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RESEARCH PAPER

Effect of Formative Assessment on Students' Achievement in Knowledge Domain in Physics at Secondary Level

Ijaz Mahmood[1] Nasir Mahmood[2] Muhammad Zaigham Qadeer[3]

1. PhD. Scholar, Department of Science Education, Allama Iqbal Open University, Islamabad, Pakistan
2. Dean, Faculty of Education, Allama Iqbal Open University, Islamabad, Pakistan
3. Associate Professor, Science Education Department, Allama Iqbal Open University, Islamabad , Pakistan

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Corresponding Author:

ijaz.mehmood@iub.edu.pk

ABSTRACT

Formative Assessment is essential part of teaching learning process. Formative assessment is used during the teaching-learning process. It is linked with the teaching learning process by exploration, estimation and analysis of record of learning activities. From the analysis of learning activates the improvement in the running process of teaching-learning become easy. There are many techniques used by experts for the formative assessment. In this study only three techniques, self-assessment, peer-assessment and feedback were used. The objective of the study was to find the effect of formative assessment on students' achievement in knowledge domain in Physics at secondary level. All the students of Government boys' High secondary school of Bahawalnagar city were selected as population for this research study. All the students of class X (English medium) of Government Boys City High School were subjects of study. The pretest–posttest control group design was used for this study. The collected data was analyzed by using inferential statistics. The finding and conclusion of the study show that the use of formative assessment enhances the achievement of the students. The use of formative assessment during the classroom teaching is recommended

Introduction

Formative assessment is an organized process of gathering proofs constantly and providing feedback to students during the teaching-learning process in the classroom. It consists of a comprehensive variety of procedure that teachers practice during the teaching learning process. Formative assessments support teachers in identifying concepts which are producing problems in the process of understanding. Real purpose of formative assessment is to gather complete information, which can be used for the improvement in instruction and learning of students, while teaching-learning is in process. Both, teachers and students use the formative assessment as a

process of improvement. This process is done during the instructions by providing feedback. This feedback provides guidelines for the modification in the teaching strategies. If there is need, the modification is also done in learning outcomes for meeting the instructional goals (Heritage, 2010 and 2011; Dunn and Sean, 2008).

Formative assessment is a compulsory part of how people learn. Because of it learners become evaluator of their own progress through the material and practice of appropriate techniques. The most efficient methods are to provide instantaneous feedback and allow learners to interrelate with the materials, peers, and instructors. Formative assessment not only updates the learner, but also the instructor. Formative assessment mostly does not add towards a student's final marks rather; it encourages for improvement in learning gain. The main objective is the change in teaching-learning pedagogies which helps students for better learning (Andersson& Palm, 2017). Self and peer assessment are also the important teaching-learning pedagogies. These are the sources of constructive and learning oriented feedback. For all these processes the teachers have to train the students. After the training students take part in learning process with boosted attitude (Andrade et al., 2015).

During the teaching-learning process questioning also play a vital role. The purpose of asking question in the formative assessment is very crucial because the information is obtained about the student learning. The understanding is also considered as a part of learning. These objectives can only be achieved by active and effective questioning. The questions should also be able to determine the depth of knowledge of students. In this regard the probing types of questions are effective (McMillan, 2014). Formative assessment provides help to both student and teacher. Teacher notes the progress of student in an informal way and provides the remedial measures. This action takes place as the learning difficulties appear during the teaching-learning process (Srivastava, Waghmare, &Vagha, 2015)

Literature Review

Formative assessment is assessment for learning. It is used during the process of instruction. The teacher checks students' understanding during instructional time. Different tools are used by the teacher for determining the current status of students learning. Teacher also tries to know the previous knowledge of students and also identify the gaps and misconceptions in the learning process. In the Formative assessment students reflect on and monitor their own progress. The information gained guides teachers' decisions in how to enhance teaching and learning. Formative assessment enables students to learn through the process of feedback and opportunities to practice and improve. Formative assessment is directly linked with day-to-day learning activities of students'. This link is created by process of exploration, estimation and analysis of record of learning activities. Exploration of the learning activities provides a teacher detail about the level of learning of students. Bennett (2011) emphasizes on the purpose of the formative assessment. He reviews various definitions and then illustrated towards real purpose of formative assessment. Formative assessment provided feedback to both students and teachers. The student

progress is gage by their learning activates. For further progress, facilitation for student is find by the teacher in the process of detailed exploration of learning activities (Bennett, 2011).

According to social constructivist approaches, knowledge and understanding are constructed through interactions. These are not fully transmitted through instructions. So, emphasis is put on the interaction of teacher and pupil, pupil and task, and indeed pupil and pupil. Vygotsky (1978) puts more emphasis on that which student might achieve instead of that student has achieved. So there is need to identify this area of students for the improvement in his learning level. So the learning must be scaffolded. The process of scaffolding takes place when the teacher provides the feedback according to learning activities of student. Student needed help from experienced teacher or in some cases peer. Because of this help the learning process may be strengthen. So the teacher and student must have the quality of adaptability and creativity. Adaptability and creativity are the preconditions for the learning process (Benkler, 2011).

Bransford, Derry, Berliner, Hammerness, and Beckett (2005) in their research explain the difference between 'routine experts' and 'adaptive experts,'. They inferred that for students to become real learners there is need of teachers which are capable of changing their teaching method according to the need of students. They themselves are ready for receiving the training relating to the instructional method. So they become able to fulfill the need of their students (Black &Wiliam, 1998; Vogt &Rogalla, 2009).

Büyükkarci (2014) stated that evidence indicates that high-quality formative assessment has a powerful impact on student learning. In general terms, formative assessment is aims to help students improve their own learning. In practice, formative assessment is a self-reflective process that aims to promote student achievement. Formative assessment (FA) is intended to help learners and teachers track students' progress in an informal way and to take remedial action when learning difficulties emerge (Srivastava, Waghmare, &Vagha, 2015). Formative assessment motivates the student to be more focused and provides an opportunity to monitor different aspects of student learning (Lucas & Spencer, 2014).

Material and Methods

Formative assessment has vital role in education. Formative assessment techniques are the key factors in education process. The main objective formulated for this research study was to find the effect of formative assessment on the teaching of physics at secondary level. Pre-test and Post-test Equivalent Control Group Design was used in this study. Following steps were taken to complete the research study.

Population

There were 11 secondary boys' schools in Bahawalnagar city. All the students of Government boys' High secondary school of Bahawalnagar city were selected as population for this research study. The strength of student was 450.

Sample

The sampling technique used for current study was convenient sampling. Government Boys City High Secondary School was selected for the present study. All the students of class X (English medium) of Government Boys City High School were subjects of study. Students of class X were distributed in two groups, by using their marks in pre-test. These two groups were divided into control and experimental groups by using simple lottery method.

Instrument of the Study

Achievement test was the measuring instrument for this study. Achievement test measures the present position of students with respect to ability in given area of knowledge or skills. The researcher prepared an achievement test on the basis of cognitive domain. The three areas, knowledge (80%), comprehension (10%) and application (10%) were only considered in the achievement test. This was done because of current paper pattern of education board of Bahawalpur. The Units of the Physics for the study were selected in consultation with the Physics teacher of Government City High school Bahawalnagar. Pre and Post-test was developed on Bahawalpur Board Pattern.

Validity and Reliability of the Instrument

For validity pre and post-test were presented to the five experts in the field of physics. Tests were improved in the light of suggestion given by the experts. Tests were based on cognitive domain. In this paper only Knowledge domain was consider A pilot study was conducted for reliability of tests. In pilot study the test were taken from the 30 student of public school (Government Canal colony High School Bahawal Nagar). From this study, the value of reliability coefficient (Cronbach α) was calculated. It was 0.78. After the pilot study the changes were made in both achievement tests.

Procedure

The study was planned to see the effect of formative assessment on the teaching of physics at secondary level in knowledge domain. It was an experimental study. The total duration of the study was three month. There were two classes of English medium science group students in Government City High School in Bahawal Nagar. All the students of English medium classes were involved in the study. In one class there were 63 students while in other there were 52 students. The total strength of the students of class X was 114. In the beginning of study, the first three days were utilized for introductory session. In that session prior knowledge of Physics of class

9thand the problems of students relating to Physics subject were discussed. On Fourth day pre-test was taken. On the basis of marks of pre-test, students were divided into two groups. The simple lottery method was used for random division into experimental and control group. Experimental group received the Treatment. Lectures of both groups were taken by researcher. Teaching activities of control group were same as they received in the past and same method of assessment in the classroom.

Experimental group had been receiving treatment. The treatment consisted of different steps. The three processes, Self-assessment, Peer-assessment and feedback were components of treatment. All the students of experimental group received the training about the assessment of their learning. The important process was checking of a test according to set criteria. After completing a topic, a test was taken. This test first of all checked by the students. First time when the students checked their own test, they feel different types of difficulties. Teacher (researcher) provided them guideline to overcome all types of difficulties. In this way the self-assessment procedure took place. In self-assessment process the students got the concept of analysis of their own work.

Because by gaining the concept of self-assessment, the motivational level of students' increased. Then the second test was taken. This test was checked by peers. When the students checked the papers of other students, then this process is called peer assessment. The students checked the papers of other students according to the criteria given by the teacher. Then both the tests again checked by teacher (researcher). Under these three assessments a detailed feedback was given to each student. The detailed feedback was given at the end of each topic. During the lecture there was a time for questions by the student also. The problems relating to topic was considered by the researcher. A modification was made in the teaching-learning process as needed during the lecture also.

During the first two weeks, the pace of teaching learning was remained slowly. Students had taken lot of time in the understanding of all assessment activities. Two forms, observation record form and feedback form were used during the treatment. The data of these forms was used in giving detailed feedback after each topic. Regarding filling these forms the students were guided by the researcher many times. After practice they started working independently for all the activities relating to assessment practices.

First seven units of Physics book-X were instructed to both the groups. Units list has been given in the appendix-A. All the topics of units were not covered; in this regard the guideline of physics teacher (Govt city school) was considered. Forty eight topics of 7 chapters were taught by the researcher. On average four topics per week were taught. The complete detail of topics is given in the annexure B. Both the groups were instructed by researcher himself. The duration of lecture was 30 minutes. In the time table there were two lectures of Physics. There was no chance of the meeting of student of both groups on daily bases as they were instructed by the same teacher (researcher) on different time. At the end of each unit there was a complete test for both the groups of students. After the treatment, a post-test was taken from both the

groups. The number of student was same (114) as present in the pre-test. The data obtained from two achievement test (pre and post-test) were then analysed by using appropriate statistical test.

Results and Discussion

The data were collected by using two equivalent tests (pre-test and post-test) for this research work. As the special treatment was applied on experimental group, so the t-test was used to check the significance of treatment. According to the need of objectives, independent sample t-test and paired sample t-test were used in this research work. If the calculated value of t is more than t-table value then the difference will be significant. The test of significance is always functional at a pre-selected probability level. It provides the procedure on the basis of which the rejection of null hypothesis becomes easy. The probability level for this research work was 5%. It means, by chance, only 5 times out of every 100 studies there may be chance of accepting null hypothesis. Therefore, we conclude that the null hypothesis is probably false and reject it (Gay, 2014). For the calculation of both t-test SPSS software was used. This software provided much facilitation for accurate calculation. The following two tables are for the knowledge component:

Table 1
Overall Comparison from Control group to Experimental Groups of Knowledge component

Group	Students	Control Group Mean	SD (Cont. Group)	Exp. Group Mean	SD (Exp. Group)	Gain	t-value	Sig (2-tailed)	Effect Size(d)
Pre-test (N=57)	High achievers (16)	43.18	3.745	43.43	4.03	0.250	.182	.857	0.064
	Average achievers (29)	32.75	3.86	32.82	3.66	0.068	.070	.945	0.018
	Low achievers (12)	17.91	5.64	18.16	5.54	0.25	.109	.910	0.044
	Total (57)	32.61	9.69	32.66	9.85	.052	.029	.977	0.005
Post-test (N=57)	High achievers (16)	47.25	4.44	51.75	4.41	4.50	2.87	.007	1.016
	Average achievers (29)	36.89	4.10	45.65	7.51	8.75	5.50	.000***	1.447
	Low achievers (12)	28.16	3.18	42.50	4.88	14.33	8.50	.000***	3.481
	Total(57)	37.96	7.84	46.70	7.05	8.73	6.25	.000***	1.172

For finding the significant difference between the achievements of students of control group (Knowledge) and experimental group (Knowledge), independent sample t-test was applied. Calculations were done for both pre-test and post-test of control (Knowledge) and experimental group (Knowledge). The result indicated that in pre-test the mean score of high achiever students of experimental group knowledge component (M = 43.43, SD = 4.03, N=16) was not significantly more than the mean score for high achiever students of control group knowledge component (M=43.18, SD

=3.745, *N*=16) and *t* (30) = 0.182, *p*= 0.857 (sign 2-tailed), *d*= 0.064. The gain in the mean score was 0.250.The significance level was 0.05. Effect size (*d* = 0.064) was founded to be smaller than Cohen's (1988) small effect value (*d* = 0.2).

The result indicated that in pre-test the mean score of average achiever students of experimental group knowledge component (*M* = 32.82, *SD* = 3.66, *N*=29) was not significantly more than the mean score for average achiever students of control group knowledge component (*M*=32.75, *SD* =3.86, *N*=29) and *t* (56) = 0.070, *p*= 0.945 (sign 2-tailed), *d*= 0.0186. The gain in the mean score was 0.068. The significance level was 0.05. Effect size (*d* = 0.0186) was founded to be smaller than Cohen's (1988) small effect value (*d* = 0.2).

The result indicated that in pre-test the mean score of low achiever students of experimental group knowledge component (*M* = 18.16, *SD* = 5.54, *N*=12) was not significantly more than the mean score for low achiever students of control group knowledge component (*M*=17.91, *SD* =5.64, *N*=29) and *t* (22) = 0.109, *p*= 0.910 (sign 2-tailed), *d*= 0.044. The gain in the mean score was 0.25. The significance level was 0.05. Effect size (*d* = 0.044) was founded to be smaller than Cohen's (1988) small effect value (*d* = 0.2).

The result indicated that in pre-test the mean score of all the students of experimental group (*M* = 32.66, *SD* = 9.85, *N*=57) was not significantly more than the mean score for all students of control group (*M*=32.61, *SD* =9.69, *N*=57) and *t* (112) = 0.029, *p*= 0.977 (sign 2-tailed), *d*= 0.005. The gain in the mean score was 0.52. The significance level was 0.05. Effect size (*d* = 0.005) was founded to be smaller than Cohen's (1988) small effect value (*d* = 0.2).

The results of post-test indicated that the mean score of high achiever students of experimental group knowledge component (*M* = 51.75, *SD* = 4.41, *N*=16) was significantly more than the mean score for high achiever students of control group knowledge component (*M* = 47.25, *SD* = 4.44, *N*=16), *t* (30) = 2.87, *p*= 0.07 (sign 2-tailed), *d*=1.016. The gain in the mean score was 4.50. The significance level was 0.05. Effect size (*d* = 1.016) was founded to be greater than Cohen's (1988) large effect value (*d* = .80).

The results of post-test indicated that the mean score of average achiever students of experimental group knowledge component (*M* = 45.65, *SD* = 7.51, *N*=29) was significantly more than the mean score for average achiever students of control group knowledge component (*M* = 36.89, *SD* = 4.10, *N*=29), *t* (56) = 5.50, *p*= 0.000 (sign 2-tailed), *d*=1.447. The gain reported in the mean score was 8.75. The significance level was 0.05. Effect size (*d* = 1.447) was founded to be greater than Cohen's (1988) large effect value (*d* = .80).

The results of post-test indicated that the mean score of low achiever students of experimental group knowledge component (*M* = 42.50, *SD* = 4.88, *N*=12) was significantly more than the mean score for low achiever students of control group

knowledge component (M = 28.16, SD = 3.18, N=12), t (22) = 8.50, p= 0.000 (sign 2-tailed), d=3.481. The gain in the mean score was 14.33. The significance level was 0.05. Effect size (d = 3.481) was founded to be greater than Cohen's (1988) large effect value (d =. 80)

The results of post-test indicated that the mean score of all the students of experimental group knowledge component (M = 46.70, SD = 7.05, N=57) was significantly more than the mean score for all students of control group knowledge component (M = 37.96, SD = 7.84, N=57), t (112) = 6.25, p= 0.00 (sign 2-tailed), d=1.172. The gain in the mean score was 8.73. The significance level was 0.05. Effect size (d = 1.172) was founded to be greater than Cohen's (1988) large effect value (d = .80).

Table 2
Overall Comparison from Pre-test to Post-test Gain Scores of Control and Experimental Groups of Knowledge component

Group	Students	Pre-Test Mean	SD (Pre-Test)	Post-Test Mean	SD (Post-Test)	Gain	t-value	Sig (2-tailed)	Effect Size(d)
Control (N=57)	High achiever (16)	43.18	3.74	47.25	4.44	4.062	4.758	.000 ***	0.991
	Average achiever (29)	32.75	3.86	36.89	4.10	4.130	6.59	.000 ***	1.039
	Low achiever (12)	18.16	5.54	28.16	3.18	10.00	9.444	.000 ***	2.213
	Total (57)	32.61	9.69	37.96	7.84	5.350	9.70	.000 ***	0.607
Experimental (N=57)	High achiever(16)	43.43	4.032	51.75	4.41	8.31	8.322	.000 ***	1.969
	Average achiever(29)	32.82	3.66	45.65	7.51	12.82	8.69	.000 ***	2.171
	Low achiever(12)	17.91	5.64	42.50	4.88	24.58	12.93	.000 ***	4.662
	Total (57)	32.66	9.85	46.70	7.055	14.03	11.97	.000 ***	1.638

For finding the significant difference between the achievements of students of control group in pre-test and post-test, Paired sample t-test was applied. Same test was also applied on students of experimental group. The result indicated that in post-test the mean score of high achiever students of control group knowledge component (M = 47.25, SD =4.44, N=16) was significantly more than the mean score for high achiever students of control knowledge component group in pre-test, (M = 43.18, SD = 3.74, N=16) and t (15) = 4.758, p= 0.000 (sign 2-tailed), d=0.991. The gain reported in the mean score was 4.062. The significance level was 0.05. Effect size (d = 0.991) was founded to be greater than Cohen's (1988) large effect value (d = .80).

The result indicated that in post-test the mean score of average achiever students of control group knowledge component (M = 36.89, SD =4.10, N=29) was significantly more than the mean score for average achiever students of control group knowledge component in pretest, (M = 32.78, SD = 3.86, N=29) and t (28) = 6.59, p= 0.000 (sign 2-tailed), d=1.039. The gain in the mean score was 4.130. The significance

level was 0.05. Effect size (d = 1.039) was founded to be greater than Cohen's (1988) large effect value (d = .80).

The result indicated that in post-test the mean score of low achiever students of control group knowledge component (M = 28.16, SD =3.18, N=12) was significantly more than the mean score for low achiever students of control group knowledge component in pretest, (M = 18.16, SD = 5.54, N=12) and t (11) = 9.44, p= 0.000 (sign 2-tailed), d=2.2013. The gain in the mean score was 10.00. The significance level was 0.05. Effect size (d = 2.2013) was founded to be greater than Cohen's (1988) large effect value (d = .80).

The result indicated that in posttest the mean score of all the students of control group knowledge component (M = 37.96, SD =7.84, N=57) was significantly more than the mean score for all students of control group knowledge component in pretest, (M = 32.61, SD = 9.69, N=57) and t (56) = 9.70, p= 0.000 (sign 2-tailed), d=0.607. The gain reported in the mean score was 5.35. The significance level was 0.05. Effect size for this analysis (d = 0.607) was founded to be greater than Cohen's (1988) medium effect value (d = .50).

The result indicated that in post-test the mean score of high achiever students of experimental group knowledge component (M = 51.75, SD =4.41, N=16) was significantly more than the mean score for high achiever students of experimental group knowledge component in pre-test, (M = 43.43, SD = 4.032, N=16) and t (15) = 8.322, p= 0.000 (sign 2-tailed), d=1.969. The gain in the mean score was 8.31. The significance level was 0.05. Effect size (d = 1.969) was founded to be greater than Cohen's (1988) large effect value (d = .80).

The result indicated that in post-test the mean score of average achiever students of experimental group knowledge component (M = 45.65, SD =7.51, N=29) was significantly more than the mean score for average achiever students of experimental group knowledge component in pre-test, (M = 32.82, SD = 3.66, N=29) and t (28) = 8.69, p= 0.000 (sign 2-tailed), d=2.171. The gain in the mean score was 12.82. The significant level is 0.05. Effect size (d = 2.171) was founded to be greater than Cohen's (1988) large effect value (d = .80).

The result indicated that in post-test the mean score of low achiever students of experimental group knowledge component (M = 42.50, SD =4.88, N=12) was significantly more than the mean score for low achiever students of experimental group knowledge component in pre-test, (M = 17.91, SD = 5.64, N=12) and t (11) = 12.93, p= 0.000 (sign 2-tailed), d=4.662. The gain in the mean score was 24.58. The significance level was 0.05. Effect size (d = 4.6612) was founded to be greater than Cohen's (1988) large effect value (d = .80).

The result indicated that in post-test the mean score of all the students of experimental group knowledge component (M = 46.70, SD =7.05, N=57) was significantly more than the mean score for all students of experimental group

knowledge component in pre-test, (M = 32.66, SD = 9.85, N=57) and t (56) = 11.97, p= 0.000 (sign 2-tailed), d=1.638. The gain in the mean score was 14.03. The significance level was 0.05. Effect size (d = 1.638) was founded to be greater than Cohen's (1988) large effect value (d = .80)

Findings

There was no significant difference between the mean scores of pre-test of all the students of experimental and control groups. There was a significant difference between the mean scores of post-test of all students of experimental and control groups. There was a significant difference between the mean scores of pre-test and post-test of all the students of control group. But the effect size was small

In case of knowledge component, there was a significant difference between the mean scores of pre-test and post-test of all the students of experimental group.

Conclusion

From study it was concluded that all students were at same achievement level of knowledge component in the start of experiment. There was a significant difference between the mean scores of post-test of all the students of experimental and control groups. So, these all student showed improvement. There was a significant difference between the mean scores of pre-test and post-test of all the students of control group.

There was a significant difference between the mean scores of pre-test and post-test of all the students of Experimental groups. All the students of Experimental group showed an improvement. This improvement is more than the improvement of the control group.

Discussion and Recommendation

The findings and conclusions of this research study intended to find the objectives of the study. The objective of the study was to find the effect of formative assessment on the achievement of student in physics at secondary level. The study shows a significant effect of formative assessment on the achievement of students of experimental group in physics at secondary level. These results are similar to a research conducted by Mehmood (2012). In this study, he concluded that students assessed by formative assessment achieved significantly high scores than the students who were not assessed. Formative Assessment system comprising Self-assessment, Peer-assessment and Feedback may be practiced for the teaching of Physics at Secondary level. The teachers may use the Formative Assessment system as teaching method in teaching of Physics because it increases the achievements of students learning outcomes.

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