she has previously learned or gained. The individual participates in the process actively by engaging himself/herself in questioning, exploring, experimenting, and assessing what he/she has learned.

The theory of constructivism is attributed to Jean Piaget, who articulates the mechanism, by which knowledge is internalized by the learners. Through the process of assimilation, accommodation the learner constructs new knowledge by experiences he has. When the individual assimilates, he incorporates new knowledge into the existing framework, without changing the framework. Accommodation is the process in which the individual reframes his mental representation in order to fit the new knowledge. In this way one acquires an efficient understanding by his own experiences. Piaget claims that a child can learn a lot of things when he/she plays with mud, and in the Piaget's view, when a child interacts actively with his/her environment, he/she gives meaning better to the events and objects (Onur, 1993).

If an individual associates meaningfully pieces of knowledge in the active interaction and forms connections, he can classify, organize and code this knowledge easily. The knowledge gathered in this way can be kept in memory for long time (Bruner, 1972). The founder and proponent of radical constructivism Ernst Von Glasersfeld also argued that knowledge is not passively received through the senses but also actively constructed by the cognizing subjects, the learner, and that the function of cognition is organization of experiential world rather than discovery of an independent reality. The pioneer of social constructivism Lev Vygotsky also believed that an active individual and an active environment are needed to make co-construction of knowledge besides the third essential element is the product of accumulation of the prior-generation culture.

Teaching physical science subjects through conventional method of classroom teaching makes students unable to successfully integrate understand facts and formulate with real-life applications outside the classroom. The old methods used in science curriculum do not develop student interest in the subject matter. The old methods also do not empower students to become deep thinkers who are capable of making new discoveries and solving complex problems. Constructivism is a theory that gives hope to the development of the deep understanding of the science subjects in students of all ages.

The constructive learning theory is one of these approaches is becoming more prominent in recent time. There are various kinds of models being used in teaching process with different transaction steps based on constructive learning theory. One of the most useful model is the 5E Model, developed by Roger Bybee. The 5Es consist of five phases: Engagement, Exploration, Explanation, Elaboration, and Evaluation.

Engagement

The main goal of the first phase of 5E model is to make students to be excited or motivated about the information they will learn. It is designed to tap into student's previous knowledge and identify the misconceptions before proceeding with new learning process. This is done with questions, activities, stories, demonstrations to grab student's attention and help them to make connection between new knowledge with previously gained knowledge.

Exploration

In this stage, students get opportunities to work together without direct involvement of teacher. Teacher acts as a facilitator for helping students to frame questions by asking and observing.

Explanation

This phase also known as interactive phase, where teacher gives information to students which they may not able to learn by themselves. At this point of 5E model, teachers help students to understand scientific explanations, introduce terminologies to provide students with a common language of content.

Elaboration

The elaboration phase of 5E Model, helps students to apply their newly gained knowledge to various situations so that they can expand their understanding.

Evaluation

Evaluation should take place throughout the learning process. Teacher should observe students' knowledge, skills, application of new concepts and change in thinking. Students should assess their learning, and ask questions to improve their understandings.

Rationale of the Study

Science lessons help the students to develop their cognition and productivity. Thus, modern theories must be applied in teaching of science (Isman, Baytekin, Balkan & Horzum, 2002). Classroom teaching becomes more effective, when it is well informed by an understanding of how students learn and how learning will be more successful and interesting. If students are given the opportunity to explain and clarify their ideas in the class, then it becomes more effective. The teachers should use productive teaching method in order to make learning meaningful (Olosunde & Akinpelu, 2013). Traditional teaching method is the process of transmission of knowledge from teacher to students. It is a one-way process and focuses only on rote memorization without proper understanding and creative making. The scenario has changed after recommendation of National Curriculum Framework (2005) by adopting constructive approach of learning. It recommended for connecting the life with real life situation and transform the students from passive listeners to active learners. The constructive approach of learning signifies the 5E method of teaching which is a systematically organised model that gives real science experiences leading to construction of knowledge, incorporating hands on activities, directing discussion and improving problem solving capacity. The learner creates new understanding for himself/herself and teachers provide activities that engage the students leading to cognitive development.

Martin (2000) reported that the 5E model is based on research oriented constructive learning theory and experimental activities. It includes students in activity at every phase, encourages students to constitute their own concepts. Similarly, the result of the study conducted by Campbell (2000) revealed that students who were instructed by inquiry based science investigations through the use of 5E learning cycle model increased their knowledge about force and motion concepts. Whereas, Kesar (2003) found the difficulties in realising the expected changes due to the factors that shaped activities in traditional physics classes, it was concluded that the 5E design model developed by this study had a feasible structure to apply. But, Ates (2005) reported that when the students' pre-test scores on electric circuits concept test were used as covariate, significant difference was found between experimental groups and the control groups with respect to students' post-test scores on electric circuits concept test, favouring experimental group which constituted learning cycle instructional method. Furthermore, the findings of the study undertaken by Balci (2005) revealed that experimental groups subjected through 5E model of instruction had more conceptual understanding and clarification than the control group. However, Garcia (2005) reported that a significant change was found based on paired pre-test and post-test comparison. In addition, it was revealed that 5E learning cycle model had some positive effects on lower level of students. Similarly, Akar (2005) reported that 5E model caused a significantly better acquisition of scientific conceptions related to acid-base and

produced significantly higher positive attitudes toward chemistry as a school subject than the traditionally designed chemistry instruction.

Dogru-Atay & Tekkaya (2008) found a statistically significant post-treatment difference between the experimental group and control group in favour of experimental group after instruction. Results also revealed that students' logical thinking ability and meaningful learning orientation become more significant. Whereas, Adesoji & Olatunbosun (2008) suggested that Chemistry, being a science subject is important in scientific and technological development of nation and should be taught in student-centric approach. This can be accomplished when the students take interest and the teachers, on the other hand inclined in using proper methods and resources in teaching students. Similarly, Prokes (2009) observed that teaching in 5E model helped the students to become more active and motivated than students in lecture method of classroom and these students could find opportunities to share their knowledge and experiences. But, Liu, Peng, Wu, & Lin (2009) reported that 5E Learning Cycle helps to activate prior knowledge, overcome their misunderstandings, and help them further expand the conceptual understanding. Further, Hokkanen (2011) observed that the 5E model has the potential to improve students' academics, interest and confidence in science when implemented properly with dedication and fidelity.

Akanwa & Ovute (2014) noted that constructivist approach had a significant effect on both the achievement and interest in physics of senior secondary school students. Similarly, Duyilemi & Bolajoko (2014) found that constructivist approach is better than traditional approach in teaching of science. Further, Ayaz & Sekerci (2015) reported that the constructivist learning approach in comparison to traditional teaching methods, had a positive effect on the students' academic achievements. Whereas, Barman and Bhattacharya (2015) noted that the 5E method of teaching had a significant effect on students' academic achievements and knowledge increasing. Similarly, Abdi (2014) reported that Achievement of those students who were taught through inquiry-based learning method found better than students who were taught through traditional method. However, Valdez (2015) concluded that constructivist approach is better/superior than conventional approach to improve students' achievement and retention in mathematics. But, Chowdhury (2016) reported that students who were taught through 5E method scored higher than those who were taught through traditional approach. Hence, the study was undertaken to ascertain the effectiveness of 5E model of teaching physical science at secondary school level. Further, the studies conducted previously have been taken large samples from a given population, thus, the researchers wanted to investigate its effectiveness in teaching physical science concepts over small sample and how far the learning achievement of students are improved.

Objectives of the Study

The study was undertaken with the following objectives:

1. To develop a 5E model lesson plan on the topic "Force" for 9th grade students.
2. To transact the lesson both in traditional and 5E method of teaching to the students.
3. To develop a unit test in consultation with experts on the topic "Force" to assess the learning performance of the students exposed to traditional method and 5E method.
4. To find out the effectiveness of 5E model by comparing the achievement scores of the students exposed to traditional and 5E method of teaching.

Hypotheses

The following hypothesis was formulated:

- H₀₁:** There exists no significant difference in the learning achievements of students exposed to 5E-model and the learning achievements of students exposed to traditional method of teaching.

Design of the study

The present study followed a quasi-experimental research design where a pre-test post-test non-equivalent group design was used.

Sample and Sampling technique

The sample of the study consisted of students of class-IX of Mohapatra High School, Balasore district of Odisha. The sample was drawn from two sections of class-IX as experimental group and control group selected randomly. The sample of the study was confined to 20 students (the experimental group and control group consists of 10 students each). Random sampling technique was used to select the sample in the present study.

Tools used for data collection

For collecting data from the sample, the investigators developed lesson plans following the steps of 5E-model and traditional method along with a self-prepared unit test for assessing the learning performance of the students.

Procedure of data collection

The investigators personally visited the school seeking permission from the Head of the school for research purpose. The study was carried out in two phases such as: **Phase-1: Developmental phase**-In this phase, the investigators followed the ways- content analysis, preparation of lesson plan, planning for assessment. One chapter from class-IX physical science textbook i.e. “Force and Laws of Motion” was identified and content analysis was done. The lesson plan was developed by making use of steps of 5E-model. **Phase-2: Experimental phase**-The chapter was taught to the experimental group in 5E method and to the control group in traditional method. The effect of treatment was tested by post-test scores. The post test scores were measured after conducting the unit test in both the groups.

Analysis and Interpretation

The instrument used to gather data in this study was the unit test on the chapter “Force and Laws of Motion” of class-IX physical science textbook. The statistical technique of ‘t-test’ was applied for analysis and interpretation of data.

Table 1: Summary of Difference between learning achievement mean scores in Physical science of students belonging to control and experimental groups

Groups	N	Mean	SD	t (18)	p
Control	10	27.70	3.529	2.53	.021
Experimental	10	31.40	2.989		

The critical value of t for df 18 at 0.05 level of significance is 2.10 and the calculated t-value 2.53 is greater than the table value. Hence, null hypothesis is rejected and it is stated that two groups differed significantly on their mean achievement scores. Therefore, the resulted data shows that there exists a significant difference between the Lecture method of teaching to control group and the 5E model of teaching to experimental group students’ achievement mean scores in learning Physical science. From the observed mean scores, it is highlighted that the experimental group of students exposed to 5E model of teaching have high achievement scores in learning Physical science than the control group of students exposed to Lecture method of teaching. So, 5E teaching-learning model is more effective than the lecture method of teaching in Physical science. The result of the study also shows that the students could discover and learn the main concepts of the content on their own by Engaging and exploring themselves in the learning process. This study also revealed that the 5E learning model is an effective teaching method comparatively better than the traditional teaching methods. This finding corroborates the findings of the studies conducted by Campbell (2000), Kesar (2003), Ates (2005), Prokes (2009), Dogru-Atay & Tekkaya (2008), Hokkanen (2011), Adesoji & Olatunbosun (2008), Rajashree (2013), Balci (2005), Barman and Bhattacharya (2015), Abdi (2014), Akanwa & Ovute (2014), Duyilemi & Bolajoko (2014), Chowdhury (2016), Valdez (2015). The result of the study proved that the students of experimental group not only learnt and achieved better but also their retention of learning was also apparent. This study also revealed that the 5E learning model is an effective teaching method comparatively better than the traditional teaching methods.

Major Findings of the Study

- i. Teaching through 5E model resulted a significant difference in the learning achievements of students exposed to experimental group.
- ii. The post-test achievement scores of experimental group are higher than the post-test achievement scores of control group
- iii. Students are more engaged and motivated to learn while teaching in 5E method.
- iv. The classroom environment became more interesting, collaborative and cooperative.
- v. The 5E method of teaching learning process promoted knowledge construction rather than transmission through active participation of both the teachers and students.
- vi. The knowledge gained by the students was in a meaning making way and connects to their real life situations.
- vii. Conceptual clarity over the topic became more comprehensive to the experimental group learners as compared to controlled group.
- viii. The students exposed to experimental group got more opportunity to ask questions and to inquire the solutions of the questions by their own.

Delimitations of the Study

- The study was only confined to class-IX students
- The study was only conducted in govt. high school of Balasore district in Odisha.
- The investigation was only carried in physical science subject

- There are also other factors which affect the achievement scores of students but the study was only carried out to ascertain the effectiveness of teaching method.

Educational Implications of the Study

The 5E model of teaching promotes Constructivist principles and emphasizes on the explanation and investigation of phenomena. Students become able to redefine, recognise, elaborate and change their initial concepts through self-reflections and interactions among the peers. Hence, students need to be given enough scope for free expression and sharing of opinions in classroom discourses. Students interpret objects, phenomena and internalise those interpretations in terms of their conceptual understandings. Therefore, teachers need to be oriented to provide effective and sustained professional development in science content, pedagogy, and assessment. Further, they need to employ the best suitable method of teaching science, Coordinate curriculum, classroom practice and students' assessment. Efforts need to be made for Enhancing the science content knowledge in real life situations by Enabling teachers to personalise lessons according to students' needs.

CONCLUSION

Several national reform documents illustrate the need to make science classrooms active and participatory. Many teachers are preferring for this non-traditional teaching approach as evident from research studies. The incorporation of 5E teaching approach in the classroom helps teachers in the pursuit of effective physical science lessons. The 5E Model serves as a flexible learning strategy which assists curriculum developers and classroom teachers to create science lessons very interesting and effective too.

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