Kifayat Khan[*]   Wajeeha Aurangzeb[†]   Tehsin Tahir[‡]

Effectiveness of 5 Es Learning Cycle Model on Students Learning in Physics at Secondary School Level in Pakistan

Abstract   This study is designed to find the effectiveness of Learning Cycle Model (LCM) on students learning in physics at the secondary school level. To achieve this objective, null hypotheses were tested. All physics students of Haripur district Khyber Pukhtunkhwah Pakistan at secondary level were included as the population. Eighty (80) physics learners of grade 9th of Hazara Public School and College (HPSC) were chosen as sample of the study. True experimental research design was employed. The pupils were divided uniformly into experimental and control groups such that 40 students included in each group. Physics Academic Achievement Test (PAAT) of reliability coefficient 0.82 was utilized. Experimental and control groups were instructed through LCM and Traditional Teaching Method (TTM) for twelve (12) workweeks. Statistical outcomes showed that pupils instructed via LCM were found more effective learners in Physics than the pupils instructed via TTM.

Key Words: Effectiveness, Learning Cycle Model, Learning Physics, Learning Skills, Experimental Group, Control Group

Introduction

According to Özmen (2004), the 5 Es Learning Cycle Model (LCM) is the best applied model of the constructivist learning scheme (Bybee et al., 2006). This model depends upon the concept that students are necessary to build their own information about novice ideas and knowledge through examining, exploring, testing, and purifying their earlier outlooks and opinions. During experiential learning, the students practice concepts and realities instead of mere hearing. Positive alterations occur in outlooks, knowledge, abilities, interest and rational of the students. What amount of learning occurs mainly depends upon the quality of experience (McElhane, 1998). According to McElhaney (1998) and Bybee et al. (2006), 5Es LCM was developed in 1960s by Biological Science Curriculum Study (BSCS) in order to create greater quality active learning practices and continue in practice form the 1980s at elementary and secondary school level science courses. This model is frequently utilized within the paradigm of science education (Soomro, Qaisrani, Rawat, & Mughal, 2010) and can be utilized for all subjects. Through the utilization of this model, the learner can learn supplementary knowledge about science content, science process and critical thinking skills (Buntod, Suksringham & Singseevo, 2010; Yalcin & Bayrakceken, 2010). The 5Es learning model stimulates the scholars' interest and creativity (Rasul, Shahzad & Iqbal, 2019).

This learning model comprised of events that are necessary to develop learners' interest in research, reply to their subject related expectations and contain the effective utilization of their information and skills (Ergin, 2006). It is comprised of the five stages namely: engagement, exploration, explanation, elaboration, and evaluation (Tinker, 1997; Carin & Bass, 2000 and Lorsbach, 2006). It motivates the learners at all phases to formulate their own concepts (Martin, 2000) and are interconnected to one another as shown in figure 1 below:

[*] Assistant Professor, Department of Education, The University of Haripur, KP, Pakistan. Email: kifayatkhan@uoh.edu.pk
[†] Assistant Professor, Department of Education, NUML, Islamabad, Pakistan.
[‡] Assistant Professor, Department of Education, University of Haripur, KP, Pakistan.

Figure 1: Adopted from: https://www.teachingchannel.org
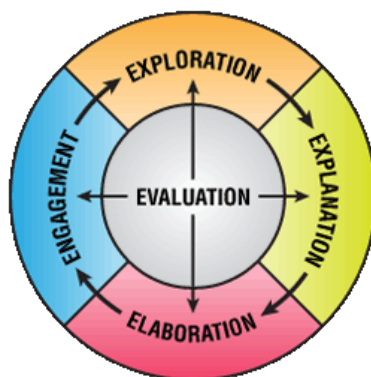
The 5Es every element is carefully shaped to develop student's construction of knowledge and information. Evaluation is not the last phase of learning cycle but includes in all four phases of the cycle. Prior knowledge is accessed in the engagement phase through the learners' involvement with the new idea by short activities to motivate interest. Students personally develop a link with the topic and the learning activity to create relations among educational practices. The learners' curiosity for the subject is developed. Right at this step, the teachers state a question or a problem, pose questions or exhibit an occasion about the subject, then support learners to discuss the subject in order to recognize learners' earliest information (Bybee, 1997; Wilder & Shuttleworth, 2005).

At the exploration phase, the learners effectively create thoughts to solve the queries. The Instructor guides and provides the necessary material to make the learners responsive (Newby, 2004; Carin & Bass, 2000). In the explanation phase focus is made on a feature of engrossment to show hypothetical understanding, procedure skills, or performances. The instructor supports learners to pay off misplaced knowledge otherwise replace their misrepresentation by the novel information. The instructor uses supplementary outstanding practices for example verbal clarification, film, movie, and demo (Bybee et al., 2002; Campbell, 2000). Further, at the elaboration stage, students utilized their newly acquired knowledge to altered position. Students study the concepts in more detail consequently learn additional relationships. The lesson comes to an end at this stage by confirming student understanding. New knowledge and understanding develop deeper and wider. The students apply the acquired knowledge. The instructor offers the learners to utilize their newly acquired knowledge in different and novice circumstances and have responsibility (Morse, Roberts, Szesze, & Wayne, 2004). Lastly, at the evaluation stage, the students alter their actions and gauge their development. The instructor becomes busy with pupils to judge students' scientific understandings, students' inquiry, and problem-solving skills and gauge students' progress regarding instructional goals. The knowledge gained at this stage directs the instructor in his preparation for the next class. Moreover, the various evaluation methods like concept mapping, instructor planned observation graphs, checklists, learner conferences, individual progress portfolios, homework assignments, and the traditional assessment methods may be used (Bybee et al., 2002). These phases provide opportunities for the instructor to continually monitor students' improvement by employing inquiry approach and debates. Right at this phase, conventional assessments may be integrated depending upon the types and material of the learning experience.

Numerous researches have revealed that learners cannot maintain knowledge which has been offered to them through traditional way (Ahmad, Samiullah & Khan, 2019). 5Es LCM is a modern and active learning method necessary for effective learning. Much researches have been accomplished to expose the usefulness of the 5Es Learning Cycle Model (LCM) on learners' scholastic achievements inside the subject of science generally and in physics particularly. Campbell (2000) has involved students in an inquiry-based science investigation by utilizing 5Es LCM to investigate grade 5th learners'

insight of force and motion notions. Pre and post-test research strategies were applied. It was found that 5Es learning cycle model did increase students' knowledge about force and motion, while textbook-based instruction did not increase their knowledge (p. ii). Kevin (2003) has studied the influence of the constructivist learning cycle on students' success in learning the "law of mechanics." The treatment and control groups continued taught via utilization of learning cycle and conventional method. The results continued in support of the treatment group. Amann (2005) published a study on exploring physics in the classroom. For this study, it was believed that student involvement is the key to learning. Two teaching techniques were selected by the American association of physics teachers Manuel. The learning based on the 5E model is superior in students' involvement as compared to other methods. Vincent, Cassel and Milligan (2008) in a scientific investigation named "Will it float? - A learning cycle investigation of mass and volume". The study is built on the 5E learning model planned to focus attention on the conceptions of mass, density, and volume. The learners answered the questions and made predictions centered on their observation at the end of the session. The study revealed that the 5E LCM is effective in getting an enhanced understanding of the notions and scientific achievement.

Further, the main intent of the research carried out by Ceylan and Geban (2009) was to examine the effectiveness of the instructions delivered through 5E LCM for comprehending the states of matter and solubility perceptions of 10th grade students. At completion of the experiment, 5Es LCM was found significantly better in acquiring scientific conception related to the concerned topic. The learning cycle model was applied to gauge achievement of the students in physics subject in a public school at secondary level (Soomro et al, 2010). Forty (40) physics scholars of grade 10th were enrolled in a study in 2008. Twenty (20) scholars each were haphazardly allotted to the treatment and control group. Classes or groups were instructed via 5Es learning cycle model and traditional lectured method, respectively. A pretest and posttest were constructed from "simple machines" and operated on the two groups to assess students' achievement. The learners treated with the 5E LCM showed greater achievement in contrast to the learners exposed to conventional teaching methods (Soomro et al, 2010). Wilson, Taylor, Kowalski, and Carlson (2010) performed a study to examine effect of inquiry-based teaching. Fifty-eight (58) pupils of the age of 14 to 16 years were randomly distributed into two groups. The treatment and control groups were instructed through the 5Es teaching model and commonplace teaching methodologies. The group instructed via inquiry-based model has a greater level of achievement as compared to the group instructed via commonplace instructional method (Wilson et al, 2010).

Furthermore, Hokkanen (2011) explored whether presenting the lesson by the application of the 5E learning cycle model can improve the learner's interest, academics achievement, and confidence in science. It was decided that the 5E model can enhance learner interest, academics performance, and confidence in science, when employed correctly with devotion and loyalty. Aydin and Hanuscin (2011) on a study named "Secret in the margins: Rutherford's gold foil experiment" through the utilization of 5E learning cycle. It helped the students not only in understanding the atomic model but also how Rutherford helped to develop it. Madu and Amaechi (2012) studied the effects of the 5Es LCM on pupils' perceptions of the elasticity. Hundred (100) pupils were investigated to answer questions on a physics concept test before and after treatment. The pupils' answers were analyzed according to their responses. Findings revealed that the majority of the pupils had diverse views about the elasticity concept prior to the treatment. But, on the other hand greater scientific understanding was investigated for some pupils at the end of the treatment. However, a few of them still maintained their prior conceptions (Madu & Amaechi, 2012). The study carried out by Osawaru & Eravwoke (2012) was to verify the impacts of the 5E learning cycle as an instructional technique on biology and chemistry on student's achievement. It was found that learners treated to LCM have greater attainment in biology and chemistry as compared to students taught with lecture method.

Moreover, Kinqir and Akqemer (2013) researched utilizing the learning cycle method on gas concepts to increase learners' understanding. Therefore, the 5Es LCM was found successful in learning and understanding the gaseous concept deeply among students. The study of Olaoluwa & Olufunke (2015) has assessed the usefulness of Learning-Cycle Approach (LCA) and Inquiry-Teaching Approach

(ITA) in enhancing learners' academic achievement and learners' attitude about Physics in Nigeria. To carry out this research, the nonequivalent pre and posttest design were applied. The sample of this study comprised of 103 senior secondary-two physics pupils. The collected data were analyzed. The experimental groups (LCA and ITA) have greater scores in academic performance and have improved attitudes toward physics than the control group, with the LCA being the utmost successful (p. 169). Shaheen, Alam, Mushtaq, and Bukhari (2015) explored the influence of inquiry-based learning on pupils' performance at the elementary level in the subject of science. Pre and posttest experimental control group design was utilized. Fifty (50) class-6th science students SLS school were haphazardly nominated as a sample of the study from district Rawalpindi. The treatment group exposed with the 5Es learning model (inquiry-based learning) was found superior to traditional lecture approach.

Statement of the Problem

This research is designed to explore the comparative effectiveness of the 5Es LCM and TTM on pupils' learning in Physics at the secondary school level.

Objectives of the Study

To carry out this study, below objectives were framed:

1. To find the pre-test PAAT mean scores difference among the experimental and control group students in learning Physics of grade 9th.
2. To find the effectiveness of the learning cycle model on students learning in Physics of grade 9th at the secondary level at the end of the experiment.

Research Hypotheses

The study was having the below two (2) null hypotheses:

H_{01}. There is no significant difference between the experimental and control group students in pre-test learning skills of grade 9th physics at the secondary school level.

H_{02}. There is no significant difference in post-test learning skills of academic achievement of students taught Physics through LCM, and those taught through TTM of grade 9th at the secondary school level.

The Study Delimitations

Owing to limited sources and time restrictions, this research was restricted to the grade 9th Physics pupils of Hazara Public school and College (HPSC); four (4) units out of nine (9) of Physics textbook; seven (7) out of 21 Physics practicals were included; and students learning in Physics were delimited to the academic achievement in Physics.

Research Methodology

To study the effectiveness of LCM, a pretest and posttest control group research design was employed. This design was adopted because it is the most solid and the true-experimental research design. Moreover, this was believed to be the suitable design (Watenable, Hare & Lomax, 1984). This research design controlled all the factors of internal validity (testing, history, maturation, differential selection, instrumentation, experimental mortality, statistical regression, maturation interaction, and selection of subjects (Campbell, Julian & Stanley, 1963; Gay,1992; Raninga, 2009). The following methodologies and procedures were adopted.

Population and Sample

All students of grade 9th learning Physics at secondary level of district Haripur, Khyber Pakhtunkhwa (KP), Pakistan were included in the population of this study. A total of 6009 Physics students were

registered in grade 9th (EMIS, 2012-13; 2013). Eighty (80) Physics' students of class 9th were chosen from HPSC through pretest PAAT via matched random sampling procedure. The students were haphazardly allocated to treatment and control groups (N=40). A class of forty (40) students' is the most suitable for the active learning and more effective for students' academic successes (Mulongo, 2013).

Instrument of the Study

To carry out this study, a Physics Academic Achievement Test (PAAT) was developed soon after the detailed review of the test items construction techniques, contents of grade 9th Physics textbook and practical notebook for the curriculum 2006. Based on specification table, the PAAT was constructed from chapters No. 4, 7, 8, 9, and Physics practicals, respectively. The test was composed of six (6) learning skills and a hundred (100) multiple choice test questions along with four (4) options. The conceivable test scores fluctuated between 0 and 100, respectively. Learning skills including knowledge; understanding; application; problem-solving; and observation comprised of seventeen (17) test items each, whereas reasoning skill comprised of fifteen (15) test items only.

Procedure

Physics textbook (2006) of 9th grade of KP textbook board Peshawar was used to carry out this research. Four (4) out of nine (9) chapters of Physics textbook and 9 practicals have been utilized to conduct this experimental study. The Physics' students of class 9th were chosen as sample of this study. The qualifications, age and experience of the Physics' teacher were B.Sc, and M.Ed, 37 years, and 15 years of teaching experience respectively. The concerned school Physics teacher was selected and trained in the two teaching methods of LCM and TTM for two weeks for the experiment and all the relevant material was provided to him. For the construction of two groups pretest PAAT was carried out by instructor with the cooperation of the investigator. The tests answers were collected through answer sheet and were scored using a planned key. The experimental group instructed Physics via LCM and the control group instructed via TTM teaching methodologies. Overall, thirty (30) lessons were instructed in sixty (60) periods and for each lesson two (2) successive periods of thirty-five (35) minutes were used. Both groups were instructed in the same classroom through the utilization of all sorts of aids or supporting materials to make the environment harmonious. The study lasted for sixteen (16) weeks. Towards the end of the experiment, students' academic achievement was measured through posttest PAAT.

Data Collection and Analysis

The experimental and control groups formed on account of the collected data through pre-test PAAT and were instructed through LCM and TTM by the Physics teacher of the school during the experimentation. To observe and provide responses during experimentation, the researcher has thoroughly inspected the concerned school. Towards the end of the experiment, posttest PAAT data was collected by Physics teacher of the school with the assistance of the researcher to examine the difference in students' academic achievement. Mean scores, standard deviations, and t-tests were employed to examine the collected data through the SPSS package.

Results

The students of the two groups were compared over mean scores obtained in pre and posttest PAAT over learning skills. The interpretations were made in the tables given below:

Table 1. Pre-test PAAT Comparison of the Experimental and Control Groups (N=40)

Learning Skill	Group	Mean	S.D	S.E.M	T	P
Knowledge	Exp	9.14	3.10	0.49	0.04	0.97
	Con	9.11	2.62	0.42		
Understanding	Exp	7.52	2.39	0.39	0.00	1.00
	Con	7.51	2.71	0.44		
Application	Exp	7.04	2.39	0.39	0.00	1.00
	Con	7.04	2.66	0.44		
Problem Solving	Exp	5.52	2.02	0.33	0.00	1.00
	Con	5.52	2.16	0.35		
Observation	Exp	5.21	2.01	0.33	0.29	0.77
	Con	5.09	1.88	0.31		
Reasoning	Exp	4.54	1.86	0.29	0.07	0.95
	Con	4.51	1.56	0.26		

Table 1 shows the assessment of the treatment and control groups for academic performance over pretest PAAT. The average scores computed for the treatment group are M_E (9.14, 7.52, 7.04, 5.52, 5.21, and 4.54), while means scores for control group are M_C (9.11, 7.51, 7.04, 5.52, 5.09, and 4.51) correspondingly. So, the whole statistics reveals that the disparity amongst the groupings is not important in learning physics prior to the experimentation because p>0.05. The null hypothesis H_{01} is, therefore, accepted. Hence, two groups are similar in learning skills at the start of the experiment. The situation is also obvious from figure 2.2 below:
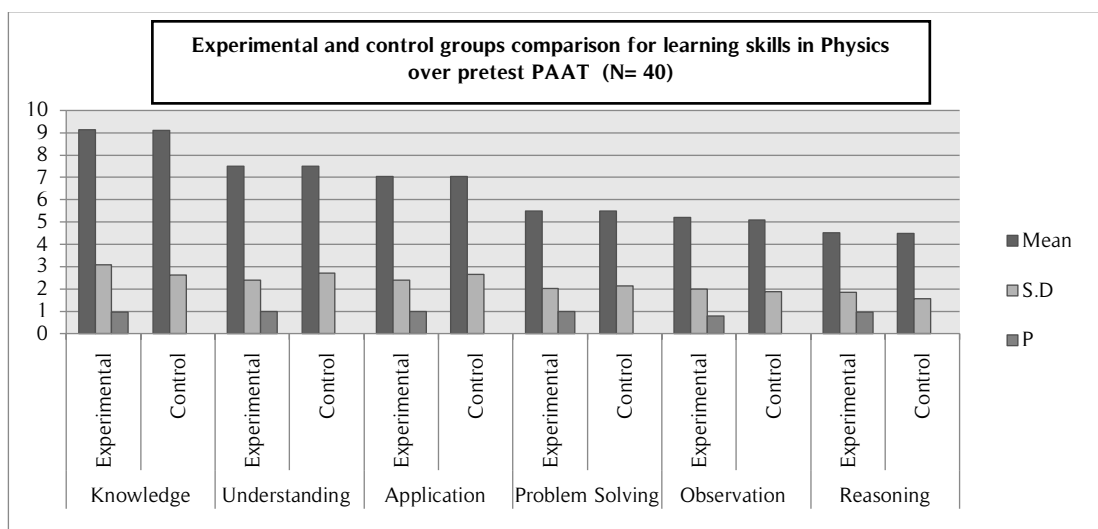
Figure 2.

Table 2. Posttest PAAT Comparison of the Experimental and Control Groups for Knowledge skill (N= 40)

Group	Mean	SD	SEM	t	p
Exp	14.50	1.81	0.29	11.04	0.000
Con	8.90	2.65	0.42		

Table 2 illustrates the comparison between two groups for knowledge as a skill. The estimated mean scores of the two groups for knowledge skill is (M_E=14.50, M_C=8.12, $p<0.05$). These statistics reveal that the difference is substantial at 0.05 levels. The treatment group means scores are higher than the respective control group.

Table 3. Posttest PAAT Comparison of the Experimental and Control Groups for Understanding Skill (N= 40)

Group	Mean	SD	SEM	t	p
Exp	13.05	2.28	0.36	9.09	0.000
Con	9.05	1.60	0.25		

Table 3 illustrates the comparison between treatment and control groups for post-test PAAT for understanding skill. The estimated average scores of the two-group for understanding skill are (M_E=13.05, M_C=9.05, $p<0.05$). These statistics displays that the difference is substantial at 0.05 levels. The treatment group means scores are higher than their respective control group pupils.

Table 4. Posttest PAAT Comparison Amongst the Experimental and Control Groups for Application skill (N= 40)

Group	Mean	SD	SEM	t	p
Exp	12.95	1.97	0.31	12.06	0.000
Con	8.15	1.56	0.25		

Table 4 reveals the comparison amongst the groups for application skills. The mean scores between the two groups for application skill are (M_E=12.95, M_C=8.15, $p<0.05$). This reveals that the dissimilarity is statistically considerable at 0.05 levels. The treatment group means scores are higher than the respective control group.

Table 5. Posttest PAAT Comparison Amongst Experimental and Control Groups for Problem Solving Skill (N= 40)

Group	Mean	SD	SEM	t	p
Exp	12.88	1.94	0.31	12.94	0.000
Con	7.15	2.02	0.32		

Table 5 displays the comparison between treatment and control groups in learning physics for problem solving skill. The two groups average scores for problem-solving skill is (ME=12.88, MC=7.15, $p<0.05$). This dissimilarity is substantial at 0.05 levels. Further, the treatment group means scores are higher than the respective control group.

Table 6. Posttest PAAT Comparison Amongst the Experimental and Control Groups for Observation skill (N= 40)

Group	Mean	SD	SEM	t	p
Exp	12.38	2.33	0.37	12.63	0.000
Con	6.40	1.88	0.30		

Table 6 reveals the comparison between treatment and control groups in learning physics for observation skill. The two groups mean scores for observation skill is (M_E=12.38, M_C =6.40, $p<0.05$). The disparity is important statistically at 0.05 levels. The experimental group means scores are higher than the respective control group scoring.

Table 7. Posttest PAAT Comparison Amongst the Experimental and Control Groups for Reasoning Skill (N= 40)

Group	Mean	SD	SEM	t	p
Exp	10.25	2.33	0.37	9.98	0.000
Con	5.50	1.91	0.30		

Table 7 discloses the comparison between treatment and control groups over reasoning skills. The two groups' mean scores for reasoning skill are M_E=10.25, M_C =5.50, p<0.05. This disparity is substantial at 0.05 levels. The means score of the treatment group exceeds control group.

Discussions and Conclusion

Tables 2, 3, 4, 5, 6, and 7 reveal that for p<0.05, the estimated mean score values of the two groups for every component of learning skill including knowledge, understanding, application, problem-solving, observation, and reasoning are M_E (14.50, 13.05, 12.95, 12.88, 12.38 and 10.25) and M_C (8.12, 9.05, 8.15, 7.15, 6.40 and 5.50) correspondingly. The complete evidence shows that the dissimilarity is statistically substantial for each component of learning physics. Thus, the null hypothesis H_{02} is entirely disapproved. Consequently, the treatment group achieved high academic achievement than the control group pupils for learning physics towards the end of the experimentation. Subsequently, the students taught via LCM were found better than those instructed via TTM. This result corroborates with the results of the investigations carried out by Campbell (2000), Kevin (2003), Amann (2005), Vincent, Cassel and Milligan (2008), Ceylan and Geban (2009), Soomro et al (2010), Wilson et al (2010), Hokkanen (2011), Aydin and Hanuscin (2011), Madu and Amaechi (2012), Osawaru and Eravwoke (2012), Kinqir and Akqemer (2013), Olaoluwa and Olufunke (2015), and Shaheen et al (2015). From all these, it is found that 5Es LCM is better in learning physics in contrast to TTM at secondary school level.

Implications

Due to minimum researches in educational science in Pakistan, this research may be of diverse importance and insinuations. The outcomes of this study may invigorate the LCM paradigm in comparison to TTM and may be supportive: in creating new and more information about LCM in physics subject and may complement to the philosophy and preparation right at the classroom and institution level; in developing the teachers training qualities by reviewing the programs of teacher education and the trainers might be trained in LCM in additions to the other teaching methods in physics to promote this model at secondary school level; in providing assistance to institutional heads and educational management to organize workshops for in-service science/physics teachers in order to build their capacity in LCM; for textbook writers, science experts, and curriculum designers to best utilize their energies by integrating LCM in the courses of science/physics which might add to further exciting science, effective and active instruction, and best standard textbooks of science and physics at secondary school level, for future researchers who desire to conduct the similar research in other levels of schooling either utilize it lonely or blend with other teaching methods; and for the teachers to select novel methods of teaching that may not only develop their teaching skills but may also be useful for their learners to improve critical-thinking, academic performance, confidence, and make their learning more creative and stimulating.

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