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Science Learning Through Interactive Teaching Method: An Experimental Study

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Abstract

An experimental study was conducted to find the impact of interactive teaching methods on science learning. 70 students from seventh grade were selected to participate in this study. A control group with 35 randomly assigned students was taught by the traditional lecture method and an experimental group with another 35 students was taught by an interactive teaching method. A pre-test was conducted before implementing the intervention to measure the baseline score while a post-test was administered to measure the impact of the intervention. An ANCOVA (Analysis of Covariance) was used to find the significant difference in science achievement scores of students between the traditional teaching method and interactive teaching method after controlling the effect of pre-test scores. There was a significant difference in students' science achievement scores between students in the traditional teaching group and students in the interactive teaching group, F (2, 67) = 153.47, p <.001 η2 = .82. It was concluded that the interactive teaching method significantly improves student science learning.

Keywords: Interactive Teaching, Science, Experiment Study

Introduction

Sustainability in this demanding era seems impossible without having a technologically and scientifically sound educational environment. In this global age, science has become the backbone for progress in every field of life. It is essential to teach students with more appropriate teaching methods to equip them with the necessary scientific foundation. Today in developed countries in general and in many developing countries too, various new methods and models are in used to teach science subjects. The interactive model of science instruction is one of them which is being employed for imparting and promoting science education specifically at the middle school level. According to Bennet (2003), the prime aim of science education is to help the students understand scientific ideas. There is overwhelming evidence that supports that there is a link between science and technology, and economic development. What has been troubling is that the number of students at the secondary and tertiary levels pursuing science has been decreasing. The lack of motivation in science subject due to the traditional lecture method is one of the major causes of students drop-out of science classes. Recent trends of students shifting from science to business studies point out that there is not much scope for persons with qualifications in the science field, and also that careers in the business fields are more financially rewarding.

Student learning is affected by various internal and external factors. Teachers' pedagogical practice is one of the major factors that contribute to what, how, and how much students learn. Studies have been carried out in Pakistan to examine children's learning outcomes in the core school subjects including science.

The teaching of science is a great challenge in several developing countries. Inappropriate and unproductive teaching approaches are responsible factors for lowering the achievement level of students in science. At the secondary education level, a variety of instructional techniques are not adopted by both teachers and students which can make them able to deal with scientific concepts (Abimbola, 2013). For enhancing the interest of students and maximizing their achievement ratio in science learning, alternative teaching strategies can play a vital role (Ajaja, 2013).at the same time, for taking innovative and active teaching strategies into the class fruitfully, scientifically enlightened teachers are unavoidable (Oyelekan & Olorundare, 2015). According to Halai (2008), In Pakistan, for

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effective science education, teaching methods, rote memorization-based assessment, and availability of scientific aids are considerable factors. An integrated curriculum coupled with capable teachers showing readiness for change can only be an effective package for science.

Students are afraid of learning science just because of overloaded books, the poor printing quality of the book, untrained science teachers, and lack of scientific equipment (Nayyer, 2016). The teaching of science cannot and should not be dependent on teachers' viewpoint but on students as well who usually perceive things differently (Salvin, 2005).

Educational settings usually exhibit three possible teaching-learning situations, passive, active and interactive. In the first situation, learners face one-way delivery of information. It is appreciated in case of stuffing the audience with the bulk of information in a very limited time. Active and interactive classroom settings fully allow students to put up and fix their queries with a slightly different pattern. Active learning provides students an opportunity to share their views with the teacher while interactive teaching poses a platform for a communicative activity in which they can reflect upon what they think and do not only with the teacher but with each other also (Atanasescu & Dumitru, 2017).

Cooperation is a significant element in interactive learning that involve face-to-face interaction for mutual success among all group members to make an artifact as well as involves process such as discussions, negotiations, and approval of the viewpoints of other group fellows (Kozar, 2010). Students are encouraged to do group tasks together to give better results in the future also and they learn from each other through acceptance of opinions about conflict resolution. (Altun, 2015). Cooperative teaching is one of the suitable approaches for science (Abdulwahab, Oyelekan & Olorundare, 2016) Through computer-assisted activities science can also be taught effectively (Gambari, Yousuf, & Thomas, 2015). Nigerian Educational Research and Development Council (2009) proposed discussion, demonstration, experimentation, and field trips as useful methods in science teaching and learning.

Different elements of interactive learning are listed and reported by researchers and various terms were used to define interactive learning, such as cooperative learning, interdependence, face-to-face interaction, teamwork, etc. According to Slavin (2015) when students work together in groups to accomplish some task, positive interdependence, individual accountability, and confidence plus critical thinking are developed and social skills are inculcated in them. Instructors might use other activities along with the above-mentioned to enhance students learning and to engage them in mini-lectures in a positive way inside the classroom throughout the session. Questioning to students during and at the end of class is one of the best activities to engage students in the classroom and foster critical thinking in them. Questions might be posed by the teacher to students, students to teacher, and student to student in peer engagement. Instructor-posed questions can help arouse student curiosity as well as interest, and it may sharpen learners' thinking skills by demonstrating the application of theory to practice, plus assessing students' knowledge, skills, or attitudes, in addition to preparing students for examinations. Student-posed questions can encourage student-teacher interaction particularly by identifying areas of confusion or test understanding and formulating personal connections with course content, as well as encouraging student-student cooperation.

Results of large-scale studies depict unpleasant results of students learning outcomes in schools specifically in mathematics and science (South Asia Forum for Educational Development, 2010). While these studies provide empirical evidence of students' performance these do not focus on determining a teacher's pedagogical practice which is one of the key contributing factors in students' learning. In Pakistan, for effective science education, teaching methods, rote memorization-based assessment, and availability of scientific aids are considerable threats. Therefore, an integrated curriculum coupled with capable teachers showing readiness for change can only be an effective package for science. The present study focused on how interactive teaching methods can influence students' science achievement and how much interactive teaching methods can contribute to students' science achievement scores.

Statement of the Problem

The teaching of science in a traditional way is a major cause of students' lack of interest in science subjects and thus it also leads to students drop-out of school. Students consider it a boring and useless subject with no practical implications. It is essential to learn science subjects by experiments and activities for effective teaching and learning process of science subject.

Objectives of the Study

- To measure the growth rate in science achievement by incorporating interactive teaching methods in science class.
- To assess the impacts of interactive methodology on the students' achievement in the science subject.
- To provide recommendations for improving the existing teaching methodologies of science subjects.

Hypothesis

H_o1: There is no significant effect of interactive teaching methods on students' science achievement.

Significance of the Study

This study provides some significant benefits for teachers, parents, school administrators, and policymakers. The findings of this study are useful for science teachers to enhance the teaching methodologies of their prospective subjects. Secondly, results reveal the amount of variance explained in students' learning outcomes by teachers' pedagogical practices. Thirdly, this evidence base would be particularly important to feed into current reform efforts that the educational departments are engaged in for mapping out its future directions. Fourthly, results would inform policy in the context of teachers' professional development to enhance access to quality education specifically in the area of science and other STEM subjects.

Literature Review

Hassan and Ibrahim (2018) highlighted the significance of science through sharing facts that science was taken as a topic of 60% STEM (Science, technology, engineering, and Mathematics) based researches during 2010-2016 in the world. In educational institutions of developing countries, the teaching of science is a very vague process (Ornek et al., 2008).

Student learning is affected by various internal and external factors. Teachers' pedagogical practice is one of the major factors that contribute to what, how, and how much students learn. Studies have been carried out in Pakistan to examine children's learning outcomes in the core school subjects including science. Tomasello (2009) concluded in his research studies on interactive teaching and students' performance that interaction and cooperation are inherited in human beings. It is not a learned behavior. He argued that children grow and help each other without any expectation of reward in return, later on, these children, being adult members of society perform different socially acceptable roles based on interaction and cooperation. Similarly In all educational situations all around the world, in business, in social sciences, general science, and from primary to higher secondary and even at tertiary level cooperation and teamwork are widely supported (Slavin, 2015). Concerning science as a subject to teach, teachers are found with misconceptions, associating low expectations from students, and being poorly equipped with scientific approaches towards teaching and learning. In 2004, Angell et al. exposed in their study that science is taken as a difficult subject just because of workload. The difficulty of science subject is indicated with graphical representations of facts, calculations, manipulations, scientific terminology, and conceptual elaboration. In 2004, Angell et al., exposed in their study that science is taken as a difficult subject just because of workload. The difficulty of science subject is indicated with graphical representations of facts, calculations, manipulations, scientific terminology, and conceptual elaboration.

The exploration of pupils' perceptions about science reveals that students have an aversion to the science subject is only based on teacher's teaching strategies and what is taught to them in the science period, as well as, is more related to how science subject is taught in the classroom. Goldenberg's (2011) studies revealed that students enjoy learning science when they are taught employing inquiry method, along with discovery learning, but they feel unreceptive into having to conform to the well-organized, passive methods of delivery.

The opportunity to actively participate in science learning allows it to produce its reward. Students might be engaged by using interactive worksheets in science classes because worksheets seem to be able to achieve much more than traditional teaching. Furthermore, the instant learners' feedback facilitates that in-class worksheets provided permitted for concluding the when and why of students' lack of comprehension in science learning. The worksheets also allowed for better daily

evaluation of students' learning and significantly improved students' participation in class. Moreover, Hake (1997) used several interactive activities in the classroom and found that creating interactive settings within the classroom motivated students of all types to participate in class activities for science and they learn much from each other. Later, Goldenberg's (2011) study showed that even passive learners along with active students of the science disciplines were asking and suggesting ways for a more interactive approach to be implemented in their science classes for inquiry and cognitive development.

It is argued that students' learning outcome is complex construct. The complexity arises because of its multifaceted nature. *First*, it subsumes factors with broader linkages. For instance, students' learning outcomes, on the one hand, are associated with classroom practices (Rivkin, Hanushek & Kain, 2005) and, on the other hand, also involve family background factors like the socio-economic background of students (Helland, 2007) and parental involvement (Bakker, Denessen & Brus-Laeven, 2007) that lie outside classrooms. *Second*, the impact on students' learning is mediated by teachers' characteristics - how teachers impart knowledge to students is a function of their content knowledge and pedagogical skills. Therefore, teachers' characteristics become central to the classroom interaction where learning takes place (Goldhaber & Brewer, 2000). *Third*, student learning outcomes are also a function of classroom characteristics including class size (Blatchford et al., 2003). All these complexities of students' learning outcome measurements require different layers of data for model-building and testing. More specifically, it is to assess the impact of teachers' pedagogical practice on students' learning while considering the other important factors that have been highlighted in the research literature (Rivkin, Hanushek & Kain, 2005; Bakker, Denessen & Brus-Laeven, 2007; Blatchford et al., 2003) to have both direct and indirect effects on students' learning outcomes.

Understanding these concepts, symbols and formulas get students away from studying science like Physics (Lozano & Cardenas, 2002). Von-Rhoneck et al. (2007) declared lack of interest as a highly significant factor in the failure of students in science subjects. The teacher's role becomes crucial in designing an attractive and effective instructional program for science students keeping their caliber and culture in view. For making and taking science as an attractive domain a shift is needed from traditional to active strategies of learning.

Traditional Instructional strategies commonly used for science teachings like lecture or chalk and talk method cause boredom among students. A typical and outdated standpoint that scientific rules can be memorized provoked a need for change in the method of science teaching. According to Oeleykan, Igbokwe, and Olorundare (2017) use of laboratories and models has mostly used teaching techniques in science.

Methodology

An experimental study design was used to find the impact of the interactive teaching method on science learning. A science test paper was designed to measure students' science learning. A pre-test was conducted to measure baseline scores before the intervention and a post-test was conducted after the intervention to measure the impact of treatment.

Research Design

For this study, ANCOVA (Analysis of Covariance) was used which is the combination of ANOVA and regression analysis. Any ANOVA design can become an ANCOVA design by the addition of a covariate variable. The induction of covariate increase statistical power and reduced bias by equating groups on one or more variable. Thus, it is very important to partial out the effect of the pre-test score to determine the actual mean differences of science achievement scores between the control and treatment groups. The dependent variable was the post-test score, the independent variable was the control and experimental group while the pre-test score variable was considered as covariate variable.

Instruments

An achievement test of science was used for data collection. A test paper was developed from the first four chapters of the book prescribed by the government. There were thirty objective-type questions in the test paper including multiple-choice questions, fill-in-the-blanks, and true-false.

Participants

There were 70 participants randomly selected for this study from five different schools in Hyderabad district, Pakistan. These were all male students from age 12 to 14 years. These 70 students were randomly divided into two groups: control group ($n = 35$) and experimental group ($n = 35$).

Procedure

A test paper was developed for students. This test paper was also evaluated by subject experts to ensure content validity. First, the pre-test was conducted for both the control and experimental group to gather the baseline data. Students of both groups (i.e., control and experimental) were taught by the assigned teacher for one class of 35 minutes each day. The same content material was used for control and experimental groups but with different teaching methods. The first group was taught science through interactive teaching method and for the second group traditional teaching method was used. Threats to experimental validity were controlled by the researchers. Both groups were taught four chapters from the textbook. After the completion of four chapters, a post-test was taken from both groups. The post-test was identical to the pre-test.

Data Analysis

Both descriptive and inferential statistics were used to analyze data. Analysis of Covariance (ANCOVA) was the main statistical test used in this study. The purpose of using ANCOVA was to control the effect of the pre-test score. The collected data were tabulated, analyzed in the SPSS (v.22), and the significance level was set at $p < 0.05$.

Findings

A single-factor between-subjects analysis of covariance (ANCOVA) was used to measure the significant difference between traditional teaching methods and interactive teaching methods after partially-out student pre-test scores. Before analyzing the data, all the ANCOVA assumptions including homogeneity of slopes, homogeneity of variance, and normal distribution assumptions were tested and results revealed that all statistical assumptions were tenable. There was no significant interaction between pre-test and post-test scores which is one of the key assumptions of ANCOVA.

Table 1. *ANCOA result*

Tests of Between-Subjects Effects

Dependent Variable: Post-test

Source	Type III Sum of Squares	*df*	Mean Square	*F*	Sig.	Partial Eta Squared
Intercept	6278.49	1	6278.49	178.30	<0.01	0.73
Pre-test	143.94	1	143.94	4.09	<0.05	0.06
Group	10655.70	1	10655.70	302.60	<0.01	0.82
Error	2359.32	67	35.21			
Total	300656.00	70				
Corrected Total	13167.49	69				

a. *R* Squared = .821 (Adjusted *R* Squared = .815)

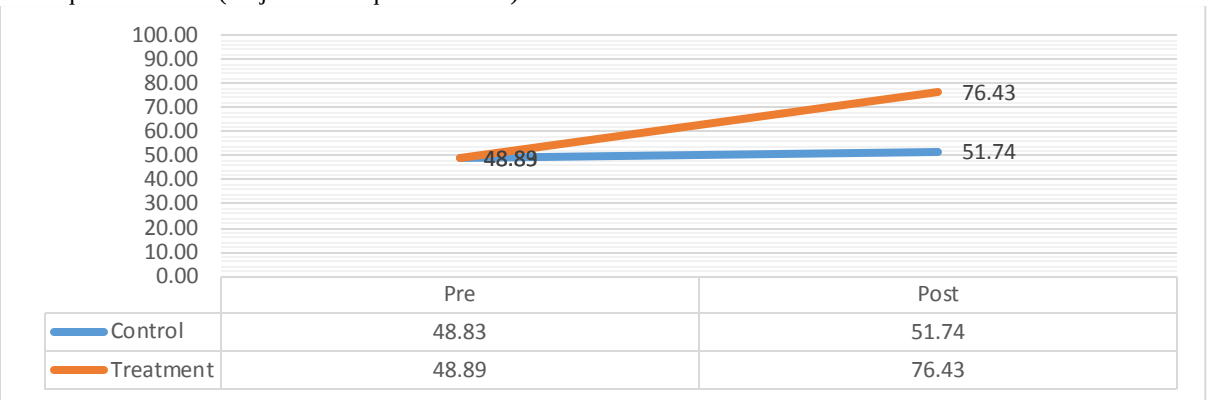

Figure 1. Mean Scores of Pre-test and Post-test in Control and Treatment Group

The data depicted in Table 1 and Figure 1 depict that there was a significant difference in students' science achievement scores between students in the traditional teaching group and students in the interactive teaching group, $F(2, 67) = 153.47$, $p < .001$ $\eta^2 = .82$. Therefore, the null hypothesis 'there is no significant effect of interactive teaching methods on students' science achievement' is rejected.

Discussion

The purpose of this study was to assess the impact of interactive teaching on students' science achievement. An experimental design was used to find the significant difference in science achievement of students between the control group using the traditional teaching method and an

experimental group using the interactive teaching method. Results revealed that 82% variation in science achievement score is due to the interactive teaching method.

Ebrahim (2012) in his experimental study "comparing the effectiveness of lecture method and interactive learning on students' achievement in science subject/s and their use of social skills" with a sample of 163 elementary science girls in eight different sections of the same grade found that students in the experimental group taught using interactive learning showed a significant academic achievement and social skills as compared to those taught by using the traditional method. Similarly. Reza, Abozar, Ali, and Akbar (2013) in their research study indicated that interactive teaching is much more significant at the elementary level. Ahmed and Mahmood (2010) in experimental research about comparative analysis of the study of the effectiveness of different teaching methods traditional instruction, loosely structured cooperative learning, and students team achievement on students' academic success concluded those students who were taught in the experimental group enjoyed their learning. Similar results were found in the current study.

Traditionally, in Pakistani public schools, science teaching relies heavily on lectures, reading, and teacher-centered demonstrations with very little involvement from the students' side. It is, therefore, important to shift science teaching from traditional methods to interactive methods to gain students' interest in a science subject at the elementary school level.

Conclusions

In this era, one of the indicators of educational performance as an end product is the achievement of students in subject areas. Achievement in science subjects is given a unique accentuation by policymakers since it manages the ideas and rules that are needed for an innovative and technologically developing society. This study provides empirical evidence to support interactive teaching methods in science subjects at the middle level. This study was conducted in one district with a limited sample. This is one of the major limitations of this study. Another limitation was that only seven-grade science students were tested from four chapters in their prescribed book. Despite these limitations, this study provides some significant benefits for teachers, parents, school administrators, and policymakers. The findings of this study are useful for science teachers to enhance the teaching methodologies of their prospective subjects**.**

Recommendations

As the study assessed the impact of interactive teaching on students' science achievement and found that the students' scores increased significantly due interactive teaching method, so it is recommended that interactive teaching methodology may be used by teachers of elementary schools. Focus on utilizing innovative and interactive methodologies may be given in pre-service teacher education programs. In-service training sessions may be organized for elementary-level science teachers to familiarize them with interactive teaching methodologies.

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