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The Effect of Activity-Based Teaching on Students' Academic Achievements in Physics At College Level

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Abstract

The aim of this study was to investigate the effect of activity- based teaching on the student achievement in Physics at College level. Ten (10) chapters were selected from 11th grade Physics for this study. All the science students at Colleges of KpK, studying Physics at the 11th grade, constituted the population. A sample of 60 students was randomly selected from Govt College Peshawar. Pre-test-Post-test Control Group Design" of experimental research was selected for this research study. Two MCQs type achievement tests were used as research tools for the data collection. Experimental group was taught with the help of activities whereas the control group was taught the same lessons through traditional method of teaching for the period of two (2) months. T-test was used to analyze the data by using SPSS version -16. The results showed that the activity- based teaching is more effective for the development of higher order skills in the students.

Keywords: First year physics, Activity based learning, Academic achievements, cognitive skills

Introduction

(ABL) Activity-based learning defined by Prince (2018) is a learning method in which students are engaged in the learning processes. All European citizens appreciate the significance of science and want to be more informed about science education. Over 40 % of population believe that science Education and technological innovation can have a positive

effect on the environment, better health and personal empowerment, dynamic engagement in public affairs and society, and improve employability and basic infrastructure in the future (Shah. K, 2019). In Activity-based learning (ABL) teaching method, in the words Panko Kenley (2007) "students actively participate in the learning experience rather than sit as passive listeners". Learning activities if based on "Real life experience" help learners to transform knowledge into their personal knowledge which they can apply in different situations (Edward, 2001). Davies, (2007) by quoting Prince (2004) say that active learning method is different from traditional method of teaching on two points. First, active role of students and second, collaboration among students. Suydam, Marilyn and Higgins (1977) define activity –based learning as the learning process in which "student is actively involved in doing or in seeing something done." According to them Activity –Based teaching (ABT) method "frequently involves the use of manipulative materials". Meaningful learning, according as Churchill (2003) engages activity. According to Churchill (2003), ABL helps learners to „construct mental models that allow for 'higher-order' performance such as applied problem solving and transfer of information and skills. In ABL the learner examines learning requirements and thinks how to solve a problem in hand. The students do not learn about the content. Rather they learn about the process to solve the problem. As they go towards the solution of the problem, they also learn about the content (Curchill 2003). Effective teaching –learning process is not possible without students‟ motivation. Hake (1998) argues that students‟ motivation by engaging them in interactive- activities is an effective and useful method for teaching complex concepts. He highlights the importance of different activities related to the concepts being presented. Activity-based learning (ABL) theory is a cognitive-learning theory which is basically a "constructivist" learning theory (Hein, 2009).

In an "active-learning classroom," students are active learners not the passive receivers. According to Stößlein (2009) this approach provides a way to integrate learning within students‟ knowledge, and, by exposing them to a variety of activities, helps them learn how to learn. He describes ABL as a "successful teaching model" in the field of science. These activities, if carried out in an effective manner, develop skills like Team-working, Communication, Design, Leadership, Project management, Research, Problem-solving, Reflection and Life-long learning in the learners. These activities, if based on the real life experiences, can help students to apply the same in their practical life and hence prepare students for future life. In activity –based teaching /learning environment, the teacher is a facilitator, motivator, guide, and a coach not a sage on the stage (Stolen 2009)). There is a famous saying of Confucius about the success of the students‟ learning that is given below.

"Tell me, and I will forget, Show me, and I may remember, Involve me, and I will understand."

According to Chickering & Gamson (1987) "students must talk about what they are learning, write about it, relate it to past experiences, and apply it to their daily lives. They must make what they learn part of themselves". Students' motivation is high if these

activities are personally relevant to them. There is research evidence which shows that students will retain limited knowledge if they are involved passively in teaching- learning process (McKeachie, 1998). The same is indicated in the 'Dale's cone of experience' developed Dale (1969) shown below. Learning activities provides opportunities for experiential learning which involves links between the thinking and the doing. It is assumed that students who handle the learning activities successfully have learnt the concept to perform that particular activity (Marx, 2005).

Review of Literature

There are mixed findings of different researchers about the effectiveness of ABL. Higgins (2017) reached on the conclusion that ABL in elementary mathematics is more effective than traditional method of teaching. According to Brophy (2000) students learn concepts in depth if these concepts are learnt in a different context which may include classroom lecture, laboratory experiments, textbook readings etc. Moreover, they can apply this knowledge in novel situations in a better way. To familiarize students with scientific knowledge is one of the aims of science teaching (Smith, 2013) so they can apply this knowledge in problem solving situations. Science is more than collecting and manipulating data or memorizing knowledge.

Shah Kiramat & A. Nazir (2019) emphasize, that the promotion of the science education at university stage in rural population and organize training program for the in - service science teachers on the same spot a mobile science laboratory must be developed by the government. For the promotion and development of science education national seminars, meeting and working session and conferences would be organized. But due to lack of financial inputs and efforts some of the targeted proposals were implemented in that time and maximum of the given proposal delayed. Also, in different areas of science subjects, scholarship programmes were announced and under the limitation of University Grant Commission science fairs were established. With the collaboration of foreign organization different developmental works occur that is Pakistan Science Foundation.

According to National Research Council (1996), it is "a process of inquiry that requires asking questions, observing, data exploration and data manipulation. It requires learning to apply and generalize scientific knowledge". Creating such learning environment requires engaging learners in different activities. Active engagement in learning activities develops conceptual understanding and motivates students to seek further information (Brophy, 1995).

Hake (1998) found that ABL significantly improves conceptual understanding of the students in a physics class. Magno, et al. (2005) reached on the conclusion that "the classes receiving the PBL activity on memory had significantly higher performance accuracy in the test and had higher attitude as compared with the other classes who received instruction through traditional method". While conducting research on teaching experimental economics

for high schools, Brock and Lopus (2004) concluded that "ABL do a good job of satisfying the conditions sufficient for economic experiments".

Wong (2000) view that traditional teaching approaches do not encourage learners to associate with previously acquired knowledge. On the other hand, Boud(1999) remarked that activities -based learning encourage students to „learn how to learn" through different activities and real-life problems. Effectiveness of ABL to facilitate self-directed learning and problem-solving skills is well documented in medical education (Barrows and Tamblyn, 1980; Schmidt, 1983), in higher education and K–12 education settings (Hmelo-Silver, 2004).

Hussain, et al. (2011) reached on the conclusion about the effect of activity-based learning (ABL) that ABL is more effective to teach physics at secondary level as compared to traditional method of teaching. However, Lieux, (2001) and Zumbach et al. (2004) found no significant difference in knowledge acquisition between students who learned through ABL method and who learned through traditional method of teaching. Doucet et al. (1998) and Blake et al. (2000) found that students who were taught through ABL performed significantly better on both basic and clinical sciences. Verhoeven et al. (1998) partially agreed, while Dochy et al. (2003) completely agreed with their findings. Berkson (1993) and Colliver (2000) could not find any evidence to maintain the superiority of ABL method over traditional method of teaching.

Gallagher, (1996) found no significant difference on „short-term retention" assessment between students of ABL and traditional students. Norman and Schmidt (1992) cited Dochy et al., (2003) and Mårtenson et al. (1985) that on „long-term retention assessments" students of ABL performed better than traditional students. Hung, Jonassen, and Liu (2008) referred Eisensteadt et al. (1990) that traditional students retained more than ABL students in the recall test conducted immediately. However, retention rate of traditional student declined fast as compare to ABL students. In higher order thinking skills, ABL students performed significantly better than traditional students in one of the studies conducted by Polanco et al. (2004) to investigate the impact of ABL on "students" academic achievement" in mechanics. Shelton and Smith (1998) conducted a research study on biomedical students and found better performance of the biomedical students of ABL in the achievement test than their counterparts. In a study, Gallagher et al. (1992) noted remarkable improvement in the results of ABL students than their counterparts and viewed that ABL is an effective method of developing "problem-solving processes and skills". Hung, Jonassen and Liu (2008) mentioned that ABL has "positive impact on students" abilities to apply basic science knowledge and transfer problem-solving skills in real-world professional or personal situations". Suydam, Marilyn and Higgins (1977) and Shepherd (1998) reported same kind of results. Coulson and Osborne (1984), Blumberg and Michael (1992), Norman and Schmidt (1992), Ryan (1993), Dwyer (1993), Dolmans and Schmidt (1994), Woods (1993), van den Hurk et al. (1999) Schmidt and van der Molen (2001) and Schmidt et al. (2006) reached on the similar conclusion about the impact of ABL. Kaufman and Mann, (1996) noted students

believe about ABL to be more effective to "enhancing of information management skills", Caplow et al. (1997) to enrich their "learning of basic science information", Martin et al. (1998) to promote their learning to "deal with complex situations", Dean (1999) to enhance their confidence in "judging alternatives for solving problems", Lieux (2001) to "develop thinking and problem-solving skills", Schmidt and van der Molen (2001).

Research Methodology

Population of the Study

All the Medical and Engineering students of XI grade of colleges of Peshawar, studying Physics at the 11th grade, constituted the population.

Sample of the Study

Govt College Peshawar was selected as sample school. sixty physics students were randomly selected as sample for this study. Control and experimental groups were randomly formed from the sample (thirty students in each group).

Content of the Study

Dimension and limitation (Ch.1), Vectors and Scalars (Ch.2), Projectile Motion (Ch.3), Absolute Gravitational potential (Ch. 4), Angular momentum (Ch. 5), Bernoulli's Equation (Ch 6), Simple Harmonic motion (Ch.7), Newtonian Formula (Ch. 8), Coherent Sources (Ch. 9), and Heat (Ch. 10) were selected for treatment.

Research Design

The researcher used Pre-test - Post-test Control Group Design for this study which involves two groups, experimental and control. In this design both randomly formed groups (control & experimental) are pre-tested and after treatment, post tested. Pre-test and post-test are same for both the groups. It is a strong experimental design in which all sources of internal invalidity are controlled due to random assignment, pre-test and the presence of control group.

Instrument

MCQs type written tests were developed for the collection of data. Pre-test was developed from ten chapter of 11th grade Physics of Peshawar, keeping Blooms' taxonomy in view. Out of 60 questions, twelve (12) of knowledge, twelve (12) of comprehension, twelve (12) of application, twelve (12) of analysis, and twelve (12) questions of synthesis were constructed. Post-test was constructed from ten chapters of the same textbook whereas the distribution of the questions remained same for each domain as in the pre-test. Test items were finalized after item analysis. Item difficulty and item discrimination index were calculated, and test items of mixed difficulty were selected finally. Content validity of the tools was established by discussing them with two different subject specialists and an educationist in the field of science education. Reliability of the Pre-test and post-test was estimated at 0.83 and 0.81 by using split-half reliability method.

Procedure

The study was conducted for two months. Before treatment both experimental and control groups were given pre-test. The research team prepared thirty (20) lessons from the above mentioned ten chapters with the help of classroom teacher. The treatment was given by a qualified, trained, and experienced classroom teacher; however, a member of the research team monitored all the activities. The classroom teacher was given training for the proper implementation of treatment. After treatment both experimental and control groups were given post-test.

Analysis and Interpretation of the Data

Independent samples T-test was applied for mean at the significant level of 0.05. Different null hypotheses were developed to test the significant difference between the control and experimental group.

H_{01}. There is no significant difference in the achievement scores of the students of control group and experimental group in the pre-test.

Table 1: Achievement Scores of the students of control group and experimental group on pre-test

Domain	**Group**	**N**	**Mean**	**df**	**t**-value	**P (0.05)**
Knowledge	Experimental Control	30 30	5.24 5.50		0.67	0.67 < 2.01
Comprehension	Experimental Control	30 30	5.21 5.20		0.93	0.93 < 2.01
Application	Experimental Control	30 30	5.02 5.00	58	-0.67	-0.67 < 2.01
Analysis	Experimental Control	30 30	4.24 4.24		1.66	1.66 < 2.01
Synthesis	Experimental Control	30 30	5.81 5.35		0.87	0.87 < 2.01

Critical value of "t" at 0.05 = 2.01

The calculated t-values are less than the table values. It is clear from the results shown above in the Table 1. That there is no significant difference between the mean scores of the experimental and control group in the cognitive domains of knowledge, comprehension, application, analysis, and synthesis. Hence, It is concluded that both the experimental and control groups were the same in the cognitive skills before the treatment.

H_{02}.: There is no significant difference in the achievement scores of the students of control group and experimental group on post-test in the domain of knowledge.

Table 2: Achievement Scores of control group and experimental group on post-test t in the domain of knowledge

Group	**N**	**Mean**	**df**	**t**-value	**P (0.05)**
Experimental Control	30 30	5.24 5.50	58	1.00	1.00 < 2.01

The calculated t-value is less than the table value (calculated t=1.00 and table value=2.01). Hence, it is concluded that there is no significant difference in the achievement of the students of experimental group and control group in the domain of knowledge.

H_{03}. There is no significant difference in the achievement scores of the students of control group and experimental group in the post-test in the domain of comprehension.

Group	**N**	**Mean**	**df**	**t**-value	**P (0.05)**
Experimental Control	30 30	5.24 5.50	58	1.09	1.09 < 2.01

As the calculated t-value is less than the table value (calculated t=1.09 and table value=2.01), there is no significant difference in the achievement of the students of experimental group and control group in the domain of comprehension.

H_{04}.: There is no significant difference in the achievement scores of the students of control group and experimental group in the post-test in the domain of application.

Table 4: Achievement Scores of control group and experimental group on post-test in the domain of application

Group	**N**	**Mean**	**df**	**t**-value	**P (0.05)**
Experimental Control	30 30	5.24 5.50	58	3.60	1.00 < 2.01

The calculated t-value is greater than the table value (calculated t=3.60 and table value=2.01). It is clear from the result shown above in the Table 4. That there is significant difference between the mean scores of the experimental and control group which means that there is significant difference in the achievement of the students of experimental group and control group in the domain of application. Hence, It is concluded that activity-based teaching method is more effective than the traditional method of teaching to develop higher order thinking skill (application).

H_{05}.There is no significant difference in the achievement score of the students of control group and experimental group in the post-test in the domain of analysis.

Table 5: Achievement Scores of control group and experimental group on post-test in the domain of analysis

Group	**N**	**Mean**	**df**	**t**-value	**P (0.05)**
Experimental Control	30 30	5.24 5.50	58	1.06	1.00 < 2.01

The calculated t-value is greater than the table value (calculated t=1.06 and table value=2.01). Hence, it is concluded that activity-based teaching method is more effective than the traditional method of teaching in developing analyzing ability in students.

H_{06}.There is no significant difference in the achievement score of the students of control group and experimental group in the post-test in the domain of Synthesis.

Table 6: Achievement Scores of control group and experimental group on post-test in the domain of Synthesis.

Group	**N**	**Mean**	**df**	**t**-value	**P (0.05)**
Experimental Control	30 30	5.24 5.50	58	4.18	1.00 < 2.01

The calculated t-value is greater than the table value (calculated t=4.18 and table value=2.01). It is clear from the result shown above in the Table 6. that there is significant difference between the mean scores of the experimental and control group. Hence, It is concluded that activity-based teaching method is more effective than the traditional method of teaching to develop synthesizing ability.

Conclusion

From the results shown above it was concluded that there was a positive impact of activity-based teaching in developing cognitive skills in the students of physics at secondary level. ABL method of teaching is more effective for the development of higher order thinking skills in the students. These results are supported by the findings of Hung, Jonassen and Liu (2008), Suydam, Marilyn and Higgins (1977), Coulson and Osborne (1984), Blumberg and Michael (1992), Gallagher et al. (1992), Norman and Schmidt (1992), Ryan (1993), Dwyer (1993), Dolmans and Schmidt (1994), Woods (1993), Shepherd (1998), van den Hurk et al. (1999) Schmidt and van der Molen (2001) and Schmidt et al. (2006), Martin et al. (1998), Dean (1999), Lieux (2001, Thornton (2001), Schmidt and van der Molen (2001) and Schmidt et al. (2006).

Although the mean scores of Experimental Group, in the domain of knowledge and comprehension, is greater than control group, there is no significant difference found between the mean scores of both the groups which means that ABL is more effective for higher order thinking skills (application, synthesis and analysis) than lower order thinking skills (knowledge, comprehension). Gallagher and Stepien (1996), Lieux (2001) and Zumbach et al. (2004) reached on the same conclusion regarding the effectiveness of ABL.

Recommendations

Following recommendations are made on the basis of the results obtained from the analysis of the data:

1. The role of Activity-Based Learning (ABL) is well acknowledged in the literature to develop higher order thinking skills. As this study is consistent with past findings, it is therefore, recommended that ABT should be adopted at secondary level to teach Physics in Pakistan.
2. The study should be replicated in all science disciplines.
3. The study should be replicated to compare the ABT Activity- Based Teaching with other methods of teaching to find out the relative effectiveness of the different methods with ABT.
4. The study should be replicated in all grades from elementary to university level.

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