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Effectiveness of Non-Traditional Activities to Develop the Mathematical Higher Order Thinking Skills of Grade-Seven Students

EMMANUEL P. ABUZO
ORCID No. 0000-0001-9203-9081
abuzoemmanuel@gmail.com
Sawata National High School
Davao del Norte, Philippines

ABSTRACT

Developing critical thinking and problem solving skills of students are some of the important goals that every school must set. This study determined the effectiveness of non-traditional activities to develop mathematical higher order thinking skills of grade seven students. This study employed the non-equivalent control group experimental design, which involved 83 grade 7 students of Sawata National High School. There were two sections used in this study, the control group which the researcher used the traditional lecture activity and the experimental group, were the students exposed to non-traditional activities: manipulative activities, computer-aided activities, and reflective writing activities. The specific subject matters covered were the second-grading mathematics seven topics which are measurement and measuring of length, measuring mass/weight and volume, and measuring angles, time and temperature. The data were gathered using the multiple choice teacher's made test in the pre-test and post-test. Prior to the study, the higher order thinking skills of the two groups had no significant difference. The result changed after the treatment was given. The study concludes that the used of non-traditional activities were effective over the traditional activity in the development of the higher order thinking skills of

the students. The study recommends integration of non-traditional activities to develop the higher order thinking skills of the students.

Keywords **-** Education, non-traditional activities, higher order thinking skills, experimental, non-equivalent, Davao del Norte, Philippines

INTRODUCTION

One of the most important educational goals that every school must set, across all year levels, especially in mathematics, is developing problem solvers which involve higher order thinking skills and critical analysis (Jonassen, 1997). However, in most schools, this is one of the challenges that the teachers are facing in teaching-learning process. Some of the learners cannot easily connect their prior knowledge and experiences to the new topic even it was in the same context (Leongson & Limjap, 2003). In Nebraska, some secondary school teachers were frustrated to their learners' low-level results in the tests and assignments even sufficient time and activities were given according to Dean (2008) in his study due to poor connection of the foregoing knowledge to a new topic. If the factual knowledge of the learners cannot link and translate to other disciplines, the thinking skills of the learner are in low level. The students must develop thinking skills that disable them to isolate the facts they gathered and acquired that these information can associate to other disciplines and can be used to solve problems and to form another knowledge (Leikin & Waynberg, 2007).

As specified in the Philippine Constitution of 1986, all educational institutions in the Philippines must nurture Filipino learners to be creative and critical thinkers. Aligned to this, the Department of Education aims to create critical and problem solver learners by engaging to contextualize realistic problems. However, despite in this quest in building Filipinos with higher order thinking abilities, the current methods of teaching-learning process, both public and private schools, is ineffective in developing such abilities to Filipino learners. Ramirez and Ganaden (2010) mentioned in their study that the results in different competency-based examinations in 2004 in terms of mastery level were dreadful especially in Science, in English, and in Mathematics. The poor performance of the Filipino learners in terms of international achievement examination like Trends in International Mathematics and Science Study implies continuing decline in the quality of Philippine education. These poor performances in strongly indicate undeveloped higher order thinking skills or abilities. Because the test required

reasoning and analyzing skills, as well as about factual knowledge and conceptual understanding, the lack of these led to faulty achievement (Mullis et al., 2004).

Sawata National High School has faced the same dilemma in terms of the problems mentioned. Students could not easily connect a previous knowledge to a new one, and they schemed to forget what were discussed previously. The National Achievement Test mean percentage score of Sawata National High School in relation to Mathematics and Science were lower compared to the national, regional, and division passing rates in 2011. In the Division report in SY 2011 – 2012, one of the least learned competencies of students was the problem–solving. The least ability of the students to answer correctly the problems in the examination implied that students did not develop well their critical thinking abilities.

For the above reasons, the researcher attempted to investigate the effectiveness of using non–traditional activities in the classroom to develop and evaluate high order thinking skills of grade seven students. The output of this research can assist teachers in integrating non - traditional activities with instruction to develop and improve the high order thinking skills of the students.

FRAMEWORK

The theoretical framework in this study was based on cognitive learning theories as applied to the problem solving and critical thinking. This framework was anchored on Jean Piaget's constructivism which state that it is a learning procedure which permits a learner to encounter an environment direct, in this manner, giving the learner dependable trust-commendable information (Krontiris-Litowitz, 2003). The learner is obliged to follow up on the environment to both procure and test new learning. Constructivism also described as a model that explains the arrangements with the way individuals make importance of the world through an arrangement of "individual construct" (Shapiro, 2001). Constructs are the different types of filters people choose to place over their realities to change their reality from chaos to order.

This study also supported by the studies using meta-analysis which conclude that computer-based activity provides positive effects to the levels of mathematical achievement of the learners (Kulik, 1994 & Sivin-Kachala, 1999). The theory mentioned above were outlined primarily as an informative structure inside the field of human development applied to mentor-learner connections where instructor might be taken to incorporate peers especially in the interaction

between learner and teacher through technology according to Mcmahon in 2009.

This study was likewise adjusted to experiential learning theory which expressed that learning is the procedure whereby information is made through the conversion of experience. This kind of learning could be characterized as the methodology whereby information is made through the change of experience. Information results from a blending of getting a handle on and changing encounters (Pugalee, 2001). The experiential theory viewed as more complete approach and stresses how encounters, including comprehensions, ecological elements and feelings impact the learning methodology (Holliway, 2009).

Operationally, non – traditional activities are learners focused exercises where there is more chance to handle thoughts and to work synergistically. Manipulative activities are make utilization of manipulative items to ponder a theme. Computer-aided activities are exercises utilizing computer programs and instructions as a part of the major learning process. Reflective writing activities are exercises in which an understudy composes what are realized, what are the troubles they experienced, and how they face these challenges. Traditional activity is an instructor focused methodology where the educator is the wellspring of the data and the learners are the beneficiaries of the data. Address system for educating is a work on having an educator, or instructor, in the classroom conversing with learners. This is seen as restricted correspondence, since the speaker is the one and only talking. Basic deduction aptitudes are abilities in which the understudy enhances the nature of his or her reasoning by skillfully assuming responsibility of the structures characteristic in intuition and forcing scholarly measures upon them.

Parts of high – order thinking skills are analyzing, evaluating, and creating. Analyzing is an ability of differentiating ideas from segment parts so that the understudy comprehends a hierarchical structure. Evaluating is an expertise of making judgments about the estimation of a thought or thing. Creating is an aptitude of making new items or thoughts out of a past inform.

OBJECTIVE OF THE STUDY

The objective of the study is to determine the effectiveness of non-traditional activities which are manipulative activities, computer-aided activities, and reflective writing activities to the development of mathematical higher order thinking skills of grade seven students.

Hypotheses

The following null hypotheses were treated at the given level of significance states that:

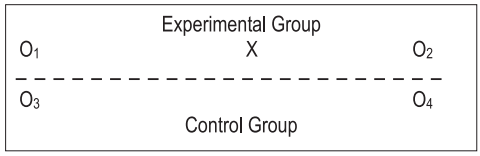
1. There is no significant difference between the pretest mean score of the experimental group and the control group in higher order thinking skills in terms of:
    1.1 Analyzing,
    1.2 Evaluating,
    1.3 Creating.
2. There is no significant difference between the pre-test and post-test means score of the experimental group in terms of the same thinking skills.
3. There is no significant difference between the pre-test and post-test mean score of the control group in terms of the same thinking skills.
4. There is no a significant difference between the mean gain score of the experimental and control group in terms of the same thinking skills.

METHODOLOGY

Research Design

This study used the quasi – experimental design which was a non – equivalent control group pretest – posttest design. This design involved two different groups of students; the experimental group and the control group. Both groups were given the same pre-test and post-test. After giving the pre-test, the experimental group was treated to non – traditional activities while the control group was exposed to traditional activity. The respondents were intact group of grade seven students in a naturally assembled setting at Sawata National High School, Sto. Niño, San Isidro, Davao del Norte.

The design is exemplified in the diagram below:



Where: O_1 = Pre-test of the experimental group
O_2 = Post-test of the experimental group

O_3	=	Pre-test of the control group
O_4	=	Post-test of the control group
X	=	Treatment of the experimental group using non-traditional activities
-----	=	Non-random assignment of subjects

Research Subject

The study was conducted at Sawata National High School, Sto. Niño, San Isidro, Davao del Norte, whose participants in this investigation were students in Grade Seven of S.Y. 2012 – 2013. Shown in table 1 is the respondents of the study.

Table 1. Distribution of respondents

Section	Male	Female	Total
Rose (Control Group)	16	22	**38**
Dahlia (Experimental Group)	25	20	**45**
Total	**41**	**42**	**83**

Section Rose with 38 students was considered as the control group and section Dahlia with 45 students was considered as the experimental group. Both sections had the same syllabus and references. However, the experimental group had non – traditional activities while the control group had traditional activity. Both groups were handled by the researcher. The first-grading mean grade of the control group was 80.43 with the standard deviation of 13.09 while the first-grading mean grade of the experimental group was 80.06 and the standard deviation of 13.37. The mean grade and the standard deviation of the two groups were almost the same.

This result implies that the two groups were comparable with each other. The researcher secured informed consent from the study subjects in compliance to research ethics protocol.

Research Instruments

This study used a researcher – made test in mathematics for the second grading-period. Contents were as follows: measurement and measuring of length, measuring mass/weight and volume, and measuring angles, time and temperature, dealing with higher order thinking skills. The instrument utilized within this study was produced by the researcher and with the guidance and

suggestions of his adviser. The pre-test and the post-test were designed to measure the higher order thinking skills of the respondents. To ensure the test's validity of the research questionnaire, a table of specifications were drawn up to facilitate the crafting of the test. The pre-test and the post-test content validity were carefully checked and validated by the panel of validators. After the validation, this was pilot–tested to 49 students to establish the reliability and construct validity of the test. The results showed that the test instrument had a reliability index of 0.865 which suggests good internal consistency. All of the items on the test had more than 0.3 discrimination index which denotes all of the items were good items.

The respondents took the test twice with the same content of the test, pre-test and post-test. The pre-test was administered to all subjects prior to the treatment. The pre-test was helpful in assessing students' prior knowledge of the topics and also in testing initial equivalence among groups. The post-test was administered to measure treatment effects.

The following parameters were observed in the scoring of the Pre-test and Post-test results:

Range	Qualitative Description	Level
4.80 – 6.00	Outstanding	Denotes very high level of achievement.
3.60 – 4.79	Very satisfactory	Denotes a high level of achievement.
2.40 – 3.59	Satisfactory	Denotes a moderate level of achievement.
1.20 – 2.39	Poor	Denotes a low level of achievement.
0.00 – 1.19	Very poor	Denotes a very low level of achievement.

The following parameters were observed in getting the mean gain score of the experimental group and control group.

Range of Mean	Qualitative Description	Level
3.09 – 3.86	Very High	Denotes very high improvement in the level of performance
2.32 – 3.08	High	Denotes high improvement in the level of performance
1.55 – 2.31	Moderate	Denotes moderate improvement in the level of performance
0.78 – 1.54	Small	Denotes small improvement in the level of performance

0.01 – 0.77	Very Small	Denotes very small improvement in the level of performance
0.00	No Improvement	Denotes no improvement in the level of performance

Data Analysis

To test the theories defined, the accompanying factual instruments were utilized within the examination: mean gain scores, mean scores, t-test for uncorrelated samples, t-test for correlated samples.

RESULTS AND DISCUSSION

The Comparability of the Experimental Group and Control Group

The mean score of the experimental group was 0.82 which has a description of very poor performance. Up to the higher order thinking skills of the experimental group, analysis had a mean of 1.27, evaluation, 0.96; and, the creation, 0.80. Data revealed that only analyzing skill of the experimental group had the description of poor performance and the rest of the skills were very poor. The mean score of the control group was 0.82 which was very poor. The analyzing skill of the control group was 1.26; evaluating, 0.92; and, the creating of 0.24. Only the analyzing skill had a description of poor and the rest were very poor. This means that prior to the study, the students of the experimental and control group had the same level of higher order thinking skills in terms of the first six topics covered by the second-grading period which needs to be improved.

The computed t-value of the pre-test mean scores of the experimental and control group in terms of analyzing was -0.017 while the evaluating was -0.173 and creating of -0.362 with an overall pre-test mean scores t-value of- 0.204. These t-values were all located in the noncritical region with a critical value of ±1.98 at 0.05 level of significance. The results revealed that the experimental group and the control group were comparable prior to the experiment. This enables the researcher to reject the null hypothesis stating that there was no significant difference between the pre-test mean score of the experimental group and control group.

Table 2. Pre-test mean score of the experimental and control group

Higher Order Thinking Skills	Pre-test Mean Score of the Experimental Group	Description	Pre-test Mean Score of the Control Group	Description	Computed t-value	Tabular value @ $\alpha = 0.05$
Analyzing	1.27	Poor	1.26	Poor	$- 0.017^{ns}$	**±1.98**
Evaluating	0.96	Very Poor	0.92	Very Poor	$- 0.173^{ns}$	
Creating	0.80	Very Poor	0.24	Very Poor	-0.362^{ns}	
Overall	**0.82**	**Very Poor**	**0.80**	**Very Poor**	**-0.204^{ns}**	

ns = Not significant

The Post-test Mean Score of the Experimental Group

The table 3 has shown a significant improvement of the experimental group from an average of 0.82 which has a description of very poor to 2.64 which has a description of satisfactory. To be specific, the analyzing skill of the experimental group increased from 1.27 to 2.98 which can be described to be of moderate improvement. The evaluating skill of 0.96 was increased to 2.91 with a description of satisfactory. The poor performance of the creating skill of the experimental group was moved to satisfactory with a mean score of 2.51. Overall, the higher order thinking skills of the experimental group was increased to 2.80 with a description of satisfactory from 0.82. It is implied that the non – traditional activities introduced to the students were effective in developing the higher order thinking skills of the students. This result was supported by the study conducted by Forawi in 2012 that proving the used of non – traditional activities in the classroom enhanced the development of the students' higher order thinking skills.

Table 3. The Post-test mean score of the experimental group

Higher Order Thinking Skills	**Post-test Mean Score of the Experimental Group**	**Description**
Analyzing	2.98	Satisfactory
Evaluating	2.91	Satisfactory
Creating	2.51	Satisfactory
Overall	**2.80**	**Satisfactory**

The Significant Difference of the Pre-test and Post-test Mean Score of the Experimental Group

Depicted in table 4 the comparison between the pre-test and post-test mean score of the experimental group. The computed t-value in analyzing was -9.892 while in the aspect of evaluating, it was -9.734; and, as to creating, it was -19.483. The overall mean had a computed t-value of -18.916. All computed t-values were significant at α five percent level of significance at a value of –2.010. This result implied that the null hypothesis stated that—there is no significant difference between the pre-test and post-test mean score of the experimental group was rejected.

Table 4. The Pre-test and post-test mean score of the experimental group

Higher Order Thinking Skills	Pre-test Mean Score	Post-test Mean Score	Computed t-value	Tabular value @ α = 0.05
Analyzing	1.27	2.98	-9.892[s]	
Evaluating	0.96	2.91	-9.734[s]	
Creating	0.80	2.51	-19.483[s]	**±2.010**
Overall	**0.82**	**2.80**	**-18.916[s]**	

s = Significant

The Post-test Mean Score of the Control Group

The table revealed the significant improvement of the control group after the experiment. The analyzing skill of the control group increased from 1.26 to 2.58 with the description of satisfactory. The evaluating skill of this group also increased from very poor to satisfactory with the mean score of 2.42. The creating skill also improved from 0.24 which was very poor to 2.42, which is satisfactory. The overall post-test mean score of the control group increased from very poor to satisfactory which has a mean score of 2.47.

This result indicates that still the lecture method, which was considered a traditional method in the learning process, was effective in developing the higher order thinking skills of the students. The result used with Lin in her study of 2009 that traditional activities like lecture increases the performance of students. Thus, it also augments the development of the higher order thinking skills of the students.

Table 5. Post-test mean score of the control group

Higher Order Thinking Skills	Post-test Mean Score of the Control Group	Description
Analyzing	2.58	Satisfactory
Evaluating	2.42	Satisfactory
Creating	2.42	Satisfactory
Overall	**2.47**	**Satisfactory**

The Significant Difference of the Pre-test and Post-test Mean Score of the Control Group

The computed t-value of the control group in terms of analyzing was -8.199 while the evaluating was -10.021 and the creating was -3.950. The overall computed t-value of the higher order thinking skills of the control group was -8.370. These computed t-values were significant at alpha 0.05 level of significance which has a tabular value of ±2.021. This confirmed the result of table 3.6 that the traditional activity contributes the increased in the higher order thinking skills of students in the control group. This enabled the researcher to reject the null hypothesis stated that there was no significant difference between the pre-test and post-test mean score of the control group.

Table 6. The pre-test and post-test mean score of the control group

Higher Order Thinking Skills	Pre-test Mean Score	Post-test Mean Score	Computed t-value	Tabular value @ α = 0.05
Analyzing	1.26	2.58	-8.199[s]	
Evaluating	0.92	2.42	-10.021[s]	
Creating	0.24	2.42	-3.950[s]	**±2.021**
Overall	**0.80**	**2.47**	-8.370[s]	

s = Significant

The Mean Gain Score of the Experimental and the Control Group

The mean gain score of the experimental group as to in the analyzing skill was 1.84 which means that the improvement of this skill was moderate while as to control group's mean gain score that was 1.32 suggested a small improvement in the analyzing skill. As to the evaluating skill, the mean gain score of the experimental group was 1.96 with a description of moderate improvement while the control group achieved 1.34 to mean of small improvement. The mean gain

score of the experimental group in terms of creating was 2.27 with a description of moderate improvement while the control group earned 1.68 suggesting a small improvement. The overall mean gain score of the experimental group of 2.02 suggested a moderate improvement in the level of performance while the control group at 1.45 showed a small improvement as to the level of performance.

The result implies that the improvement in the higher order thinking skills of students in experimental group were considerable compared to the improvement of the students in the control group. The result was supported by McMahon (2009), and Krontiris-Litowitz (2003) that using non – traditional activities can significantly improve the higher order thinking skills of the students over the use of traditional activities.

Table 7. The mean gain scores of the experimental and control group

Higher Order Thinking Skills	Mean Gain Score of Experimental Group	Description	Mean Gain Score of Control Group	Description
Analyzing	1.84	Moderate	1.32	Small
Evaluating	1.96	Moderate	1.34	Small
Creating	2.27	Moderate	1.68	Small
Overall	**2.02**	**Moderate**	**1.45**	**Small**

The Mean Gain Score of the Experimental Group and the Control Group

Shown in table 8 is the significant difference between the mean gain score of the experimental group and the control group.

The result in table 8 attest to the result in table 7. There was a significant difference between the main gain score of the experimental group and the control group as supported by the t-test result of five percent level of significance. The computed t-value in terms of the analyzing was -2.250 as to evaluating skill was -2.177; and for the creating skill, -2.951. The overall mean gain score of the two groups had a computed t –value of -4.045. These computed t-values were significant at alpha 0.05 level of significance which had a tabular value of -2.010 which enabled the researcher to reject the null hypothesis state that there was no significant difference between the mean gain score of the experimental group and the control group.

Table 8. Mean gain score of the experimental group and the control group

Higher Order Thinking Skills	Mean Gain Score of Experimental Group	Mean Gain Score of Control Group	Computed t-value	Tabular t - value
Analyzing	1.84	1.32	-2.250[s]	
Evaluating	1.96	1.34	-2.177[s]	
Creating	2.27	1.68	-2.951[s]	**±2.010**
Overall	**2.02**	**1.45**	**-4.045[s]**	

s = Significant

The respondents of each group in this study were not the same. By this reason, the research design used in this study was non-equivalent control group pretest-posttest design. In this study, the total population in the group, both experimental and control group, were utilized with random selection. The same concept, as mentioned, was used in choosing the groups.

CONCLUSIONS

Based on the findings, the accompanying conclusions were drawn out: 1) The improvement of the students exposed to non-traditional activities was higher compared to the students exposed to traditional activities; and 2) The use of non-traditional activities are more effective in the development of higher order thinking skills of students against the use of traditional activity.

RECOMMENDATIONS

Based in the findings and conclusions, the following recommendations were drawn out: 1) Teachers teaching mathematics in grade – seven must consider the use of non – traditional activities in developing the higher order thinking skills of the students; 2) The administrators must encourage and support the teachers in developing and using the non – traditional based activities in the classroom; 3) The Department of Education must initiate seminars and workshops in developing and using of the non – traditional based activities in the classroom; 4) Similar studies must be conducted in different venues and larger populations.

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