ENHANCING STUDENT'S LEARNING THROUGH INSTRUCTION IN CONSTRUCTION AND EXTRACTION OF GRAPH IN PHYSICS

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Abstract: The use of graphs as teaching material is common especially in science classes. In this study, the effectiveness in the use of graphs is explored in learning physics. The students' ability to construct graphs and extract information from graphs was determined using the Schnotz model. The respondents were from three (beginning) physics classes in a local university. The three groups received similar instructions in mechanics for equal amounts of time spread over equal duration. However, one group received explicit instruction on construction and extraction of graphs, the second, without, and the third, implicit instruction. Initial tests established that the three groups were comparable. ANOVA of pretest mean scores showed that there was no significant difference in the graphing skills of the three groups. The same result was obtained for the pretest mean scores for the physics test. However, the posttest mean scores for both physics test and graphs test of the three groups revealed a difference. This suggests knowledge in graphical skills influences learning physics.

Key Words: Teaching Approach in Dealing with Graphs; Performance in Physics; Graphing Skills

1. INTRODUCTION

Construction and extraction of graph comprises of specific technique which is considered as a culture of technique that students need to consider and learn in dealing with graphs. Some evidence from the studies (Curcios 2005), (Schnotz 2008), shows that a great familiarity with the representation in the use of graph is necessary for effective understanding, so that expectation in understanding and learning graph will manifest automatically specially during independent construction and analysis of graph, this will served as a source of knowledge and the beginning of effective understanding.

The main objective of this study is to determine if instruction in construction and extraction of graph affect the performance of the students in physics, to accomplish that, an experiment is conducted to determine if there is a significant difference among the three treatment groups, at the start and at the end of the experiment in terms of graphing skills and achievement test scores. In addition to that, the study sought to determine if there is a significant change between the pretest and posttest performance for each treatment group. The earlier issue is particularly interested in the didactics of science subject where graphs are often used in the classroom thus the used of graph in science education must still be done specially by teachers and instructors to promote the necessary skills which the students need in their study. In this study, structural model in dealing with graph is introduced that will serve as guide during independent construction and analysis of graph. In connection to this, remarks on the student's level in constructing and extracting graph within the three groups will be highlighted so that the study will determine its effect in learning.

Extraction of Graph

The study of Ainsworth (2007) point out that extraction of information in dealing with graphs is strongly related with the skills in construction of graph. The understanding of graph was started after Ainsworth identifies some frame of considerations that provide readers an overview of the graphs regarding on what is the main purpose of the diagrammatic representation. She realized that student's ability to identify assigned variables into a chosen axis is essential. Thus student ability to assign listed variables into graphical structure is related to the skills of the students to analyze graphs.

Construction of Graphs

While there are many researches dealing with the extraction of information from the graph, there are only few who make active view in designing diagram independently. It has been found that construction of diagrams is the center of learning activity in which they made comparison on the acquisition of knowledge during the independent construction of graphs from other chart made earlier (pre-maid charts). Based on the study pertaining to the construction of graphs, it turned out that independent construction can have a significant beneficial effect on the learning of the students (Stern, Sims, & Hegarty: 2003). In the other hand, there are researchers (Aprea & Ebner, 2003) claiming that there is no need of independent construction of graph in learning.

Propose Structural model of Cognitive Ability in Dealing with Diagrams

On the integration model propose by Schnotz (2005) for understanding texts and diagrams, the model contain cognitive skills that specialize in dealing with graphs in three areas such as extraction, integration and design purposes. The capability of information extraction in dealing with graphs is divided into two areas: identification and reading. Under identification, the process can be summarize in the following steps: recognition on the relationship shown in the graphs, the assignment of variables shown on each axis, the assignment of symbols in each row and correct observation on the range of scale. These are in the model below (Schnotz 2005) to which they are all indicated and entered.

Table1. Proposed Structural Model of Cognitive Ability in Dealing with Graphs

Different Graphing Skills	
Construction of Graph	Extraction of Graph
• Sketching the axis (x, y, & z) of the graph • Assigning variables to their corresponding axis • Labeling of axis properly • Sketching the legend properly • Assigning the scale in each axis • Entering of scores or Cartesian point • Connecting point using line • Adding multiple value to the graph	• Read and recognize the relationship shown • Identify the axis variables • Recognize symbols of variable to the data series • Read the range of the graph • Read the assigned scales • Analyze the score properly • Compare multiple values properly • Constructing statement about it

Source: Schnotz (2001, p23), Graphical Representation, International Journal of Science Education

2. METHODOLOGY

This research utilized the pretest-posttest matched group design as shown in Table 2 below.

Table 2. Pretest- Posttest Matched Group Design

Groups	Pretest	Treatment	Post test
TWOCE	O_1O_2	X_1	O_3O_4
TWCE	O_1O_2	X_2	O_3O_4
FWOCE	O_1O_2	X_3	O_3O_4

Note: O = observation, X = teaching approach

Where O_1 corresponds to observation or score obtained from achievement test pre-test, O_2 correspond to the observation or score obtained from the pre-test on students construction and extraction of graphs. X_1, X_2, X_3 correspond to the teaching method for the three groups: X_1 (TWCE - teaching approach with instruction in construction & extraction of graphs), X_2 (TWOCE - teaching approach without instruction in construction & extraction of graphs), X_3 (FWOCE - facilitating teaching approach without instruction in construction & extraction of graphs). O_3 is the observation or score obtained from the achievement test posttest while O_4 corresponds to the observation of score from the post test in constructing & extracting graph.

The subjects of the study were utilized using the Purposive Sampling Technique. The target population of this study consisted of 3 sections or classes of 2nd year students enrolled in Mechanics course of the Physics Department, College of Science, Technological University of the Philippines, Ayala Boulevard, Ermita Manila.

To start formally the investigation, students in the three classes or groups were requested to answer the Physics Achievement Test and the test in constructing and extracting graph on the first two days of classes.

The three selected classes were randomly assigned to the following treatments: One class (group TWCE) was taught using teaching approach that include construction and extraction of graph, another class (group TWOCE) was taught using the teaching approach that does not include construction and extraction of graph, and the third class (FWOCE) was taught in facilitating approach and receive no instruction on graph construction and extraction. The three classes were taught for a term (3 hours for Monday, Wednesday, and Friday) of the summer SY 2011-2012.

To determine the level of graph constructed and extracted by the students, the mean frequency of high-level constructed and extracted graph was obtained. Student constructed graphs were classified using rubric derived from the model in dealing with graphs, the scale includes five level (level 1 to 5) that would identify the level scale of the students' graphing skills.

The mean frequencies of the high level graphing skills were obtained to find how many graphing skills out of the number of expected graphing skills could students in a group perform. Each student had the choice to construct different type of graphs. The frequency of graphing skills according to level was counted for each student from the three groups. The average of these frequencies corresponded to the mean for a specific level of graphing skills of each group.

Analysis of variance (ANOVA) with the result in the graphing skills test was used to determine whether the groups differ with their graphing skills. If the significant difference existed, then pair-wise comparison using the t-test was obtained to determine which pair of group had a significant difference.

To compare the achievement scores among groups, ANOVA was also used with the result in the achievement pretest. t-test was also obtained for the pretest scores and posttest scores in the achievement test and graphing skills test.

RESULTS AND DISCUSSION

Pretest in the Achievement Test and Graphing Skills

The pretest scores result in the achievement test show comparison of the three groups using ANOVA. The value of F (1.58) is less than the critical value at .06 level of significant. This indicates that there is no significant difference on the pretest scores of the three groups in their achievement test. However, the results of the graphing skills test show the comparison of the three groups using ANOVA. The value of F (0.41) is less than the critical value at .05 level of significant. This shows that there is no significant difference on the graphing skills of the three groups in the pretest scores.

Posttest in the Achievement Test and Graphing Skills

The posttest scores result in the achievement test show comparison of the three groups using ANOVA. The value of F (13.10) is greater than the critical value at .05 level of significant. This indicates that there is a significant difference on the pretest scores of the three groups in the achievement test. However, the posttest results of the graphing skills test show the comparison of the three groups using ANOVA. The value of F (4.46) is greater than the critical value at .05 level of significant. This shows that there is a significant difference on the graphing skills of the three groups in the posttest scores.

Pretest and Posttest of Group TWOCE

The computed t value of the pretest and posttest in the achievement test is 13.66, which is greater than the critical value at .05 level of significance. This implies that there is a significant difference between the result of the pretest and posttest in the achievement test in group TWOCE. The significant on the pretest scores and posttest scores in the achievement test indicate that, there is an improvement on the achievement test scores of the students. However the computed t value of pretest and posttest in the graphing skills test is 1.23, which is greater than the critical value at .05 level of significance. These findings indicate that there is a significant difference between the result of the pretest and posttest in the graphing skills of group TWOCE.

Pretest and Posttest of Group TWCE

The computed t value of the pretest and posttest is 25.82, greater than the critical value at .05 level of significance. This implies that there is a significant difference between the result of the pretest and posttest in the achievement test in group TWCE. However the computed t value of the pretest and posttest in the graphing skills test is 4.45, which is greater than the tabular value at .05 level of significance. These findings indicate that there is a significant difference on the results of the pretest and posttest in the graphing skills of group TWCE.

Pretest and Posttest of Group FWOCE

The computed t-value between pretest and posttest in the achievement test is 17.69, greater than the critical value at .05 level of significance. The significant on the pretest and posttest in the achievement test indicate that, there is an improvement on the scores of the students in the achievement test. In the other hand, the computed t-value of the pretest and posttest in the graphing skills test is 2.00, lesser than the critical value of at .05 level of significance. This implies that there is no significant difference between the result of the pretest and posttest in the graphing skills of group FWOCE.

CONCLUSION

Base on the findings of the study, instruction in construction and extraction of graph may be included in teaching to help and encourage students to construct and extract graph as well as integration of both construction and extraction of graph, second, future research may focus on the use of other teaching method such as teaching strategies style with instruction on construction and extraction of graph that may increase posttest mean score to in the achievement test and graphing skills of the students, third, educators or Department Heads of institutions may conduct a training program to train teachers and students in constructing and extracting of graph, and lastly, students may use their graphing skills they learned from science to other subject.

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