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RESEARCH PAPER

Evaluating the Effects of Problem Solving Model, Traditional Instructional Model and 5E Instructional Model on Students Academic Achievement

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ABSTRACT

Educationists are focusing to introduce changes in the pedagogy and create new paradigm which suits the globalized generation. This study has compared the effects of traditional instructional model, problem solving model and 5E instructional model on 9th grade Secondary School students' achievements in the subject of general science. Objectives of the study were to compare the effects of these instructional models and to explore the effect on gender difference. The experimental design, 'pretest posttest control group design' was used. By adopting purposive sampling technique, 90 girls and 90 boys were selected. These 180 students were further distributed into two control and four experimental groups, comprising of 30 students in each group. The results revealed that these models yielded better achievement results. While, no significant difference was observed among male and female students. It was recommended to enhance competency of teachers by equipping them with innovative instructional methodologies.

KEYWORDS 5E Instruction Model, Problem Solving Teaching Model, Traditional teaching Methodology

Introduction

The twenty first century has brought about the concept of globalization in the world. The globalized world has affected the education system by producing a number of challenges from policy makers to teachers for instructional delivery while globalization demands achieving international standards. Globalization focuses critical internationalization based on local context and indigenous conditions. It is pertinent to generate changes in the pedagogy and create new paradigm which suits the globalized generation. In the local context, the work of Shaheen and Kayani (2015) suggests that the new paradigm is likely to work on creating ways for lifelong learning for students and competing the challenges, contrasting the customary paradigm of education which focuses on providing knowledge and skills to a local community.

It was noted in a local study that the traditional approaches to teaching are insufficient to meet the needs of individuals and their development to become as a productive members of the society (Chaudry & Ayyaz, 2016). Today's teacher is considered as a designer who is responsible to take all the decisions of teaching and learning in a classroom. He/she decides what is to learn by the students, what should be the context of their learning, what strategies they should use for learning and how they are to be evaluated (Gros, 2002).

One of the instructional models which uses constructive approach, the 5E instructional model, has been used worldwide since its emergence in late 1980s (Bybee

et al., 2006). Each step of the 5E instructional model has been crafted for the construction of knowledge, skills and thoughts among students.

The problem solving model creates critical thinking among students by providing them opportunity to inquire and find solution to the problems by using scientific process (Kemertaş, 2001). This is closely linked with creativity. In developing scientific thinking and conceptual understanding, the problem solving ability enables the students to cope with problems that occurs in our environment. It is linked with the scientific reasoning and making appropriate decision while solving scientific problems (Abdullah & Shariff, 2008).

Several research studies have emphasized the importance of instructional models for developing reasoning skills among students and enhancing their academic achievements. Kaynar et. al., 2009; Bulbul, 2010; Shaheen & Kayani, 2015; Shaheen, 2017).

Usually, teachers have no innovative teaching strategies and they use traditional teaching methodologies in classrooms. In current study, researchers have compared the effects of traditional instructional model, problem solving model and 5E instructional model on Secondary School students' achievements.

Literature Review

Instructional Models of Teaching Science

Odom and Kelly (2001) state that adopting a scientific results-oriented teaching strategy to improve scientific outcomes; promoting the role of students and teachers as active participants and facilitators is an important area of interest for science educators. Consequently, Bülbül (2010) states that instructional models has gained the attention of many researchers and educators as well. Following is the brief description of the models used in this research.

Traditional Instructional Model

Teachers in the traditional learning environment adhere to the central map, followed by the traditional learning model (Vighnarajah, et al., 2008). Although it has witnessed some learning (Ertmer & Newby, 1993). Aronson (2005) argues that traditional education shows a unique flow of information from teachers to students. Learning from memory is a hallmark of this teaching method.

The 5E instructional model

The 5E Instruction model presented by Bybee et al., 2006 is widely used by instructors for exploring knowledge among learners.

Table 1
5E Instructional Model: A Brief Description

Stage	Brief Description
Engaging	Teachers or core course assignments attempt to acquire prior knowledge of the student. Therefore, they look into small activities to inspire their curiosity and recall their previous information. Therefore, these activities must bridge the gap between past and present learning.
Exploring	The exploration process involves the concepts of the past to establish the concepts acquired by the tasks currently completed. Participation

	in the exploration phase provides students with a common starting point at which to build existing ideas, procedures and expertise. Completing lab activities supports the use of prior knowledge to generate new concepts, extend queries and possible options to design and communicate initial search levels.
Explaining	The phase emphasizes that students focus on the specific characteristics of the experience gained during the exploration process. It also provides an opportunity to know about understanding based on concepts, planning expertise and performance. This stage also provides opportunities for teachers to publicly present concepts, procedures or expertise. Here, students are free to express their understanding.
Elaborating	The interpretation of the teacher or core curriculum can also prove its value in a deep understanding, because this is the relevant step at this stage. Teachers are also testing and expanding the theoretical foundations of student knowledge and expertise. Therefore, the development of new skills has given people a deep and broad understanding of other facts and important expertise. The learner understands this idea by taking on additional tasks.
Evaluating	The evaluation phase motivates students to assess comprehension skills. It also provides opportunities for teachers to assess students' improvements in achieving their guiding goals.

Problem Solving Model

Bransford and Stein (1984) use the acronym IDEAL to determine five steps:

- I = Identification of opportunities and problems
- D = Defining goals and representing the problem
- E = Exploring possible strategies
- A = Anticipating outcomes and acting upon the procedure
- L = Looking back to learn.

Hypotheses

Following null hypotheses were developed for the study;

H_o1: There is no significant difference in the mean academic achievement scores of students taught through 5E instructional model, problem solving model and traditional instructional model.

H_o2: There is no significant difference in the mean achievement scores of male and female students taught through 5E instructional model.

H_o3: There is no significant difference in the mean achievement scores of male and female students taught through problem solving model.

H_o4: There is no significant difference in the achievement scores of male and female students taught through traditional instructional model.

Material and Methods

Brief description of the research methodology of the study is discussed here. The study was experimental in nature. True experimental design named 'pretest posttest

control group design' was used to conduct the study.All students of grade 9th in the district Rawalpindi, who were studying General science as an elective subject were the population o the study.

Research instrument

For the collection of data, a self-developed Subject Achievement Test was used in this study as a research instrument. Curriculum-based terms as reflected in General Science text book were taken as test items. It consisted of 60 items from General Science text book of class 9th published by Punjab Text Book Board. This achievement test was used as pre-achievement and post achievement test. Concepts included in achievements test were regarding our Life and Chemistry, Biochemistry and Biotechnology, Human Health, Environment and Natural Resources. All the 180 participants (90 boys students of grade 9th and 90 girls of grade 9th) attempted the pre and posttests. The response rate was 100%.

Sample

By adopting purposive sampling technique, researchers randomly selected 90 girls students of grade 9th from Government Girls High School Kahuta and in the same way researchers took 90 boys students of grade 9th from Government Boys High School Kahuta for sample purpose. For conduction of experiment, these 180 students were further distributed in two control and four experimental groups. Each group constituted 30 students in this way.

Table 2
Sample of study

Type	Control Group	Experimental Group I	Experimental Group II	Total
Boys	30	30	30	90
Girls	30	30	30	90
Total	60	60	60	180

Results and Discussion

This portion describes results on the basis of analysis and interpretation of data. For this, both descriptive and inferential statistical techniques were used. One Way Analysis of Variance (ANOVA) and independent sample t-test were used to test the null hypotheses at a significance level of 0.05.Before testing null hypotheses, it was necessary to check whether there were preexisted differences among the groups regarding students' achievement. Hence, to analyze the results of pre- test and see pre-existed differences among students' achievement test, one way ANOVA was carried out.

Table 3
One Way ANOVA: Pre Subject Achievement Test

	Df	*F*	Sig.
Between Groups	2	0.620	0.539
Within Groups	177		
Total	179		

Table 3 indicates the results of One Way ANOVA. It can be summarized as there was no statistically significant difference in the mean scores of students' Subject Achievement Test using traditional instructional model (M=22.57, SD=6.283), 5E

instructional Model (M=21.78, SD=6.574) and Problem solving model (M=23.10, SD=6.676), F (2, 177) = 0.620, p= 0.539) before the treatment assigned.

Table 4
One Way ANOVA: Post Subject Achievement Test

	Df	*F*	Sig.
Between Groups	2	4.466	0.013
Within Groups	177		
Total	179		

The results indicated that there was a statistically significant difference between post mean scores of students' achievement using 5E instructional model, problem solving model and traditional instructional model (F (2, 177) = 4.466, p= 0.013). Hence, Post Hoc Tucky test was applied.

Table 5
Post Subject Achievement Test

(I) Type of Model	(J) Type of Model	Mean Difference (I-J)	Sig.
5E Model	Problem Solving Model	0.016	0.997
	Traditional instructional model	5.817*	0.025
Problem Solving Model	Traditional instructional model	5.650*	0.031

*. The mean difference is significant at the 0.05 level.

Table 5 indicated results of Post Hoc Tucky test for checking difference between groups w.r.t. post mean scores of students' achievement. It is clear from Table 5 that there was no significant difference in the mean achievement test scores of the students taught through 5E Model (N=60, M=36.62, SD=12.921) and Problem solving model (N=60, M=36.45, SD=10.831), as p=0.997>0.05. Furthermore, the students taught through 5E Model (N=60, M=36.62, SD=12.921) showed slight rise but not significant better achievements as compared to the students taught through Problem solving model (N=60, M=36.45, SD=10.831).

Table 5 also depicted that there was a significant difference in the mean achievement scores of the students taught through Problem solving model (N=60, M=36.45, SD=10.831) and Traditional instructional model (N=60, M=30.80, SD=12.556), as p=0.031<0.050.Furthermore, the students taught through Problem solving model (N=60, M=36.45, SD=10.831) showed significantly better scores in achievements as compared to the students taught through Traditional instructional model (N=60, M=30.80, SD=12.556).

Table 5 also depicted that there was a significant difference in the mean achievements scores of the students taught through 5E Model (N=60, M=36.62, SD=12.921) and Traditional instructional model (N=60, M=30.80, SD=12.556), as p=0.025<0.05. Furthermore, the students taught through 5E Model (N=60, M=36.62, SD=12.921) showed significantly better scores in achievements as compared to the students taught through Traditional instructional model (N=60, M=30.80, SD=12.556).Following is the description of testing second null hypothesis.

Table 6
Subject Achievement of male and female students using 5E Instructional Model

Category	N	Mean	SD	*T*	*df*	Sign(2tailed)
Male	30	44.63	11.038	6.108	58	.000

Female	30	28.60	9.212

The results of this independent sample t-test analysis can be summarized (Table 6). Furthermore, it was found that there was no significant mean difference between male (N=30, M=44.63, SD=11.038) and female (N=30, M=28.60, SD=9.212) in students' achievement using 5E Model as t (58) = 6.108, p = 0.000>0.05. Male (N=30, M=44.63, SD=11.038) students showed significantly better achievement scores as compared to female (N=30, M=28.60, SD=9.212) students. Moreover, the values of Standard deviation i.e. 11.038 and 9.212 showed that for female students, most of the numbers were very close to the average, while, in case of the male student, the numbers were spread out.

Table 7
Post Subject Achievement of male and female students using Problem Solving Model

Category	N	Mean	SD	*t*	*df*	Sign(2tailed)
Male	30	43.60	10.166	6.795	58	.000
Female	30	29.30	5.434			

The results of this independent sample t-test analysis can be summarized (Table 7). Furthermore, it was found that there was no significant mean difference between male (N=30, M=43.60, SD=10.166) and female (N=30, M=29.30, SD=5.434) in students' achievement using Problem solving model as t (58) = 6.795, p = 0.000>0.05. Male (N=30, M=43.60, SD=10.166) students showed significantly better achievement scores as compared to female (N=30, M=29.30, SD=5.434) students. Moreover, the values of standard deviation i.e. 11.038 and 9.212 showed that for female students, most of the numbers were very close to the average, while, in case of the male student, the numbers were spread out. Following is the description of testing fourth null hypothesis.

Table 8
Post Subject Achievement of male and female students using traditional instructional model

Category	N	Mean	SD	*t*	*Df*	Sign(2tailed)
Male	30	22.03	6.825	7.551	49.164	.000
Female	30	39.57	10.731			

The results of this independent sample t-test analysis can be summarized (Table 8). Furthermore, it was found that there was no significant mean difference between male (N=30, M=22.03, SD=6.825) and female (N=30, M=39.57, SD=10.731) in students' achievement using traditional instructional model as t (49.164) = 7.551, p = 0.000>0.05. Female (N=30, M=39.57, SD=10.731) students showed significantly better achievement scores as compared to male (N=30, M=22.03, SD=6.825) students. Moreover, the values of standard deviation i.e. 11.038 and 9.212 showed that for male students, most of the numbers were very close to the average, while, in case of the female student, the numbers were spread out.

It was found that there was no significant mean difference with respect to students' Subject Achievement Test of Traditional instructional model , 5E Model and Problem solving model F (2, 177) = 0.620, p = 0.539) before the treatment (Table 3).

The results indicated that there was a statistically significant difference between post mean scores of students' achievement using 5 E instructional model, problem solving model and traditional instructional model (F (2, 177) = 4.466, p= 0.013). (Table 4).The results of Post Hoc Tucky test showed that there was no significant difference in the mean achievement test scores of the students taught through 5E Model and Problem

solving model as p=0.997>0.05. Furthermore, the students taught through 5E Model showed slight rise but not significant better achievements as compared to the students taught through Problem solving model. There was a significant difference in the mean achievements scores of the students taught through Problem solving model and Traditional instructional model as p=0.031<0.050. Furthermore, the students taught through Problem solving model showed significantly better scores in achievements as compared to the students taught through Traditional instructional model .There was a significant difference in the mean achievements scores of the students taught through 5E Model and Traditional instructional model as p=0.025<0.05. Furthermore, the students taught through 5E Model showed significantly better scores in achievements as compared to the students taught through Traditional instructional model. So, $H_0$1: There is no significant difference in the mean academic achievement scores of students taught through 5E instructional model, problem solving model and Traditional instructional model was rejected (Table 5).

It was found that there was no significant mean difference between male and female students' achievement using 5E instructional Model as t (58) = 6.108, p = 0.000> 0.05. Male students showed significantly better achievement scores as compare to female students (Table 6). Hence, the second null hypothesis which stated that there is no significant difference in the mean achievement scores of male and female students using 5E Model, was accepted.

It was found that there was no significant mean difference between male and female students' achievement using Problem solving model as t (58) = 6.795, p = 0.000> 0.05. Male students showed significantly better achievement scores as compared to female students (Table 7). Hence, the third null hypothesis which stated that there is no significant difference in the mean achievement scores of male and female students using Problem solving model was accepted.

It was found that there was no significant mean difference between male and female students' achievement using Traditional instructional models t (49.164) = 7.551, p = 0.000> 0.05. Female students showed significantly better achievement scores as compared to male students (Table 8). Hence, the fourth null hypothesis which stated that there is no significant difference in the mean achievement scores of male and female students using Traditional instructional model was accepted.

Conclusions

This study compared the three models i.e. traditional instructional model, problem solving model, and 5E instructional model to measure the five areas of students learning in General Science; Our Life and chemistry, Bio-chemistry and Bio-technology, Human Health and Environment and Natural Resources. Analysis of data revealed that 5E instructional model and problem solving model were effective than traditional instructional model in imparting instructions. The study results has resemblance with a number of previous studies conducted by other researchers (Seyhan & Morgil, 2007; Marek et al, 2008).

A study conducted by Seyhan and Morgil (2007) compared two classes of the secondary schools who were instructed using 5E instructional model with the two others who were instructed through traditional methods. The results of the study indicated that the students taught through the 5E instructional model improved statistically better as compared to those who were taught by using traditional methods. A plausible feature

was that the students who were taught through 5E instructional model showed better interpretative skills as compared to those who were taught through traditional methods.

Along the lines a study conducted by Saka and Akdeniz (2006) found effects of 5E instructional model accompanied with computer-aided materials on the subject of Genetics. The results of the study concluded that the classroom activities designed keeping in view the 5E instructional model were likely to decrease conceptual errors among the students. It was also found that the students felt themselves released from monotonous class environment by those activities.

The results of the present study indicated that 5E Instructional Model and problem solving teaching Methodology were effective way of instruction at secondary level as compared to traditional method of teaching. No significant difference was observed between male and female students with respect to their achievements scores.

The studies conducted by Shaheen (2017) and Shaheen and Kayani (2015) in local context also concluded that the gender had no effect on students' attitude while using different instructional models. While, the study conducted by Haidar and Al Naqabi (2008) on 162 (80 boys and 82 girls) found that both the groups of gender had equal achievement scores. Furthermore, the study conducted by Akyol, Sungur and Tekkaya (2010) yielded a significant difference in achievement scores of 7th grade students in Science.

Recommendations

On the basis of conclusions, following recommendations were suggested.

- 5E Instructional model and problem solving model may be included in present curriculum structure of teacher education in Pakistan. Policy makers and curriculum developers may give increased attention to upcoming instructional models for the betterment of quality of education especially in scientific and mathematical courses at secondary level.
- Training institutes may adopt 5E Instructional model and problem solving model to train pre-service and in-service teachers.
- Teacher training institutes need to develop 5E instruction based and problem solving model based modules for enhancement of quality education.
- Authorities may offer professional development opportunities for teachers to learn about and implement the 5E Instructional Model and Problem-Solving Model effectively.

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