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# Effect of 5Es Instructional Model on Achievement of Secondary Level Students in Physics

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**Abstract:** *The use of the 5Es instructional model develops a deep conceptual understanding of learning in sciences. The study was conducted on a sample of 80 students who were randomly selected from a public school in district Sargodha during the academic session 2020-2021. For this study, a pretest-posttest control group design was used. An intervention program based on a constructive learning approach and academic achievement test in physics were used. The study's main objective is to determine the effectiveness of secondary students' achievement in physics through the 5Es instructional model and lecture method. An achievement test was administered to both groups as a pre and post-test in order to assess their achievements. The data obtained were tabulated and analysed by using SPSS to means, standard deviation and t-value. It is concluded that instruction based on 5Es instructional model caused a significantly better achievement as compared to the lecture method. It is therefore recommended that 5Es instructional model may be organised as an essential component for in-service and pre-service teachers' training programs.*

**Key Words:** 5Es Instructional Model, Physics, Achievements, Lecture Method,

## Introduction

The study of physics is important for understanding the world around us, the world inside us, and the world outside us (Johnson, 2019). In many respects, physics is the most basic and fundamental natural science, including the study of universal laws, behaviours and relationships between various important physical phenomena (Cutnell & Johnson, 2017) because physics is one of the most important secondary school subjects in Pakistan. Therefore special skills are required for the teaching of physics. "What to teach" and "how to teach". Each teacher has to make serious decisions to answer the questions of his or her task in the classroom. However, if the problems and issues are understandably and alternatives are thoroughly reflected by teachers of science, it may be sensibly estimated that the value of science education in Pakistan will slowly but surely improve. Teaching is a lifelong, conscious and orderly process. This needs the fundamental information, skills, attitudes, ideas and thoughts that may maximise students' learning. Education and learning create the capability to share and develop knowledge (Shrigley, Koballa & Simpson 2018). According to Keskin (2018), some of the models used in the educational process at various transaction steps are built on constructivist learning theory. Originally published in Science Teacher in the learning, derived from Oliver (2017) has been used in science education since its foundation. Perhaps one of the primitive and most

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important followers of the learning model was the Science Curriculum Improvement Study (SCIS) platform, which was adapted and incorporated into the science curriculum. There are different "E" versions (such as 3Es, 4Es, 5Es, 7Es and other modifications. It may be inferred that the most widely held version of constructivism is the 5Es model. In the 5Es instructional model, each step marked with "E" means supporting student learning through an experience that links prior knowledge to new concepts. The 5Es learning model has been shown to be particularly effective in eliminating alternative conceptions (misunderstandings) (Bybee, Taylor, Gardener, Powell, Westbook & Landes, 2016).

In the traditional way of teaching, a teacher is considered only a source of information, whereas passive students seem archaic in their learning. The lecture method of scientific instruction does not yield good outcomes in terms of information retention, nor does it create good science graduates for higher education. The lecture method totally depends on the instructor's ability to teach physics in the classroom rather than promoting the students' ability to learn. The teacher considers that his prime duty is to convey to students. Students are passive in the lecture method of teaching Hake (2018). The traditional teaching method is considered an effective technique for achieving higher achievement in the final examination, but it is a fact that this method mostly relies on rote memorisation. The traditional way has nearly the same meaning as the lecture and query response method (Ergin and Unsal, 2018). A well-known science teaching and learning model is known as “the 5Es instructional model” known as "the 5Es." In the 1960s, Robert Karplus, as a part of the Science Curriculum Improved Study (SCIS), wrote the first reference to it. There are five elements/steps of the 5Es instructional model for developing the science lesson plan:

**Step 1:** Engage “Capture the students` interest and attention”

**Step 2:** Explore “Activity, investigating, questioning and developing critical thinking skills about the topic”

**Step 3:** Explain “Link to other concepts”

**Step 4:** Extend "Apply to learn"

**Step 5:** Evaluate “Feedback”

In science education, the inquiry method is used in the 5Es model and has two meanings: the first of which is concerned with scientific education methods, and the second with science as inquiry (Tamair, 2015). It comprises developing inquiry skills, such as identifying and investigating an issue, formulating a hypothesis, collecting, analysing, and interpreting data, and finally making conclusions. According to Brew (2018), engaging students in science subjects increases knowledge, improves motivation, and improves academic performance. The 5Es are a dynamic teaching and learning process. Learners are actively engaged in learning and comprehending concepts, meanings, and information. The 5Es model promotes a student-centred philosophy in which the teacher serves as a facilitator and leaves learners to solve problems of science on their own edge (Galileo Educational Network, 2014).

## Literature Review

According to AAAS (2019), Science is built on the factual confirmation, i.e. suitable and trustworthy. The explanation made will be reasonable so that these are suitable and supportive to understanding the nature of all God's creatures. Science cannot give full answers to all questions, but scientists are aware of the reality that the world is rational as well as comprehensible. Science not just tries to discover reality, i.e. scientific information, but also efforts to locate the rational and possible ways to understand this rational world.

## The Education of Science and its Significance

John Dewy (1999) considers scientific education as facilitative, with student facilitation playing a

critical role. It supports and assists students in properly grasping the fundamentals of scientific knowledge that are required for the evolution of more advanced scientific concepts. Science education is a vital instrument for developing basic scientific abilities, methods of thinking, and applying scientific principles to real problems. At the school level, students struggle to understand the basic scientific concepts, facts, principles and scientific laws in both the classroom and science lab.

## Science Teaching in Pakistan

The current situation of beloved Pakistan is the result of poorly, antiquated, and obsolete teaching and learning methods and beliefs (NEP, 2009). Pakistan's terrible situation can only be rectified by scientific and technical advancement, as well as relevant science education. Our country's development and survival are heavily reliant on effective training in many scientific areas, particularly science and technology. The first educational conference, held in November 1947, even proposed a breakthrough in traditional science teaching. The National Education Commission (1959) put a high value on fundamental improvements in science methodology and content. The education policy of 1972 - 1980 stresses a transition toward more meaningful science education. The National Education Policy (2009) placed a lot of emphasis on scientific instruction, and it was envisioned that education structure would be made worldwide competitive, with attempts ready to present itself for universal evaluations. Nelifor Halai (2019) discussed the nature of science education and said teaching was a challenging profession.

## Physics Scope and its Prominence

Mulligan (2015) defined physics as being deals with the qualities of matter, energy, and their mutual interaction. It is recognised as the most significant branch of science, as well as the oldest and most primary branch of science because it is concerned with the characteristics of matter and various kinds of energy. Gupta (2019) described Physics as encompassing primarily matter characteristics, energy, and macroscopic and microscopic states of matter. He further said that physics deals with physical quantities in nature, that it constructs mathematical correlations between various quantities, and that it develops models to explain these mathematical relations.

## Physics and other Sciences Collaboration

According to Gupta (2019), physics is the science of matter and energy, and it influences every aspect of human life. It has an impact on all other branches of science that are concerned with the physical universe. Physics can help us comprehend the chemical and biological processes that are taking on around us. Physics is inextricably linked to organic and inorganic sciences, and its rules apply uniformly to all fields of science.

## Science Inquiry Instructional Model (5Es)

The cited paradigm has a long history and is widely used in the establishment of learning domains and curricular innovations in science education. A collaborative initiative between the Biological Science Curriculum (BSCS) and International Business Machines (IBM) developed a new SCIS model known as 5Es (BSCS,2019)

**Table 1.** SCIS and BSCS (5Es) Model Phases Comparison

| SCIS (Model) | BSCS (5Es Model) |
|---|---|
| Exploration | Engagement (a new stage) (modified from SCIS) |
| Invention (Term introduction) | Justification (modified from SCIS) |
| Inquiry (conception application) | Explanation (modified from SCIS) |
| | Assessment (new term) |

*According to the review, centres on the BSCS (5Es) educational paradigm are located on the steps outlined:*

## Engagement

According to Bybee (2015), when students go into a new learning practice, they are concerned through specific ideas; they have assured thoughts in their heads that may be possible or not be related to the concepts that the students learn in the education scenario. The engagement element of the inquiry, like the learning element, is diagnostic in nature, providing the chance to assess the learner's abstract structure in relation to the thought provided.

## Exploration

According to Bybee (2015), this phase entails the development of reasonable queries and methods for dealing with them. The nature of these questions is checked and evaluated by the students. The questions must be verified scientifically. The students begin by participating in the learning activities and then formulate their own queries.

## Explanation

According to Chen & Klahr (2016), during this phase, learners are supported in concentrating and increasing their devotion in terms of their explicit engagement in the learning activity. Learners are also provided opportunities to communicate their abstract framework links. During this stage, the instructor supports students in organising and arranging relevant learning settings, as well as promoting learning with comprehension. The core of explanation is learning with comprehension.

## Elaboration

According to Champagne (2017), this phase is focused on more clarity on the conceptual organisation. Such learning scenarios are provided to the students in order to further open the doors to understanding and knowledge. This phase invests more time and resources to bring about knowledge, idea creation and learning of basic concepts that aid in the development of deeper links in the current concepts.

## Evaluation

According to Klahr and Nigam (2016), this phase is evaluative in nature and prepares learners to analyse their learning and identify the advantages and drawbacks of continuing learning. This step is in the same way useful for the instructor, as the teacher discovers how the learning is taking place and, based on this evaluation, proposes meaningful alternatives. Despite the fact that this is the highest level of the inquiry-based learning approach, it just provides a strong framework for effective teaching and learning.

## Statement of the Problem

The deep conception of physics is one of the most significant issues exposed by the researcher because the concepts of physics are not developed at higher levels of understanding through critical thinking. Thus, the physics teachers have difficulties teaching their students effectively because most students do not have firsthand knowledge about the basic concept of science at the lower level. This study aimed to determine the effect of the 5Es instructional learning model on the achievement of secondary-level students in physics.

## Objectives

- To find the effectiveness of the 5Es instructional learning model on the achievement of students in Physics.
- To know the effectiveness of traditional teaching methods on the achievements of students in Physics.
- To determine the comparative effects on the achievement of students in Physics of experimental and control groups before intervention programmed.

## Research Questions

- Does the 5Es instructional learning model in physics affect the academic achievement of secondary-level students?

- Is the traditional teaching method affect the academic achievement of secondary-level students in physics?
- Is there a difference in the academic achievement of secondary level students in physics taught through the 5Es instructional learning model and the traditional teaching method?

## Delimitation of the Study

The following delimitations were mentioned in the course of this study;

1. Two teaching methods, i.e. 5Es instructional learning model and traditional teaching method.
2. Public High Schools (boys) in District Sargodha only.
3. The investigation is carried out only on Secondary School Students.

## Research Methodology

The study at hand aimed to study the effect of the 5Es learning approach on the achievement of students in physics. Keeping in view the nature, objectives and main purpose of the experimental study method was used by the researcher.

## Research Design

For the present study, a pretest/post-test control group design was used. It involved two groups of students, the experimental and control group. Intervention programming was given to the experimental group, whereas no treatment was given to the control group.

The symbolic representation of the experimental design is as under

R E = T O1
R C = - O2
Difference = $O_1 - O_2$
Where R stands for randomly selected
E = Experimental C = Control O = Observation T = Treatment

## Population and Sample of the Study

All ninth-grade students in District Sargodha were identified as the target population of the study. However, since it is not easy to contact this target population, it is coherent to define an accessible population. All ninth-grade students in Kotmomin, one of the tehsils of district Sargodha, were defined as an accessible population. The result of this study will be generalised to this population. Govt. High School Dodah was chosen from the schools in tehsil Kotmomin. In two classes, forty students from each class were selected randomly as a sample of this research work. Group A was experimental, while group B was the name of the control group.

## Variables

### Independent Variables

The independent variables in this study were two different types of teaching methodologies, i.e. the 5Es instruction learning model and the traditional teaching method.

## Dependent Variables

The nature of the study was based on the pretest and post-test equivalent control group design. Therefore the dependent variables in this particular study were the performance achievements score of students in the experimental and control group.

## Intervening Variables

There are many intervening variables in this study that have been controlled by the researcher, e.g. age, intelligence and background of the study.

## Research Instruments

The researcher developed the instrument to assess the conceptual understanding of physics by the students (Appendix A, B).

Pretest and post-test of academic achievements test

The researcher prepared the research instruments to accomplish this research study of pre and post-test achievements in physics. The test contained 50 items in the form of multiple choice questions which were related to

all six levels of Bloom Taxonomy, and this specification is supported by McDermott & Redish (2019) in physics learning. Each multiple-choice question included one right answer and three distracters.

## Validity and Reliability of Instruments

- Although the tests were developed in accordance with correct specifications, the face validity and content validity of the pretest were established by judgmental validation by experts in the field of science education.
- The split-half method was used to calculate the reliability of the pretest of academic achievements using the product moment formula (Gay, 2018; Aggarwal, 2014). The pretest academic achievement test has a reliability coefficient of 0.84.

## Treatment Procedure for Experimental and Control Group

The experimental group was given the treatment through the constructivist method of instruction based on the 5Es instructional model. A group of forty students each (experiment and control group) were taught by the researcher himself. The students of the experimental group were emphasised to construct their own knowledge; to enhance their own conceptual understanding of all the concepts through the intervention of the 5Es instructional model when students were allowed to discuss the topics and share information for their own knowledge and build their own understanding.

The control group was taught the same topics in physics for the same period, using the lecture method for an effective result, using the second intact class containing 40 students. This involves a verbal presentation of the concept to be taught. The students were expected to listen to the teacher and take down notes presented on the chalkboard.

## Data Collection Tool (pretest and post-test)

In the current study, to assess secondary-level students' achievement in physics before the start of the intervention, pretests were administered to both groups. After a period of eight weeks of treatment, the post-test was conducted on both groups by the researcher.

## Data Analysis and Results

Results of the pretest and post-test of both groups were manually tabulated in each sub–construct, i.e. and adequacy of content and cohesion. The latest statistical package for social sciences (SPSS) was used to make statistical analysis; the descriptive statistical analysis reported the achievement of each group in pretest and post-test in terms of mean value and standard deviation (SD), respectively.

Relationship of Pretest and Posttest of Experimental Group in Students' Achievement

Pretest Students = 40 Posttest Students= 40
Learning Domain Mean SD Mean SD t-value p-value
Academic Achievements 25.33 6.44 77.79 5.22 48.99 0.003
The critical value of "t" at 0.05 = 1.94

The above table shows that the experimental group had a mean score value of pretest (Mean = 25.33) and a mean score value of post-test (Mean = 79.77) with a t-test is 48.99. The t-test is particularly more (48.99>1.94) than the tabulated value at the 0.05 level. This implies that there is a momentous difference between the pretest and post-test of the experiment group.

The following figure shows the represented and described data in table 4.1. Visual representations of mean scores, SD, t- and p-value of the experimental group in respect to pretest and post-test of academic achievement in the cognitive domain of Bloom Taxonomy.


**Figure 1**

Relationship of Pretest and Posttest of Control Group in Students' Achievements

Pretest Students = 40 Posttest Students = 40
Learning Domain
Mean SD Mean SD t-value p-value
Academic Achievements 24.95 5.17 48.92 5.94 23.58 0.001

The result shows that the control group had means of pretest (Mean =24.95) and the mean score value of post-test (Mean =48.92) with t-test is 23.58. The t value is tremendously higher (23.58>1.94) than the tabulated at the 0.05 level. This implies that there is a momentous difference between the means of pre and post-test in the control group.

Show the represented and described data in table 4.2. Visual representations of mean scores, SD, t- and p-value of the control group in respect to pretest and post-test of academic achievement in the cognitive domain of Bloom Taxonomy.

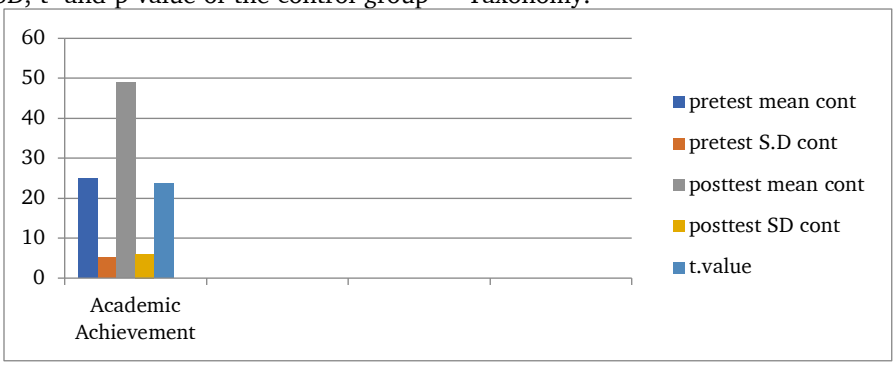


**Figure 2**

Pretest Means and Standard Deviation Statistics of Experimental and Control Groups
Learning Domain Group No Mean Score SD t-value p-value
Expt 40 25.33 6.44
Academic Achievements 0.361 0.002
Cont 40 24.95 5.17

The above table 4.3 shows that the experimental group had a pretest mean value (mean = 25.33), and the control group had a mean score (mean = 24.95) with a t-test of 0.361. Because the "t" value is smaller (0.361<1.94) than the tabulated value at the 0.05 level, both groups are equal in terms of academic performance.

The following figure shows the represented and described data in table 4.3. Visual representations of means, SD, t- and p-value of control and experimental group in respect to pretest of academic achievement in cognitive domain Bloom Taxonomy.


**Figure 3**

Posttest Statistics of Means and Standard Deviation for Both Groups

Learning Domain Group No Mean Score SD t-value p-value

Expt 40 77.79 5.22

1. Academic Achievements 28.28 0.001

Cont 40 48.92 5.94

Results show that the experimental group had a post-test mean score (mean=79.99) greater than the control group of the post-test mean score (mean =48.92) with a t-test is 28.28. The "t" test is higher (28.28>1.94) than the tabulated value at the 0.05 level. This implies a significant difference between the means of academic performance in the post-test of experimental and the control groups. This implies that treatment with the 5Es learning model significantly enhanced the academic performance of students of the experiment group compared to their courter-part in the control group.

The following figure shows the represented and described data in table 4.4. Visual representations of means, standard deviation, t- and p-value of control and experimental group in respect to post-test of academic achievement in cognitive domain Bloom Taxonomy.

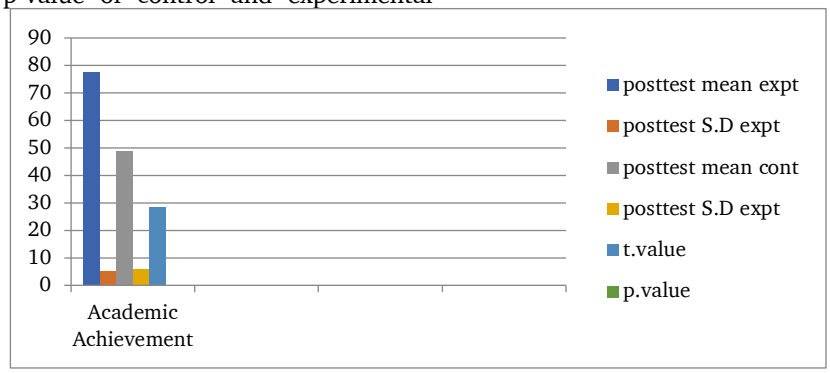


**Figure 4**

## Findings of the Study

The following findings were obtained on comparison between teaching physics with the 5Es learning model and lecture method on

academic performance in physics of grade 9th students:

- The academic achievement of the subjects of the experimental group in the post-test (mean = 77.79) was greater than the pretest (mean = 25.32), with a t-test value is = 48.99
- The academic achievement of control group in posttest (mean = 48.92) was higher than the in pretest (mean = 24.95) with t-test value is = 23.58.
- In pretest, the mean value of experimental group was (mean = 25.32) and control group (mean = 24.90) which were almost equal with the t-value is= 0.360.
- In post-test, the mean value of experimental group was (mean = 77.79) higher than the control group (mean = 48.89) with t-value is = 28.28

## Discussions

The experimental group performed significantly better than the control group. This showed that the 5Es learning model was an efficient strategy for enhancing the acquisition of high-order skills and other cognitive processes of the subjects of study. This teaching/learning approach encouraged them to explore, inquire and construct their understanding through their own experiences. In the 5Es learning model, the teacher put more emphasis on the students to allow them individual questioning and group discussion. It develops the ability of problem-solving, critical thinking, and analytical reasoning at a higher level. The 5Es learning model is useful in storing the information in long-term memory. Whereas in the traditional teaching method, teachers rely mostly on lectures and sometimes give an only demonstrations to students. It addicts rote memorisation but is unable to promote critical thinking or reflection. The information gained through the lecture method stays limited in the short-term memory. This result was supported by Martins &Oyebanji (2016), that the 5Es teaching model affects the responses of students positively and develops their interest, motivation and involvement in their lessons. Other studies, such as Mukherjee (2014), Lawson (2012) and Anderson &Krathwohl (2017), have also proved that learners' cognitive process and academic performance can be enhanced through this effective model of instructions. The 5Es learning model is aimed to promote higher order thinking skills as well as academic performance. This teaching style, in terms of inquiry method or more suitable, may be called student centred approach. It requires a wide range of activities for students to engage them in their learning and enable them to take responsibility for their own learning process. When learners come through this practice, they build their own concepts from retrieving their existing data of information (Aksela, 2015). It motivates students to solve their problems with more motivation (Oliver, 2017; Prince& Felder (2017). The 5Es learning model engages learners in their academic process, allowing them to gain a deeper comprehension of concepts and become good critical thinkers (Wang & Posey, 2016). The 5Es learning cycle model is created on the knowledge organisation process of mind when students apply concepts and make their scientific knowledge construct due to engagement by capturing their attention and interest, exploring the student by providing students with a common based of deeds that help them to practice previous knowledge to create new thoughts. The explanation that requires relating to other ideas elaboration that challenges and extends students' conceptual knowledge and abilities. Evaluation requires feedback from the student on the concept taught.

## Conclusions and Recommendation

The findings of this research study described that there was a significant difference between the experimental group's pretest and post-test mean scores. This indicated that 5Es instructional model was effective in enhancing the academic performance of students in physics at the secondary level. Similarly, the findings also showed that there was a significant difference between the control

group's pretest and post-test mean scores. This also depicted that the traditional teaching method was also effective in promoting students' academic performance in physics at the secondary school level. The mean score value of the pretest of both experimental and control groups was fond equal, which means that both groups were similar before the commencement of the study. However, the means value of the post-test of the experimental and control group was significant differences which determined the effectiveness of the 5Es instructional model as compared to the traditional lecture method.

The present study was conducted only in one district of the province Punjab, and only one subject in public sector school due to scarcity of time and other material resources, therefore the researcher recommends the following weak areas for the improvement and for further studies,

- There is a need for time to improve teaching/learning conditions through a strong linkage of the classroom with a fully equipped laboratory for conceptual understanding of the concepts of physics discipline.
- It is imperative to adopt new teaching practices such as the 5Es learning model, which is necessarily based on an inquiry approach to replace the conventional lecture method.
- Similar extensive studies with relatively larger sample sizes may be conducted in other districts and provinces of Pakistan at different grade levels.
- Working instructors may be encouraged to apply the 5Es learning model by conducting the refresher courses to inculcate then the 5Es learning model in their workshops for an effective teaching/learning process.
- In the light of the results of this research study, the lecture method may be discouraged because it is not efficient in developing higher-level thinking skills in the students at the secondary school level.

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