Improving Students' Achievement in Biology using 7E Instructional Model: An Experimental Study

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Abstract

The main purpose of the study was to compare the effectiveness of the instruction based on 7E Instructional Model and Traditional Instructional Model for the teaching of Biology on 9th grade students' achievement. Pretest posttest control group design was used in this study. A total number of 122 ninth grade students (62 boys and 60 girls) from four classes of a biology course of two schools were purposively selected. This study continued for eight weeks. Experimental group (61 students) and control group (61 students) were randomly assigned. The students in the control group were instructed with traditional instructional model, while the students in the experimental group were instructed with 7E Instructional model. A Subject Achievement Test (SAT) and Integrated Science Process Skill Test (ISPST) were used to collect data. Three hypotheses were tested using t-tests and ANCOVA. Independent sample t-test examined that there was a significant difference in the scores of Integrated Science Process Skill Test (ISPST), hence it was used as a covariate. ANCOVA examined that there was a significant difference in the mean post test scores of the groups and gender in terms of students' Subject Achievement Test (SAT) when students' integrated science process skills Test (ISPST) was controlled as a covariate. It was concluded that the 7E instructional model was more effective than the traditional instructional in terms of students' achievements. The study would be helpful for the educators and curriculum developers in implementing new strategies in the classrooms.

Keywords: 7E Instructional Model, Students' Achievements, Teaching of Biology, Traditional Instructional Model, Integrated Science Process Skills.

1. Introduction

The prime goal of science teaching in the contemporary period is to prepare a student who is ready to compete the global world. It evokes in them the most celebrated learning method of Socrates i.e. discovery through inquiry, thereupon, the process of learning takes place in its true essence. It also helps them to nourish and garnish their knowledge and skills at individual and collective levels and subsequently use these in a broad spectrum. Secondary level science education prepares the students to develop all the three areas i.e. psychomotor, cognitive and affective domains in order to understand the phenomena present in their physical environment. Learning science also helps in developing socially acceptable behavior. Positive responses towards learning, area of subject, and methods of teaching are vital for the students as they strongly influence the process of learning, and the utilization of the concepts gained in the past, but also to find out future possibilities (Safdar, 2007).

The major problems prevailing in the fabrics of education and training provided today are caused by the instructive paradigms used today. In most of the cases, they lack the demands of twenty first century's individuals and their social set up. Therefore, the focus of constructivist framework is the context or the environment in which learning takes place, here, the individuals by integrating the knowledge gained in the past and at present construct unique patterns of understanding (Richardson, 2003).

In traditional teaching approaches, the pertinent decisions, for example; what to learn; in what context; what

strategies to be used; and how acquisition should be assessed are all made by a single entity known as designer (Gros, 2002). Hence, the main focus of reformation in the field of education is to explore and introduce the ways in which the students are more able to think and reflect critically. Researches done in the past indicated that students bring their individual perception of scientific concepts with them when they approach new learning situation (Postner et al., 1982; Resnik, 1983; Strike, 1983). When the learners construct their own patterns of information, it helps them to ponder the ways in which the creation and organization of these information became possible (Vighnarajah et al., 2008). The instructional model, as a teaching method is concerned about the nature of science which is based on inquiry and the way in which children learn naturally (Cavallo & Laubach, 2001). Different versions of the instructional models have been emerged on the surface of science curricula with a number of phases ranging from 4E to 5E and most recent to 7E. Settlage (2000) stated in this context that the difference in number of phases do not matter as their central goal is same.

A number of subsequent research studies indicated that the approaches which used instructional models based directions helped the pupils in better understanding of the scientific concepts; liking of science and reasoning; and to overcome their wrong interpretation of concepts related to science (Akar, 2005; Balcı et al., 2006; Boddy et al., 2003; Brown & Sandra, 2007; Cavallo & Laubach, 1997; Ceylan & Geban, 2009, Cumo, 1992; Davidson, 1989; Davis, 1978; Gang, 1995; Garcia, 2005; Kaynar et al., 2009; Klindienst, 1993; Lawson & Thompson, 1988; Lord, 1997; Marek et al., 1994; Mecit, 2006; Odom & Kelly, 2001; Purser & Renner, 1983; Renner et al., 1988; Saunders & Shepardson, 1987; Scharmann, 1991; Shadburn, 1990; Spencer & Guillaume, 2006; Wilder & Shuttlewoth, 2005).

The research studies cited above, show that it is vital to develop new strategies to meet the entire goals of biology. If the said instructional strategies are developed and used, and the teachers' passive role and students' active role is promoted by introducing teacher as a guide and facilitator, the problems stated previously can be resolved. A long list of models is available to inculcate classroom strategies. Use of an approach based on instructional model may be involved here (Johnstone & Mahmoud, 1980; Tekkaya, 2003). The current study used the 7E instructional model amended by Eisenkraft (2003).

2. Review of the Related Literature

2.1 The 7E Instructional Model

Eisenkraft (2003) stated seven salient elements: elicit, engage, explore, explain, elaborate, evaluate, and extend as the key components of the said model.
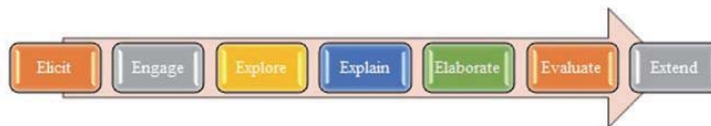
Figure 1. Eisenkraft's 7E Instructional Model (Eisenkraft, 2003)

2.1.1 Stages of the 7E instructional Model

The emphasis of tasks included in the stage of elicitation is to make students able to review their prior experiences linked with the learning situations they come across at present.

By using the tasks of engagement stage, teacher takes an attempt to grasp the interest of students and increase their attention, subsequently they get ready to learn. In this way they are motivated to build link between previous concepts and new learning situations. Hence, a logical organization in concepts formation is evident.

The focus of exploratory stage is on creating learning environment for learners which makes observation of scientific processes vivid, develop hypotheses, separate variables, record data, and pattern and organize experimental process, make graphical representation, and arrangement of final outcomes. The role of the teacher is more of a facilitator that s/he is there only to provide queries, inform about paradigms, give feedback, and measure level of comprehension.

Similarly, the purpose served by the tasks carried out during the explanatory stage is to make learners able to express the comprehension of relevant notions. Here the instructor provides guidelines to the learners regarding a broader and clear vision, facilitates them by providing new terminologies in science, and probes the areas which make the learners able to implement these items in interpretation of the findings.

The focus of tasks set for the stage of elaboration is to help learners in implementation of knowledge gained in the

past when they come across novel situation. It ranges from probing queries to formulating hypothesis for working. Learners are provided assistance regarding comprehension and skill using tasks preset for the stage of evaluation.

Tasks done during the stage of evaluation are considered by the instructors while making students' evaluation of learning on the basis of summative and formative grounds.

Successful practice in transformation of what is learnt becomes possible using tasks of extension stage (Eisenkraft, 2003).

## 2.2 Traditional Instructional Model

According to Roblyer et al. (1997), the process of learning and its outcome is less result oriented in a traditional learning environment when it is compared to an alert learning environment as the learners passively grip and retain knowledge provided by the teacher in a traditional learning environment. The teacher in a traditional learning environment persists the central figure and subsequently in the traditional instructional model. A little amount of learning takes place here though it witnesses information being transmitted (Vighnarajah, et al., 2008). While, the learning is a process of rapid development which is built on constructing individual levels of understanding about the surroundings because of particular external interactions and experiences (Ertmer & Newby, 1993).
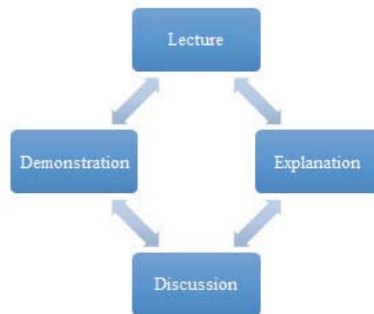
Figure 2. Traditional Instructional Model (Bülbül, 2010)

The major components of Instructional model include lectures, demonstrations and discussion, use of textbooks, strategies depending upon the explanation of teacher without taking into consideration the alternative conception of learners. Numerous studies have shown that student like to participate in a learning environment that changes into a real life like learning environment. Furthermore, traditional learning environment, makes students passive learners that only gives them a chance to retain and grasp information (Vighnarajah et al., 2008).

2.3 Conceptual Framework
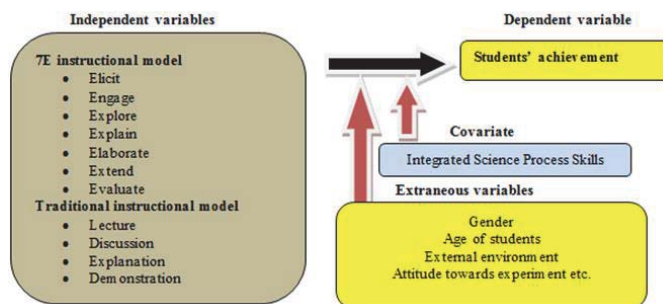
Figure 3. Conceptual framework of the study

The figure above showed the framework of entire concept. It threw light on the phenomenon in the simplest way and described the researchers' perception regarding the variables that how they built the relationship among them. The achievement of the students in biology was included in the list of dependent variables while the treatments were considered as independent variables. It was supposed that dependent variable might be affected by independent variables and would improve after the treatment. In spite of that, integrated science process skills being a covariate was taken into consideration. Different extraneous variables such as age of students, participants' attitude towards experiment, gender, and external environment were not ignored as well. For instance, Gay (2009) argued to control extraneous variables simultaneously, randomization is the best way alone. Therefore, to control extraneous variables true experimental design was used for the research.

2.4 Objectives of the Study

This study was aimed and designed;
1. To compare the effectiveness of instructions, based on 7E instructional model and traditional instructional model on students' achievement;
2. To investigate the effect of gender on students' achievement.

2.5 Hypotheses of the Study

The hypotheses of the study were:

H_01: There is no significant difference in the mean scores of students' achievements, based on 7E instructional model and traditional instructional model when integrated science process skills is to be controlled as a covariate;

H_02: There is no significant difference in the mean scores of boys and girls with respect to students' achievement when integrated science process skills is to be controlled as a covariate;

H_03: There is no significant effect of interaction between gender difference and treatment on students' achievement when integrated science process skills is to be controlled as a covariate.

2.6 Research Methodology

Following methods and strategies were adopted during the study.

2.6.1 Population of the Study

In this study, all the ninth grade students of the District Rawalpindi who opted Biology as an optional subject were defined as the accessible population of the study.

2.6.2 Sample of the Study

Two schools, Government Dennys Higher Secondary School, Rawalpindi, and Government Girls Higher Secondary School, Bagh e Sardaran, Rawalpindi, were purposively selected to conduct experiment. Random sampling technique was used for the selection of the students of both the experimental and control groups. Four classes (two boys and two girls) of grade nine, studying biology course, were selected randomly. The tabular form of the said sample is as follows.

Table 1. Sample of the study

Type of School	Experimental Group	Control Group	Total
Girls	30	30	60
Boys	31	31	62

2.7 The research design of the study

This study was designed to investigate the effectiveness of Eisenkraft's 7E instructional model. The researcher implemented pre-test post-test control group design as a type of the true experimental design during study. The systematic description of the said design is given underneath.
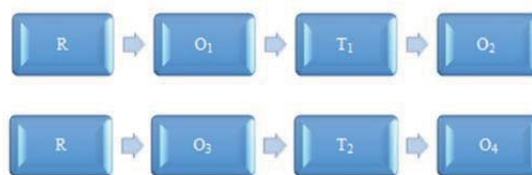
Figure 4. Research Design of the study (Creswell, 2009; Gay, 1996)

At this point

    R means "random assignment of subjects to groups",

    O_1 and O_3 stand for "Pre-tests".

    O_2 and O_4 stand for "Pre-tests".

    T_1 stands for "treatment with the 7E instructional Model".

    T_2 stands for "treatment with Traditional instructional Model".

    The experimental groups received instructions based on 7E instructional model while in the control groups, instructions were given using traditional instructional model. A male and a female teacher having same qualification (M. Sc. Biology and B. Ed) and experience (Five Years) in the selected schools played the role of instructors. Prior to implement the treatment the teachers were told about the aims and objectives of the research, and made acquainted by both traditional instructional model and the 7E instructional model. The research was spread over eight weeks. There were forty- minute teaching sessions per day for both the groups. In order to test the elements of objectivity and related criteria such as groups' academic achievements in a section of ninth grade Biology course i.e. "Life and Biodiversity", the students of both the groups (Control and Experimental) were administered Integrated Science Process Skills Test (ISPST), and Subject Achievement Test (SAT) as pretests (Table 2 describes research design adapted for the study).

Table 2. Research Design and Instruments

Groupings	Pre-tests	Treatments	Post-test
Control and Experimental Group	SAT ISPST	7E instructional model and Traditional Instructional Model	SAT

SAT = Subject Achievement Test
ISPST = Integrated Science Process Skill Test

2.7.1 Instruments

The researcher used a teacher made Subject Achievement Test (SAT) and Integrated Science Process Skills Test (ISPST) developed in 2005 by Monica, after taking permission of the author as the research instruments.

2.8 Data Analysis and Results

This section represents the results based on the analysis of data.

2.8.1 Pre-test Scores

2.8.1.1 Subject Achievement Test (SAT)

Table 3. Descriptive Statistics: Pre-SAT scores

Group	N	Min	Max	Mean	SD	Skewness	Kurtosis
Control	61	4	21	11.03	3.903	0.508	1.015
Experimental	61	4	21	11.03	3.903	0.580	1.015

According to the Table 3 there was no difference in students' mean scores with respect to both experimental group

(M=11.03, SD=3.903) and control group (M=11.03, SD=3.903). It authenticated that the students' distribution was equal in both the groups (Result 1).

Table 4. *t*-test: Pretest scores of SAT

	Equality of Variances by Levene's Test		Equality of Means by t-test		
	F	Sig.	t	df	p
Equality of variances assumed	0.000	1.000	0.000	120	1.000
Equality of variances not assumed			0.000	120	1.000

Table 4 represented the conclusions drawn on the basis of independent sample *t*-test analysis of pre-test scores of Subject Achievement Test (Pre-SAT). Equality of Variances by Levene's Test expressed vital results so equal variances were supposed. The results of the independent sample t-test showed no significant mean difference with respect to students' subject achievement test of the control group (M=11.03, SD=3.903) and experimental group (M=11.03, SD=3.903), (*t* (120) = 0.000, *p* = 1.000) before the treatment (Result 2).

2.8.1.2   ISPST and justification of using ISPST as a covariate

Table 5. Descriptive Statistics: ISPST

Group	N	Min	Max	Mean	SD	Skewness	Kurtosis
Control	61	10	25	16.07	3.820	0.306	-0.873
Experimental	61	13	25	18.33	3.198	0.248	-0.764

According to the Table 5 students in the experimental group (M=18.33, SD=3.198) had more skills to solve a scientific problem as compare to the students of control groups (M=16.07, SD=3.820) (Result 3).

Table 6. *t*-test: Scores of ISPST

	Equality of Variances by Levene's Test		Equality of Means by t-test		
	F	Sig.	t	df	p
Equality of variances assumed	1.287	0.259	-3.547	120	0.001
Equality of variances not assumed			-3.547	116.389	0.001

Table 6 represented the conclusions drawn on the basis of independent sample *t*-test analysis of Integrated Science Process Skills Test (ISPST) scores. Equality of Variances by Levene's Test expressed vital results so equal variances were supposed. The results of the independent sample t-test showed no significant mean difference with respect to students' Integrated Science Process Skills Test (ISPST) scores of the control group (M=16.07, SD=3.820) and experimental group (M=18.33, SD=3.198), (*t* (120) = -3.547, *p* = 0.001) before the treatment. To control differences existing already in the statistical analysis, students' integrated science process skills test (ISPST) was decided to be used as a covariate (Result 4).

2.8.2 Post-tests for testing Null Hypotheses

The section presents the testing of null hypotheses. To test the hypotheses, ANCOVA and t-test were used.

2.8.2.1 $H_0$1: Students' Achievements: 7E instructional model and traditional instructional model

As the first null hypothesis asserted whether significant difference was found in students' achievements, based on 7E instructional model and traditional instructional model when Integrated Science Process Skills was controlled as a covariate. The first null hypothesis was tested using ANCOVA. Assumptions pertinent to ANCOVA were tested before the implementation of analysis progressed. Since all the necessary assumptions of the ANCOVA were fulfilled, a summary of the results deduced by ANCOVA are shown in Table 8.

Table 7. ANCOVA: Post-SAT scores of Control and Experimental Groups

Source	df	F	p
ISPST	1	2.382	0.125
Group	1	54.227	0.000
Error	119		

The results (F (1, 119) = 54.227, p = 0.000) pointed out that there was a significant mean difference between post mean scores of students' achievements, based on 7E instructional model and traditional instructional model when integrated science process skills was controlled as a covariate. The experimental group (N = 61, M = 16.62, SD = 3.967) scored on significantly higher level as compare to experimental group (N = 61, M = 22.11, SD = 3.416) (Result 5).

2.8.2.2 $H_0$2: Students' Achievements: Boys and Girls

According to the second null hypothesis stated previously, there is no significant difference in the mean scores of boys and girls with respect to students' achievement while Integrated Science Process Skills was controlled as a covariate. This very hypothesis was tested using ANCOVA. As done in case of first hypothesis, assumptions pertinent to ANCOVA were tested before the implementation of analysis progressed. Since all the necessary assumptions of the ANCOVA were fulfilled, a summary of the results deduced by ANCOVA are shown in Table 8.

Table 8. ANCOVA: Post-SAT scores of boys and girls

Source	df	F	p
Gender	1	5.832	0.017
ISPST	1	13.566	0.000
Error	117		

According to the results (F (1, 119) = 5.832, p= 0.017) of Table 8, there was a significant difference in the mean scores of boys and girls in terms of their achievement while integrated science process skill was controlled as a covariate. The girls (N=60, M=20.15, SD=4.4441) scored significantly better as compare to the boys (N=62, M=18.61, SD=4.667) (Result 6).

2.8.2.3 $H_0$3: Students' Achievements: Gender and treatments

According to the third null hypothesis, there is no significant effect of interaction between gender difference and treatments on students' achievement while Integrated Science Process Skills was controlled as a covariate. This very hypothesis was tested using ANCOVA.

Again, assumptions pertinent to ANCOVA were tested before the implementation of analysis progressed. Since all the necessary assumptions of the ANCOVA were fulfilled, a summary of the results deduced by ANCOVA is shown in Table 9.

Table 9. Students' achievement: Gender difference and treatments

Source	df	F	p
ISPST	1	3.940	0.049
Group	1	54.089	0.000
Gender	1	6.782	0.010
Group*Gender	1	0.435	0.511
Error	117		

The results (F (1, 117) = 0.435, p= 0.511) pointed out there was no significant effect of interaction between gender difference and treatment on students' achievement level while integrated science process skill was controlled as a covariate (Result 7).

3. Conclusions

Conclusions drawn on the basis of above findings are as under:

1. No difference in the mean scores of pre-test in students' subject achievement test (Pre-SAT) in both the control group and experimental group was witnessed. This means that both the groups consisted of equal distribution of students, in addition, the data was distributed normally (Results 1 & 2).
2. Subjects (treatment group) persisted more skills regarding solution of the problems which they came across as compare to the students of control groups, in addition, the data was distributed normally (Results 3 & 4).
3. A meaningful gap between post-test average scores of students' achievements, based on 7E instructional model and traditional instructional model was witnessed while students' Integrated Science Process Skill was controlled as a covariate. The experimental group significantly showed better scores than the control group (Result 5).
4. A meaningful change was witnessed in the average scores of boys and girls with respect to students' achievement. The girls obtained significantly higher scores than boys (Result 6). Whereas students' skill of process in science was kept under control being a factor of variation.
5. Absence of meaningful impact as a consequence of interaction between difference in gender and experiment on learners' achievement was witnessed. Whereas students' integrated science process skill was controlled as a covariate (Result 7).

4. Discussions

Roblyer, et al. (1997) asserted that the process of learning along-with its outcome is more result oriented in an environment which is active as compare to the traditional environment of learning which is passive. Santrock (2001) echoed the similar notions. He thought that learning attains its peak if learners are fully involved in building the foundations of information and comprehension, put in other words, learners are required to participate with agility when it comes to question about how to learn and teach. Subsequently for searching, thinking, and reflecting deeply about facts and figures which they come across. According to Sunal & Sunal (2003) Strategies involved in investigative teaching consider developmental levels of students and make them able to use the knowledge they acquired in the past when learning new ways of thinking, development of better level in it, and a knowledge about logical power. According to the statistical analysis results cited previously, it became evident that 7E instructional model produced significantly better acquisition level of students' achievements than traditional instructional model. While analysis of Post-SAT results also strengthened the claim. One question is still there to answer which was raised as a result of a research study that teachers remained indecisive about the selection of one or more stage of instructional model based on 7E needed application (Yenilmez & Ersoy, 2008), however, there are other evidences that support the effectiveness of the instructions based on instructional models (Bybee et al., 2006; Perrier & Nsengiyunva, 2003; Sasmaz & Tezcan, 2009).

One of the purposes of the research centered on the investigation of any meaningful change is based on gender difference regarding academic achievements. Different research studies had shown that gender difference plays a vital role in acquisition of scientific concepts, for instance, a research claimed significant gender difference (Cavallo et al., 2004). In 1994, Fraser and Young found meaningful change in boys' success rate in biology when seen in the perspective of gender differentiation. On the other hand, Soyibo (1999) viewed that girls' performance level was on higher level when tested for identification of mistakes in giving labels (biology). Alparslan et al. (2003) conducted an experimental research. Their research unfolded potential difference produced by varied methods of experiment (for instance, one instruction based on change in concept whereas another based on tradition) when measured in the perspective of differentiation in gender. During the said research, subjects selected were studying at grade eleven. The subsequent assessment of comprehension was obtained by the topic of "Respiration". When the outcomes of male and female subjects were compared for "Genetics", there was no visible gap to be found (Doğru and Tekkaya, 2008). Likewise, no gender differentiation was found when Jamacian learners at grade eight were assessed for the notions regarding the topics of "Nutrition" and "Reproduction in Plants" (Ugwu and Soyibo, 2004). Moreover, similar findings were attained in the studies of other researchers (Azizoğlu, 2004; Bülbül, 2010; Dimitrov, 1999; Hupper et al., 2002; Shepardson & Pizzini, 1994; Thompson & Soyibo, 2002).

5. Recommendations

The central aim of teaching science today is to promote purposeful addition into the knowledge. To meet this goal it is

pertinent to bridge the gap between novel thoughts and past information. This ability helps the learners to grasp the comprehension of new materials and then use it for explanation of situations, they are supposed to face. Thereupon, teachers should take care of the information level of the students gained in the past enhance purposeful learning process. According to the findings of this study, 7E instructional model proved a better one in scientific training of the students.

Promotion of purposeful addition into the knowledge has established its status as a kind of methodology based on instructions. Therefore, instructions which make students able to connect and transfer information and visualize events by implementing the 7E instructional model and prevent formation of delusions may help students to get rid of these problems. Therefore, the strategy of inquiry teaching considers students' developmental levels and makes them able to use their prior knowledge as they gain new thought processes, develop higher levels of thinking, and became known to their own reasoning. Consequently, science curriculum planners, textbook setters and finally the teachers should be aware of the role of the 7E instructional model in science education. Therefore, teachers can pattern their instructions in a way that it is not going to create new misconceptions. Moreover, school administrations or ministry of national education are encouraged to arrange teachers' seminars and training workshops about 7E instructional model, where teachers are provided chances to improve their personal skills. Additionally, school administrations are advised to use their influential role in making their teachers ready to attend these programmers.

In understanding science education, science process skills of students are highly effective. So, teachers and parents should provide chances to their pupils to improve the said skills. Curriculum developers and administrators must try to implement the 7E instructional model to develop scientific thinking among the students.

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