Teaching of Physics with Physics Suite on the Achievement of Secondary Students

Salma Akhtar[*], Hafiz M. Irshadullah[**], Hafiz M. Inamullah[***], and Muhammad Tariq[****]

Abstract

Teaching of Physics with Physics Suite describes a variety of tools for improving both teaching and learning, including new kinds of homework and exam problems. The major objectives of the study were to examine: (i) the relative effects of teaching Physics with Physics Suite instruction on the academic achievement; (ii) the difference between treatment effects for the students of high and low level of achievement. To achieve the objectives of the study nine null hypotheses were tested. The students of 9th class of the Islamia Collegiate School Peshawar School were selected as sample of the study. Sample students were divided into two groups i.e. experimental group and control group on the basis of previous results by applying pair random sampling. The students of experimental group performed significantly better than control group on the post-test which proved that teaching of physics with the physics suite was more effective than the traditional method of teaching physics. It is recommended that new techniques may be adopted for the promotion of teaching Physics for the best interest of the students.

Keywords: Teaching, Physics, Physics Suite, Secondary students.

Introduction

Physics being the study of matter and energy is considered to be an international enterprise which plays a key role in the progress of mankind. The support of physics education and research in global perspective is important because physics is an exciting intellectual adventure that inspires the youth and expands the frontiers of our knowledge about nature. It generates fundamental knowledge required for the future technological advancements. Physics, by

[*] Salma Akhtar, Principal, (E & SE) Department, Khyber Pakhtunkhwa

[**] Hafiz M. Irshadullah, Assistant Professor of Education, Abdul Wali Khan University, Mardan

[***] Hafiz M. Inamullah, Associate Professor of Education, IER, University of Peshawar

[****] Muhammad Tariq, Assistant Professor of Economics, Abdul Wali Khan University, Mardan

contributing to the technological infrastructure, provides trained manpower required to benefit from scientific advances and discoveries. Physics is also considered to be an important element in the education and training of chemists, engineers and computer scientists as well as practitioners of other physical and biomedical sciences.[1] Physics helps in extending and enhancing our understanding of other disciplines such as earth, agricultural, chemical, biological and environmental sciences. Finally, physics improves our quality of life by providing the basic knowledge essential for developing new instrumentation and techniques for medical applications such as computer tomography. For all these reasons physics is an essential part of any education system of any society in the world. The world is passing through an age of nuclear advancement and physics is an integral part of nuclear technology. Such type of situation has made the need of physics manifold and requires special attention to be devoted for its effective instruction in our institutions in general and institutions of secondary level in particular. Unfortunately a significant number of institutions providing secondary level educations remain without physics laboratories and the training of physics teachers carries a big question mark about their education and training. There are many methods of teaching science at secondary level and the conceptual nature of physics has made two methods very popular in Pakistani situation. These are (i) project-based instruction; and (ii) instruction through lectures. Project-based instruction emphasizes students' learning on real life practice, whereas instruction through lectures relies on introducing new and complicated information through chalk and talk method. In both cases the instructor must make extensive preparations in advance to ensure the maximum level of student learning with the hope that students will use different skills to interact with information. No doubt the project-based instruction allows for more hands-on interaction for students than the traditional classroom and is considered to be the best for higher levels of secondary school students who can work individually. But due to negligence on the part of instructors and lack of hard work and interest by the learners the project-based instruction could not gain popularity in the institutions of the country. Instruction through lecture is considered to be the very popular strategy to avoid hard work complete the stipulated curriculum well in time. It is above board that the lecture-based instruction is never implemented in true letter and spirit.[2]

The major objectives of the study were:

i). The relative effects of teaching Physics with Physics Suite instruction on the academic achievement.
ii). The difference between treatment effects for the students of high and low level of achievement.

To achieve the objectives of the study following null hypotheses were tested:

i). Overall achievement of the students taught Physics with the Physics Suite strategy (experimental group) and without Physics Suite (control group) does not significantly differ on previous achievement test.
ii). Mean scores of high achievers of experimental and control groups do not significantly differ on previous achievement test.
iii). Mean scores of experimental group and control group do not significantly differ on post-test.

Significance of the Study

Keeping in view the importance of physics in this age of nuclear technology the study is considered to be significant because it's finding and conclusions may encourage the teachers to teach Physics with Physics Suite. It may also motivate the educational administrators and supervisors to promote the teaching of Physics with Physics Suite through motivating the teachers responsible for teaching physics in secondary schools.

Review of Literature

Physics in Cultural Perspective

The physicists are of the opinion that with all its doubts and uncertainties the physics is the most marvelous creation of the human imagination, a creation capable of filling an active life with meaning.[3] Perhaps physics by itself cannot answer the great questions of human existence because the physics is ethically neutral, although the physicist is not. Even then the physicist is convinced that although no ethical categories are applicable to theories about the physical universe, aesthetic ones certainly are. There should be no hesitation in saying that the usefulness of the sciences takes precedence over all other arguments in their favor. Everywhere in the world the planning documents; and the print media and electronic media support the implementation of scientific discoveries. In global perspective, even scientific institutions involved exclusively in basic research justify their

existence with claims that the results of their work will sooner or later find practical application. There is no doubt about it that the current state of the world economy, the usefulness of a scientific result is indeed of paramount importance, especially in the highly developed societies.

Methods and Strategies of Teaching Physics

Nobody can deny the importance of Physics, even then there are a number of observable problems plaguing the teaching and learning of the subject, especially at the secondary school level. These problems include lack of teaching resources and poor method of instruction.[4] This is supported by the assertion of Osokoya, Isreal Olu that attributed the deterioration in students' achievement in Physics to ineffective method of teaching Physics.[5] These perhaps may not be the only reasons for students' poor academic performance in the subject both at the secondary and tertiary levels. Based on this deplorable trend of poor performance, some prominent Physics educators have designed some instructional strategies over the years to curb the problem of underachievement in the subject. For example, Problem-Based learning for better achievement, problem solving and line graphing skills in Physics.[6]

Generative Instructional Strategy

Generative Instructional Strategy is a step-by-step instructional program, which is based on learners' views and experiences in active classroom activities.[7] It is a learner-centred approach whereby pieces of information retrieved from learners' memories on a particular concept, are explained and modified by learners themselves.[8] Generative Instructional Strategy allows for individualized form of learning and empowers learners with the ability to express their personal views. Learners are at the centre of the learning process while teachers are facilitators.[9] The major idea of Generative Instructional Strategy is that learners must not only make connection between the content being taught and his prior knowledge but also re-organize them for meaningful explanation. Generative Instructional Strategy is therefore, a model of teaching for comprehension.

i). Introductory Phase: The facilitator introduces learners to the task they are going to accomplish. He/she then divides them into different activity groups. Necessary materials are supplied to each group and the assigns learners are assigned specific tasks to be performed. The facilitator also exposes them to the concepts to be learnt and

familiarizes learners with the processes and methods of Generative Instructional Strategy.

ii). Focusing Phase: The teacher being a facilitator presents the problem area to the learners. Learners are then supposed to recall information and ideas from their memories as well as experiences on the problem presented.

iii). Activity Phase: Every learner in a group is involved in performing diverse activities. This includes carrying out some demonstration as well as performing some practical activities through following some procedural steps provided by the facilitator.

iv). Discussion Phase: Learners discuss the results of the activities performed in their respective groups. The facilitator guides learners to provide correct answers to their misconceptions where applicable. Results are then summarized by each group.

v). Application Phase: Learners present their summarized results to the whole class. They are also expected to apply the new knowledge acquired to other similar or related situation with the assistance of the facilitator.[10]

Teaching Physics by Inquiry

The Physics by Inquiry program for secondary science teachers was established in order to improve the quality of science teaching in secondary schools by encouraging science teachers develop and implement inquiry approach in their classrooms.

Training Teachers to Teach Science by Inquiry

The inquiry approach used to train the science teachers is based on the following steps:

i). Select science concepts/contents to teach the teachers.

ii). Select a traditional science laboratory activity as used in state-funded schools with their students.

iii). Discuss the laboratory activity with teachers. Draw questions about the activity, rather than having merely 'cookbook' activities as is customary with their own students when teaching laboratory activities that are usually called paper labs.

Teaching Physics through Concept Maps

The concept map is may be explained as a graphic organizer which uses schematic representation to hierarchically organize a set of

concepts, connected by means of words in order to build meaningful statements. Showing meaningful relationships between concepts in the shape of propositions, the concept map reveals each student's comprehension and knowledge structure.[11] The negotiation of ideas among students, on the basis of the concept mapping individually and/or by groups, particularly when it finally is conveniently monitored by the teacher in the class-group, helps them deepen the meaning of the knowledge upon which the maps were built. "Concept mapping is a way to help students and educators see the meanings of learning materials."[12]

Teaching Physics with the Physics Suite

The philosophy behind the introduction of physics suite is to shift the teaching of physics in social and psychological perspectives. The traditional approach of teaching physics was result oriented and could not attract the students to physics as subject. The new approach of teaching the subject according to the social and psychological needs has increased the popularity of the subject. With the increasing shift in the emphasis of physics instruction to a service course preparing scientists and engineers who will not necessarily become physicists, there is a need to shift the attitude attributed to success in the subject.. For that purpose the teaching should be based on the following principles:

i). Associative learning plays a vital role under this principle. Knowledge is built by making connections to existing knowledge; the individuals use this knowledge by productively creating a response to the information they receive. The most important thing is what the students actually do.

ii). Mental states of the people have significant role what they construct depending on context.

iii). If something matches or extends an existing schema, it is easy to learn. If the schema is changed the learning becomes difficult.

iv). As each individual constructs his or her own mental structures, different students have different mental responses and different approaches to learning.

v). Social interactions play a key role in carrying out effective learning. This is the social component of model.

Using the Suite in Recitation Sections: Tutorials

In Suite tutorials create a curricular environment for delivering active conceptual development in recitation sections. They have a

tight, carefully guided group-learning structure similar in feel to the Real-Time Physics labs or the Interactive Lecture Demonstrations. They are based on research on student difficulties and make frequent use of both cognitive conflict and bridging. An extensive set of Tutorials has been developed by the University of Washington Physics Education Group covering a wide range of topics from kinematics to physical optics. These Tutorials are designed to be usable in environments without computer tools, so they make almost no use of computer-assisted data acquisition or video. A supplementary set of tutorials using computer technology including computer-assisted data acquisition, video display and analysis, and simulations, are available as part of the Suite [ABP Tutorials]. Tutorials have been shown to be effective in improving concept learning compared to classes with traditional recitations.

Method and Procedure

Population and Sample

All the 9th class secondary school students in Khyber Pakhtunkhwa were the population for this study. The students of 9th class of The Islamia Collegiate Peshawar (an English Medium Section), were selected as sample of the study.

Research Instruments

A teacher-made test was developed as instruments of the study, i.e. post-test.

Collection of Data

In order to secure data a previous achievement scores of the sample students were obtained. The sample students of experimental and control groups were equated on the bases of their previous scores. A teacher-made test was given to the sample as post-test, immediately after the teaching was over. The purpose of this test was to measure the achievement of the students constituting the sample of the study. The same test was re-administered as retention test to see the effectiveness of independent variable in helping the subjects to retain acquired knowledge for a longer period

The achievement scores of the sample on post-test were obtained. The means, standard deviations, differences of means were computed. To see the treatment effects for the students of high and low levels of intelligence, the factorial design (2x2). For this purpose the students of both groups were divided into two

halves, i.e. high achievers (above the mean score) and low achievers (below the mean score). This division was made on the basis of scores on previous achievement test. For statistical analysis the formulae followed by Garrett and Gay were applied.[13]

Analysis and Interpretation of Data

The main purpose of this study was to investigate the effect of teaching physics with physics suite on the achievement of secondary school students. The analysis and interpretation of data obtained from the school record and through posttest is being analyzed and interpreted in this chapter. In the subject of physics the previous achievement scores were obtained from the school record to equate the groups.

Ho_1: Mean scores of experimental and control groups do not significantly differ on previous achievement test

Table 1: Overall comparison of experimental and control groups on previous test.

Comparison Group	N	M	SD	T	P
Control	20	61.75	5.09	0.089	0.93
Experimental	20	61.60	5.56		

Table 1 shows that on previous test, calculated value of t was0.089 with $p>0.05$. Hence there was no significant difference between mean scores of control and experimental groups on previous test. Therefore, the groups could be treated as equal and the null hypothesis, "Mean scores of experimental group and control group do not significantly differ on previous achievement test", is accepted.

Ho_2: Mean scores of low achievers of experimental and control groups do not significantly differ on previous achievement test.

Table 2: Comparison of low achievers of experimental and control groups on previous test.

Comparison Group	N	M	SD	T	P
Control	11	57.91	3.02	0.129	0.898
Experimental	11	57.73	3.55		

Table 2 reflects that in the comparison of low achievers of control

and experimental groups, the value of t was 0.129 with p> 0.05. Thus low achievers of control and experimental groups had no significant difference in mean scores on previous test. Hence, could be treated as equal and the null hypothesis, "Mean scores of high achievers of experimental and control groups do not significantly differ on previous achievement test", is accepted.

Ho_3: Mean scores of high achievers of experimental group and control group do not significantly differ on previous achievement test.

Table 3: Comparison of high achievers of experimental and control groups on previous test

Comparison Group	N	M	SD	t	P
Control	9	66.44	2.24	0.081	0.936
Experimental	9	66.33	3.43		

Table 3 indicates high achievers of control and experimental groups had no significant difference between their mean scores on previous test as calculated value of t was 0.081 with p>0.05. Thus high achievers of control and experimental group were at the same achievement level before treatment. Hence, the null hypothesis, "Mean scores of low achievers of experimental group and control group do not significantly differ on previous achievement test", is accepted.

Table 4: Post-Hoc test showing significance of difference between mean scores of different pairs of comparison groups on retention test.

Comparison groups		Mean difference (I-J)	S.E.	p
Achievement level (I)	Achievement level (J)			
Cont. High Achievers	Cont. Low achievers	15.03*	1.84	.000
	Exp. High Achievers	-5.55	1.93	.057
	Exp. Low Achievers	-1.24	1.84	.928
Cont. Low achievers	Cont. High Achievers	-15.03*	1.84	.000
	Exp. High Achievers	-20.58*	1.84	.000
	Exp. Low Achievers	-16.27*	1.74	.000
Exp. High Achievers	Cont. High Achievers	5.55	1.93	.057
	Cont. Low achievers	20.58*	1.84	.000
	Exp. Low Achievers	4.31	1.84	.160
Exp. Low Achievers	Cont. High Achievers	1.24	1.84	.928
	Cont. Low achievers	16.27*	1.74	.000

	Exp. High Achievers	-4.31	1.84	.160

**Significant*

Table 4 shows there was a significant difference ($p<0.05$) between the mean scores of the pairs low achievers of the control group and low achievers of the experimental group (mean difference=-16.27, p=0.00), low achievers of the control group and high achievers of the control group (Mean difference=-15.03, p=0.00), and low achievers of the control group and high achievers of the experimental group (Mean difference=-20.59) at 0.05 level of significance. However, the pairs low achievers of the experimental group and high achievers of the experimental group (Mean difference=4.31, p=0.16), low achievers of the experimental group and high achievers of the control group (Mean difference=1.24, p=0.928), and high achievers of the experimental group and high achievers of control group (Mean difference=5.56, p=0.057) had no significant difference ($p>0.05$) between mean scores on retention test. Hence the treatment proved to be more effective for low achievers of experimental group as compared to the high achievers of the experimental group.

Discussion

In this study, pre-test post-test equivalent design was used as research design for experiment. Before treatment, experimental and control groups were equated through pair random sampling on the basis of their previous scores in Physics in the last annual examination. For treatment, the experimental group was taught using Physics Suit for a period of six weeks. After treatment, the post-test was administered on experimental and control groups. Again the same test was administered after a period of four weeks in order to measure retention of the learnt material for both experimental and control groups.

Conclusions

Following conclusions were drawn on the basis of statistical analysis and the findings of the study:

- The students of experimental group performed significantly better than those of control group on the post-test which proved that teaching of physics with the physics suite was more effective than the traditional method of teaching physics to secondary school students.
- Students of high achievement level who were taught

physics with physics suite performed significantly better than those who were taught through traditional approach on the post-test.

- Significant difference was also found between the performance of low achievers of experimental group and control group on previous test.

Recommendations

On the basis of findings of the study and conclusions drawn, following recommendations are made:

- Teaching of physics with physics suite has proved its worth through this study; therefore, a well-equipped computer laboratory with internet facilities should be established in each school where physics is being taught as an elective subject.
- Concepts related with teaching of physics with physics suite be incorporated in the teacher education curriculum for pre-service teacher education and for teacher already in the system, in-service courses should be arranged and such type of training be made obligatory for physics teachers.

Notes and References

[1] Julie A. Bianchini and Alan Colburn, "Teaching the nature of science through inquiry to prospective elementary teachers: A tale of two researchers", *Journal of research in science teaching* 37, no. 2 (2000): 177-209.

[2] Jay Lemke, "Multimedia literacy demands of the scientific curriculum", *Linguistics and education* 10, no. 3 (1998): 247-271.

[3] Károly Simonyi, *A cultural history of physics* (n.p.: CRC Press, 2012).

[4] M. S. Kalijah, "Education, training and careers in Physics for women in Malaysia". In *IUPAP International Conference on Women in Physics UNESCO* (2002).

[5] Isreal Olu Osokoya, "Effects of video-taped instruction on secondary school students' achievement in history", *International Journal of African & African-American Studies* 6, no. 1 (2009): 88-93.

[6] T. O. Iroegbu, "Problem based learning, numerical ability and gender as determinants of achievements problems solving line graphing skills in senior secondary physics in badan", (PhD. diss, Ibadan: University of Ibadan, 1998); See also: A. B. Orji, "Effects of problem-solving and concept mapping instructional strategies on students' learning outcomes in Physics" (PhD. diss, University of Ibadan, 1998).

[7] Merlin C. Wittrock, "Generative learning processes of the brain", *Educational Psychologist* 27, no. 4 (1992): 531-541.

[8] Jeanne Ellis Ormrod, *Educational psychology* (n.p.: Pearson Higher Ed, 2013).

[9] T. A. Ige, "A problem solving model for bridging the gap between theory and practice in science teaching", *African Journal of Educational Research* 9, no. 1&2 (2003): 147-155.

[10] B. O. Ogunleye and V. F. T. Babajide, "Generative instructional strategy enhances senior secondary school students' achievement in physics", *European Journal of Educational Studies* 3(3), 2011.

[11] Gregor M. Novak, Evelyn T. Patterson, Andrew D. Gavrin, Wolfgang Christian, and Kyle Forinash, "Just in time teaching", *American Journal of Physics* 67, no. 10 (1999): 937-938.

[12] Ibid.

[13] Henry Edward Garrett, *Statistics in psychology and education* (n.p.: Longmans, Green and Company, 1951); See also: Lorraine R. Gay,vGeoffrey E. Mills, and Peter W. Airasian, *Educational research: Competencies for analysis and applications* (n.p.: Pearson Higher Ed, 2011).