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Effectiveness of Formative Evaluation on Mathematics Achievement

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Abstract

Assessment plays a major role in how students learn, their motivation to learn, and how teachers teach. So in this research I have intended the effectiveness of the formative evaluation with analyzing non-cognitive behavior of students of basic level in mathematics. The mixed method approach was administrated for the study. The data were collected from achievement test of experimental and control group of students, interview and classroom observation form. It was found that there is no significant difference between the achievement score pre -test and posttest of the control group. But there is significant difference between achievements of the experimental group i.e, is the score of posttest is better than the pretest. Furthermore, the students who were teaching with different formative assessment strategies are more active and creative during the classroom teaching rather than the control group.

Key words: *Evaluation, variables, assessment, achievement, participation,*

Introduction

Due to globalization and the rapid growth of information and communication technology, the concept of mathematics in applied form is increasing (Starja & Nikolova, 2020)).It has great value of aspect as communication, transportation, agriculture, health, industry, kitchen, environment etc. It helps people to understand and interpret very important quantitative and qualitative aspect of living and natural phenomena. So, for understanding and interpreting of every discipline, mathematics is essential. The incorporation of the new aspects of the innovation in teaching and learning is crucial to develop qualified and appropriate human resources for the nation to make it successful and well developed (Retno, Arfatin et al. 2019). Mathematics, as we know today, is the science of numbers and their operation, interrelation and combination of space configuration and their structure, measurement etc (Stewart) et al., 1996). Students' achievement in mathematics reveals their mathematical knowledge and skill after their studies which represent their progress. It is measured since every course has its instructional objectives which have to be achieved. The procedures and techniques of judging students' achievement is understood as evaluation. Since the evaluation is crucial as in the central part of the whole educational process and program it should be an integral part of the day to day instruction by using different techniques and tools (Mock, 1970).

According to (Hoosain & Naraine, 1999) there are three types of evaluations; formative, diagnostic and summative. The summative evaluation is also called the evaluation of the learning is defined as collection of data after instruction occurred to make judgments about the instruction such as grading, certification, evaluation of process, or research on effectiveness. Thus, any assessment that examines what a child has learned or did not learn from previous instruction could be conceptualized as part of a summative evaluation (Findley, 1971; Hargrave, 2004).

The diagnostic evaluation is that kind of evaluation in which the teacher identifies the obstacles and weaknesses of learners through diagnostic tests and then uses different remedial strategies (Mohan, 2016; Sherman, 1978).

Formative evaluation is also called evaluation for the learning is defined as a primary building process which accumulates a series of components of new materials, skills and problems into an ultimate meaningful whole (Sherman, 1978). It is also an on-going classroom process which is used to monitor the learning process during instruction. Its purpose is to provide continuous feedback to both teachers and pupils concerning learning success and failure. So that reinforcement of learning & correction of learning errors can effectively be done.

Formative evaluation is a kind of evaluation which is the means of obtaining specific information on the progress of students' learning on appropriate knowledge, skills and abilities. Formative evaluation can help to identify students who can do mental arithmetic problems in mathematics and those who cannot. In addition, the specific information obtained about the instructional process through formative evaluation would help to improve learning. The techniques of formative evaluation are observation of students' activities, questioning students, etc. (Bernard, 2013).

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Formative evaluation includes several types of evaluation, such as need assessment, evaluability assessment, structured conceptualization, implementation evaluation and process evaluation. Need assessment seeks to determine who needs the program, how great the need is, and what might work to meet the need; while evaluability assessment attempts to determine whether an evaluation is feasible and stakeholders can help shape its usefulness (Alonge, 1986). Similarly, structured conceptualization helps stakeholders define the program or technology, the target population, and the possible outcomes. Furthermore, Implementation evaluation monitors the fidelity of the program or technology delivery.

For assessing the student's progress and achievement of students both the summative and formative evaluation are necessary. Moreover, for better achievement of students, the formative assessment guide helps the learners in getting betterment in scores as well as the clarity of the content matter (Agostino et al. 2019). This study intended to identify the effectiveness of formative assessment of the students' achievement in mathematics. Effect of formative evaluation in mathematics achievement means that how the influence of mathematics achievement plays a role toward the students. The researcher gave the main focus in the achievement of the students and non-cognitive improvement of students in mathematics achievement at basic level.

In Nepalese context, school level as well as the higher level mathematics has been taken as a harder and unjucy subject. Also the students' achievement in mathematics compared to other subjects is very low (NASA, 2019). According to an educational report of an economic survey the achievement of mathematics in class 8 was 43% and 35% at 2071 and 2072 respectively. From this report the researcher came to know that the achievement of mathematics is not satisfy. Among different factors that made mathematics learning processes become challengeable, the

evaluation and assessment of students is one of the most influencing factors. Therefore, the main concern of this study was to seek answers to the following questions.

- Does formative evaluation affect the achievement of students in mathematics?
- Does the achievement of the students differ with and without using formative evaluation in mathematics teaching?
- How to analyze the non-cognitive behaviour of students?

So, the findings of this study intended to determine the effects of formative evaluation in mathematics achievement at basic level. This study would be helpful to direct the teachers for effective teaching; this also would be helpful directly to the curriculum planners, question setters and other concerned persons. Mainly the findings of this study will be significant for mathematics teachers, school administrators, educational planners, students and other stakeholders of the education sectors.

Objective of the Study

The main objective of this study was to find the effect of formative evaluation on mathematics achievement at basic level students. This was accomplishing by the following objectives:

- · To compare the mathematics achievements of students with and without using formative evaluation.
- To analyze the improvement in non-cognitive aspects of students.

Hypothesis of the Study

The use of formative evaluation provides effective results in terms of students' achievement in geometry compared to traditional teaching approaches. The statistical hypothesis of this study was:

Null Hypothesis (H_0): There were no significant differences between the mean achievements of the students and those who would be taught by formative evaluation and traditional approach. i.e.$H_0 : \mu_1=\mu_2$

Alternative hypothesis (H_1): The average achievement of the students taught by the formative evaluation is significantly higher than the average achievement of students taught by traditional methods. i.e. $H_1 : \mu_1>\mu_2$

Literature Review

According to Shute (2008) the formative feedback should be non-valuable, supportive, timely & specific. The research showed that interest with formative feedback's success at promoting learning gave better achievement in the learning process. Joshi (2010) concluded that the achievement of the experimental group was better than the achievement of the control groups. So, mathematics achievement of students taught by using formative evaluation was found better than without using formative evaluation at secondary level. But in this study, the researcher tries to find out the effect of formative evaluation on mathematics in basic level as well as to find out how to analyze the improvement in non-cognitive aspects of students. The teacher's strength in her ability to gather formative information, the strong connection between assessment and personal relevance, and the roadblock that time presents to providing meaningful formative assessments for all students Nunn (2014).

Moyosor (2011) conducted experimental research among 120 Mathematics students in secondary schools in Nigeria recommended that all school Administrators should emphasis the use of

formative assessment by all teachers and they should allow, encourage and provide incentives for them to attend seminars, workshops, conference and in-services training to enhance their performance and to acquire necessary skills for constructing formative tests homework assigned with feedback caused better achievement than homework assigned without feedback.

Joshi (2015) concluded that the main achievement scores of students taught by using formative evaluation becomes higher than the mean achievement scores of students taught without using formative evaluation in teaching mathematics. So, mathematics achievement of students taught by using formative evaluation was found better than without using formative evaluation at secondary level.

Kivuti (2015) found that mathematics teachers employed assignment tests as a formative evaluation approach to measuring students' progress in mathematics performance which form an integral part of the education system and that frequent assessment of students' performance has demonstrated to improve student outcomes. Also, in improving classroom practice and students' performance, the assessment is a crucial tool. and that it can enhance teaching and learning by providing a more focused application for learners. The study concludes that formative evaluation enables teachers to adjust their teaching to meet individual student needs, and to better help all students to reach high standards. But there was not studying in basic level students' as well as to find out the analyze the improvement in non-cognitive aspects of students.

Therefore, a number of researches mentioned above carried out different researches, websites, and books written by different scholars have directly or indirectly highlighted the importance of the teaching materials. This study was certainly different from the other studies. This study would show the effect of formative evaluation on mathematics teaching in the context of Nepal. In this research work, the researcher would try to find out the effect of formative evaluation on mathematics achievement at basic level as well as to find out how to analyze the improvement in non-cognitive aspects of students. So the present study aimed to find out the effect of formative evaluation on mathematics achievement at basic level as well as to find out how to analyze the improvement in non-cognitive aspects of students.

Methods and Procedures

I adopted a sequential explanatory mixed method with the pre-test and post-test non-equivalent group design with two groups one is experimental and another is a control group. The experimental group was taught by using formative evaluation as intervention that of the control group as usual. The independent variable was the treatment and the dependent variable was achievement of the students. The design of this study was as follows:

Table no.1: Design of the Study

Groups	Pre-tests	Treatment	Post-tests
Experimental	O_1	X	O_2
Control	O_3	-	O_4

Population and Sample of the Study

As far as the population of this study, all basic level students' of Bhaktapur district who were studying at grade VIII were taken as the population of the study. And two Schools which are more equivalent in different aspects like geography, previous results, etc, were chosen purposely as sample schools. Among them a control group and an experimental school was chosen as a lottery method. The students in the control group consisted of 35 students and that of the experimental group consists of 30 students. Formative evaluation, continuous assessment, frequency of formative evaluation, feedback on formative evaluation was independent variables. Student's achievement and student's achievement in mathematics perceptions towards mathematics, teaching approaches, group discussions, homework, motivation, regularity, teacher guided revision were dependent variables. Selection of school, instructor/teacher, subject matter, group, experimental time, test, scoring, students' labor home environment, tuition, history and maturation are considered as extraneous variables in this study.

Tools for Data Collection

The achievement test containing 14 questions of knowledge, skill and problem solving was taken as the collection of quantitative data. The classroom observation form and the is taken for qualitative data. The items of achievement test were finalized with the result of item analysis from piloting it among the non-sampled group. The subject experts' view along with item analysis was used for validating the tool and finding the reliability of the tool. The observation form was validated by piloting and expert judgments.

Process of Data Collection

After selecting the experimental and control groups, I had visited the sample schools. I have requested both schools about my purpose. I had administered the pre-test to determine the proficiency level of students in the selected topic before treatment. Both groups were taught the same lesson by the researcher only 45 min in a day during four weeks with teaching plan. After completing the four week lessons, I had administered post test to both schools. During the teaching, I had observed the classes of both experimental and control group.

Data Analysis Procedure

The data from achievement test scores have been analyzed using inferential statistics z- test with 0.05 level of significance by calculating the mean and standard deviations from pre and post test. The data from observation were analyzed and interpreted by triangulation and explanation method with literature review. Informed consent was the main method of ethical consideration.

Results and Discussions

The main focus of this study was to explore the effectiveness of formative evaluation in mathematics achievement at basic level. Achievement of the students was the main parameter to explore the effectiveness of formative evaluation. For this purpose, achievement of basic level students was collected. So, here we discuss the statistical analysis and interpretation of data obtained from the achievement scores of the students. These data were analyzed by using mean, variance, standard deviation and z-test. The data of the achievement test scores was analyzed under the following topics headings.

Comparison of the Achievement Score of Students in the Pre-test

Pretest was taken as the purpose to find out the gap between the experimental and control groups and to establish the null hypothesis of this study. In order to test the null hypothesis, the researcher established two equivalent groups of the students on the basis of coin tossing. The two tailed z-test was used in order to as certain that the difference between two tailed z-test was used

in order to ascertain that the difference between two groups was statistically significant or not. The statistical calculation of the pretest of both groups was given in the table below.

Table no.2: Achievement score of students in the pre-test

Group	**Sample size**	**Mean**	**S.D.**	**Variance**	**t-value**	**Remarks**
Control group	35	8.8	2.24	5	0.18	0.18 <2.00
Experimental group	30	8.9	2.23	4.97		

Degree of freedom (df) 63, t =2.00

The table no. 2 shows that the number of students in the control group and experimental group were 35 and 30 respectively. In the pre-test total, mean scores of the control groups and experimental groups were 8.8 and 8.9 respectively. From this result shows both groups of students were the same level. The calculated standard deviation for control and experimental group were 2.24 and2.23 respectively from this result; it shows both groups of students were the same level. Similarly, the variance of the experimental group was 4.97 and control group was 5 from this result shows both groups of students are the same level. The calculated t-value (0.18) at degree of freedom 63 was less than the tabulated value (2.00). Thus, the difference in mean score of experimental and control group on pre-test score was found to be insignificant at 0.05 levels with degree of freedom at 63.

The total mean score, standard deviation, and variance of both groups were found to be nearly equal. It means the divided two groups (experimental and control group) were equivalent or homogeneous in nature before using treatment. Similarly, the calculated t-value of total pre-test result shows that the null hypothesis was accepted and alternative hypothesis was rejected. Thus, the students of the experimental and control group were equivalent in the understanding of teaching lessons before the experimentation.

Comparison of the Achievement Score of Students in the Post-test

The mathematics achievement test in post-test was taken. The post-test of total mean score, standard deviation, variance, and *z*- value of score obtained by an experimental and control group of two schools. The statistical calculation of the post -test of both groups have been given as below.

Table No. 3: *achievement score of students in the post-test*

Group	Sample size	Mean	S.D.	Variance	t-value	Remarks
Control group	35	9.6	2.52	6.35	2.13	2.13 >2.00
Experimental group	30	11.2	3.41	11.63		

Degree of freedom (df) 63, t =2.00

This table no. 2 shows the number of students who were 35 and 30. The mean score of the students in the control group and experimental group were found to be 9.6 and 11.2 respectively; from this result the students of the experimental group got more marks than the control group. The standard deviation of the students in control and experimental groups were 2.52 and 3.41 respectively; from this result the students of the experimental group got more marks than the control group. Similarly, the variance of students of control and experimental group were 6.35 and 11.63 from this result; the students of the experimental group got more marks than the control group. The calculated *t-value* was 2.13 at 0.05. From above data it shows that the calculated *t-value* (2.13) was greater than the tabulated *t-value* 2.00. Thus, there was a significant difference between experimental and control groups due to experimental treatment provided to that of the experimental group and conventional treatment for the control group. Hence, the hull hypothesis was rejected and the alternative hypothesis was accepted. It concluded that the achievement of the experimental group was significantly better than the control group.

Therefore, I analyzed that formative evaluation played a vital role in teaching learning activities because with the help of formative evaluation learners can get a chance to see as well as hear from which they can learn many more.

Comparison between Result of Pre-test and Post-test

To find out differences, the researcher used both the methods i.e., conventional method and experimental method, both of these methods were used for treatment to find out more effectiveness of formative evaluation. To find out which method is more effective the researcher has used this product comparatively. By doing comparative analysis of pre-test and post-test results, the researcher would find out the better one. Results of pre-test and post-test were compared under the following sub headings.

Scores in Mathematics Teaching Obtained by Control Group

The pre-test and post-test mean score, standard deviation, variance and corresponding t-value obtained by the control group of students has been given below.

Table No. 4 Scores in mathematics teaching obtained by control group

Group	Sample size	Mean	S.D.	Variance	*t-value*	Remarks
Pre test	35	8.8	2.24	5	1.36	1.36 <2.00
Post test	35	9.6	2.52	6.35		

Degree of freedom (df) 68, t =2.00

The table no 3 shows the comparative study of the pre-test and post-test of the control group. The pre-test and post-test mean scores of students in the control group (taught without using formative evaluation) which were found to be 8.8and 9.6 respectively. The standard deviation and variance were 2.24 and 5for pre-test, 2.52 and 6.35 for post-test. The calculated *t-value* was found to be 1.36, which was less than tabulated *t-value* (2.00) at 0.05 level of significance. It shows that there is no significant difference between two mean achievement scores in pre-test and post-test.

Hence, the alternative hypothesis was rejected and the null hypothesis was accepted i.e., there is a significant difference between pre-test and post-test was slightly increased in the absence of formative evaluation than pre-test.

Scores in mathematics teaching obtained by experimental group

The pre-test and post-test mean score, standard deviation, variance and corresponding t-value obtained by the experimental group of students has been given below.

Table No. 5: Scores in mathematics teaching obtained by experimental group

Group	Sample size	Mean	S.D.	Variance	t-value	Remarks
Pre-test	30	8.9	2.23	4.97	3.07	3.07 >2.00
Post-test	30	11.2	3.41	11.63		

Degree of freedom (df) $_{58}$, t =2.00

The above table no. 5 shows the comparative study of the pre-test and post test result of the students. The number of students involved in pre-test and post-test were nineteen. The mean score obtained in pre-test was 8.9 and post-test was 11.2. The standard deviation and variance of the scores obtained in pre-test were 2.23 and 4.97 respectively. Similarly, the standard deviation and variance of the scores obtained in post-test were 3.41 and 11.63 respectively. The calculated t-value was 3.07 in the two-tailed test at 0.05 level of significance, which was greater than the tabulated t-value.

Hence, the null hypothesis was rejected and an alternative hypothesis was accepted. It has concluded that the pre-test and post-test achievement of the experiment was significantly better than the control group. The researcher concluded that formative evaluation plays a vital role in teaching learning activities because with the help of formative evaluation learners can get a chance to see as well as hear from which they can learn many more.

Thus, the researcher concluded that the student's mean achievement of the experimental group who were taught by using formative evaluation was found better than that of the control group, who were taught without using formative evaluation in teaching mathematics at basic level.

I have fixed a 30 days' time period for this study. In which, the researcher taught the experimental group by giving the treatment and control group without giving treatment. During this teaching, it was seen that the presence of the students of the experimental group also increased. The teachers of that school were also positive towards the formative evaluation and they really helped a lot while concluding the experiment. There was a little bit of discussion between the researcher and the students at the time of group division. Then, the researcher had described the purpose and importance of formative evaluation to the students. After mentioning them about the formative evaluation, they took it easily and understood its value. The experimental group was taught with formative evaluation and the control group was taught as usual. During the experimental teaching, the progress of the experimental group was found better than that of the control group. The use of formative evaluation in teaching had really made the researcher fully devoted to teaching with good preparation.

In this way, I have conducted class tests, unit tests, classroom assignments and the student's performance was checked. When the researcher took the posttest after a 30 days experiment. He

found that the achievement level of experimental groups was better than the control group. Therefore, it concluded that application of formative evaluation in teaching is better for low grade achiever students.

Responses of Students about Formative Evaluation in Teaching Mathematics for Non-Cognitive Aspects

Qualitative analysis is prepared on the basis of classroom observation notes which I have made with the participant observation to increase validity of the study. I have noted activities of students, student's participation, regularity and problem solving capacity of the students. In this study, I have carried out the effect of formative evaluation in teaching mathematics as well as their non-cognitive aspect at basic level. In the control group the students felt mathematics is such a difficult subject. Their attendance was low and they did not do their homework regularly. They used to be busy working at home. So they did not come to school regularly. During the class, no one asked the question and they felt very bored in the mathematics period.

I have taught the experimental group for 30 days by using formative evaluation. I found that the students' activities were changed in different aspects. The class of experimental groups was found as follows:

Episode I

I have entered the class with a kitbox of geometry. After that I asked the students about the previous class and homeworks. I have reviewed the previous class by asking questions to them and providing feedback for their response. After review, I have started the new topic by relating it with previous class and continuously using different strategies of formative evaluation such as question answers, short writing, class work and many more. The students are highly participating in teaching and learning activities. This process is continuously repeated for the compilation of topics. After completion of the unit I have conducted a unit test and analyzed the result. The students who have confusions and weaknesses are resolved by me. During the teaching in experimental groups, I have regularly recorded the students' behaviours and activities.

Episode II

I have entered the class with a kitbox of geometry. After that I asked the students about the previous class and homework. Then I wrote today's topic on the board. I do not use question answers as well as the strategies to measure the students' understanding level. The students are highly engaged in copying the solutions from the board. This process is continuously repeated for the compilation of topics. There were no other terminal and unit exams conducted for students evaluation and during the teaching in control groups, I have regularly recorded the students behaviors and activities.

The above classroom episode indicates that the teaching of mathematics at basic level with using formative evaluation is more meaningful teaching. The students were regularly assessed by using different strategies highly active in the classroom teaching learning process. Without using formative evaluation in teaching mathematics at a basic level the teaching is incomplete and boring for the students also.

It was possible to use formative evaluation while teaching the students daily. The researcher had found that the teaching materials group was not as effective as the teaching experimental group

because students of the control group were not curious and interested in reading the chapter seriously. They neglected both subject teacher and researcher. In the control group the researcher noticed the problem of irregularity of students in class, no regular homework and class work. They attend classes only due to parents and teachers pressure. Most of the students didn't ask any questions in the classroom. They only wrote the solution of the problem in their copies which was solved by the teacher. The participation of students in learning activities was passive, weak performance of students was observed but the students of the experimental group were observed but the students of the experimental group were excited for learning, motivated, curious when treatment was started students were rarely absent. Thus I have observed the participation, feelings, motivation, regularity and performance of students.

Furthermore, it was observed that the teachers and students from the experimental groups are more active as well as conscious about the test as well as responsible for the process as well as the outcome. The students who had taken the formative evaluation were more active and highly participatory with comparison of the students from the control group.

Conclusion

This research aimed to find the effectiveness of formative evaluation in mathematics achievement at basic level. Also, it aimed to compare the mathematics achievements of students with and without using formative evaluation and to analyze the improvement in non-cognitive aspects. Students who were taught by using formative evaluation during teaching learning got better achievement than that of as usual. In meaningful concept making in mathematics the formative evaluation technique is more appropriate for students. The formative evaluation not only helped in better achievement but also to motivate and encourages themselves in mathematics learning. It is also found that to make the students active in classroom practice, creative as well as critical about the content matter the formative evaluation are essential. To decrease students absent rate and to refresh the content matters. Thus it is observed that the participation, feelings, motivation, regularity and performance of students are increased by regular formative assessment.

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