IMPACT OF ACTIVITY-BASED TEACHING ON STUDENTS' ACADEMIC ACHIEVEMENTS IN PHYSICS AT SECONDARY LEVEL

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ABSTRACT

The aim of this study was to investigate the impact of activity- based teaching on the students' achievement in Physics at secondary level. Thirty (30) lessons were selected from 9th class Physics for this study. All the science students of secondary schools of Khyber Pakhtunkhwa, studying Physics at the 9th grade, constituted the population. A sample of 50 students was randomly selected from Govt. Secondary School Behzadi Chakr Kot Kohat. 'Pretest-Posttest 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 six (6) weeks. t-test was used to analyze the data. The results showed that the activity- based teaching is more effective for the development of higher order skills in the students.

Keywords: Activity based learning, Academic achievements, cognitive skills

INTRODUCTION

Activity-based learning (ABL) as defined by Prince (2004) is a learning method in which students are engaged in the 'learning processes. In Activity-based learning (ABL) teaching method, in the words of Harfield, Davies, Hede, 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 or information into their personal knowledge which they can apply in different situations (Edward, 2001). Harfield, Davies, Hede, Panko and Kenley (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) quotes Jonassen and 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 (Churchill 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, 1991, Stößlein 2009). According to constructivist view of learning each person 'constructs' their own knowledge and learning process based on previous experience. This theory asserts that learning takes place when psychological environment of an individual interacts with a particular structure. For construction students it is imperative to have variety of activities in an active classrooms (Abdelhamid, 2003, Murray, Donohoe and Goodhew, 2004). Active classrooms are basic requirements for construction education (Betts and Liow ,1993, Panko et al,2005).Traditional teaching methods are not suitable for tactile learning because tactile learning needs direct experience and involve manipulation of materials (Kolb, 1984). According to constructivism, teachers cannot transfer their knowledge to the students (Domin 2007). For meaningful learning to be taken place, learners require to experience an event. Hull (1999) noted rightly that

"*The majority of students in our schools are unable to make connections between what they are learning and how that knowledge will be used*".

One of the reasons is that we do not contextualize our teaching/learning process. ABL is helpful to contextualize the students learning.

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*". Student's motivation is high if these activities are personally relevant to the students (Harel and Papert 1991, Kafai and Resnick 1996, Hug, Krajcik, and Marx 2005,).

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.

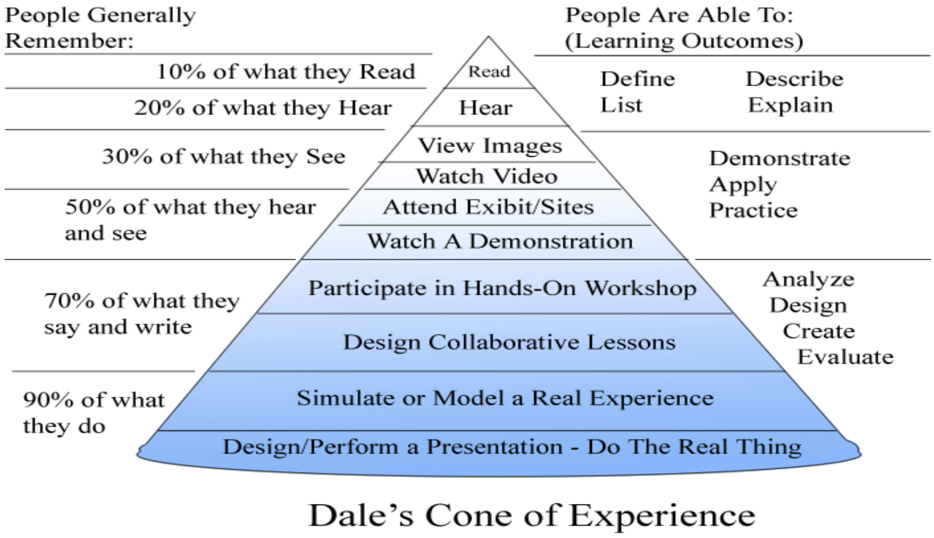

Figure 1: Source: Principles of Teaching <http://teacherworld.com/potdale.html>

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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.

REVIEW OF LITERATURE

There are mixed findings of different researches about the effectiveness of ABL. Suydan, Marilyn and Higgins (1977) reached on the conclusion that ABL in elementary mathematics is more effective than traditional method of teaching. According to Brophy (1995) 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 (Carey & Smith, 1993) so they can apply this knowledge in problem solving situations. Science is more than collecting and manipulating data or memorizing knowledge. 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*". Teo & Wong (2000) view that traditional teaching approaches do not encourage learners to associate with previously acquired knowledge. On the other hand, Boud & Feletti (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 (Barrows, 2000; Dochy et al., 2003; Gallagher et al., 1992; Hmelo-Silver, 2004; Hmelo et al., 2000; Torp and Sage, 2002; Williams and Hmelo, 1998).

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.'s (1998) partially 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 and Stepien, (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 study 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*

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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) and Schmidt et al.(2006) to '*improving interpersonal and professional skills, and advancing self-directed learning, higher level thinking'*. Thornton (2001) remarks in **'***Teaching Physics Concepts with Activity-based Learning'* that activity-based learning, greatly improves students' learning and understanding of scientific concepts.Choo (2007) noted the positive impact of ABL approach on the students as well as teachers in a vocational institution.

RESEARCH METHODOLOGY

Population of the Study

All the science students of secondary schools of Khyber Pakhtunkhwa, studying Physics at the 9^{th} grade, constituted the population.

Sample of the Study

Govt Secondary School Behzadi Chakr Kot Kohat was selected as sample school. Fifty science students were randomly selected as sample for this study. Control and experimental groups were randomly formed from the sample (twenty five students in each group).

Content of the Study

Circular Motion and Gravitation (ch7), Work, Power &Energy (ch8), Simple Mechanics (ch9), Properties of matter (ch10) and Heat (ch11) 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 the first five chapters of 9^{th} grade Physics of Khyber Pakhtunkhwa keeping Blooms' taxonomy in view. Out of 50 questions, ten (10) of knowledge, ten (10) of comprehension, ten (10) of application, ten (10) of analysis, and ten (10) questions of synthesis were constructed. Post-test was constructed from the last five 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 0.86 and 0.89 by using split-half reliability method.

Procedure

The study was conducted for six weeks. Before treatment both experimental and control groups were given pre-test. The research team prepared thirty (30) lessons from the above mentioned five 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

To find the significant difference between the mean scores, "independent samples t-test" was applied 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	25	5.24	48	0.67	0.67 < 2.01
	Control	25	5.04			
Comprehension	Experimental	25	5.08		-0.75	-0.75 < 2.01
	Control	25	5.28			
Application	Experimental	25	5.28		0.95	0.95 < 2.01
	Control	25	5.04			
Analysis	Experimental	25	4.80		1.17	1.17 < 2.01
	Control	25	4.52			
Synthesis	Experimental	25	5.24		0.68	0.68 < 2.01
	Control	25	5.08			

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 group	25	5.76	48	1.00	1.00 < 2.01
Control group	25	5.48			

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.

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Table 3: Achievement Scores of control group and experimental group on post-test in the domain of Comprehension

Group	N	Mean	df	t-value	P (0.05)
Experimental group	25	5.96	48	1.11	1.09 < 2.01
Control group	25	5.72			

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 group	25	5.8	48	3.60	3.60 > 2.01
Control group	25	4.92			

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 group	25	5.52	48	3.06	3.06 > 2.01
Control group	25	4.76			

The calculated t-value is greater than the table value (calculated t=3.06 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 group	25	4.84	48	4.18	4.18 > 2.01
Control group	25	3.76			

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.

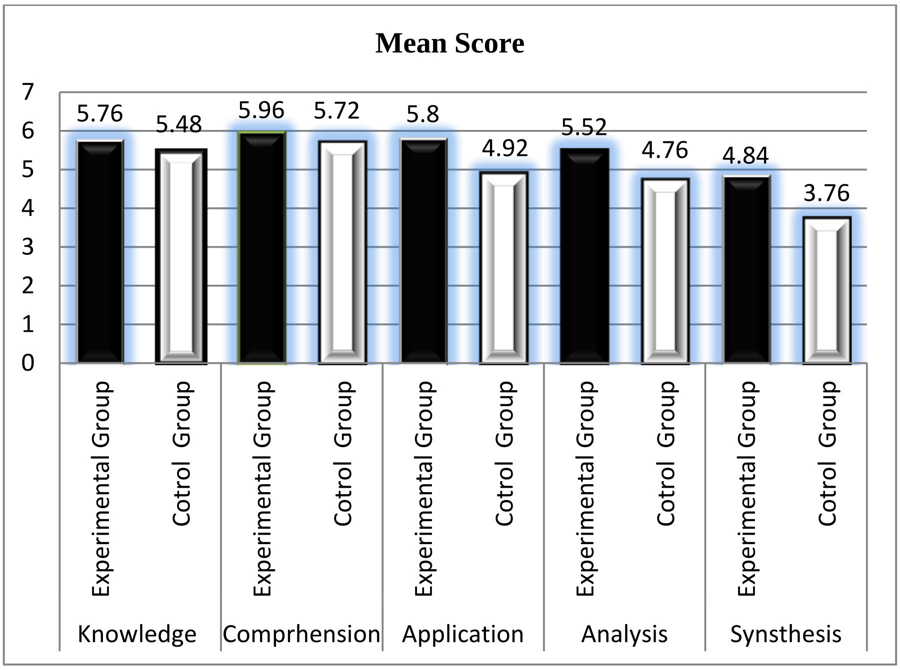

Figure 2: Summarizes the results of control and experimental group for post-test.

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 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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