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ACTIVITY-BASED LEARNING IN MATHEMATICS TOWARDS IMPROVED PROBLEM-SOLVING SKILLS OF COLLEGE STUDENTS

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ABSTRACT

This study investigated the effectiveness of activity-based learning in college mathematics as basis for improved problem-solving skills of students across courses. It utilized the quasi-experimental research which is a systematic and scientific approach. Participants in the treatment group were exposed to activity-based learning in solving the problem while participants in the control group do the lecture method. The teacher-made activity-based learning techniques was utilized to improve the problem-solving skills of the students as an intervention. Students are engaged in more problem-solving-related tasks anchored from activity-based strategy. As a result, the problem-solving skills of the students between the pre-test and post-test registered a highly significant difference for BEED, (t=-14.81, sig.=0.577), BSBA (t=-10.564, sig.=0.023), and BSIT (t=-22.589, sig.=0.729). This means that the performance of the students before and after the interventions using activity-based learning differ significantly. There is a significant increase in the score and level of problem-solving skills of the students after the intervention has been used in the teaching-learning process. It is recommended that the use of standardized problem-solving skills test should be created and administered; administration should create a foundation in the curriculum where the students will really be exposed with activity-based learning by creating intervention programs in mathematics focusing on problem-solving skills through workshops and seminars; and provision for mathematics laboratory with sufficient space, all necessary materials, and equipment for the use of activity-based teaching.

Keywords: *Activity-based learning; problem-solving skills; instruction; experimental; control group; intervention*

INTRODUCTION

Numerous teaching strategies are used by math educators. It is their responsibility as educators to create instructional strategies that will benefit students and help them succeed. Methods for quality math instruction include using visuals, making connections, using formative assessments, and teaching strategic thinking. Based on common patterns for several disciplines of mathematics, mathematicians generalize new formulae or techniques (Devlin, 2004). Each teacher should have a thorough understanding of the educational benefits that mathematics may provide before beginning to teach the subject. A suitable teaching strategy should be used as well, taking into account the students' circumstances, learning environment, and educational background. It is crucial to maintain students' motivation levels high to prevent them from losing interest in arithmetic (Butler & Wren, 1965). Students might be inspired by emphasizing the value of this topic; for instance, learning mathematics is crucial to understanding other science-related disciplines. Due to the wide range of applications of mathematics in several sectors, students can also benefit from strong career chances in the future (Rani, 2007). Teachers should be aware of the following objectives while teaching mathematics (Cornelius, 1982; Sidhu, 1995).

When they hear or use the term "activity-based instruction," educators have different ideas about what it means. Student participation in the mathematics learning process appears to be the common thread throughout these notions or descriptions. The student is actively involved in doing or seeing something get done, therefore this participation extends beyond the intellectual. The use of manipulative tools is typically a part of activity-based education, which is concerned with a teaching technique and may include a program. Numerous "activity-based" methods for teaching mathematics have gained popularity in recent years. Students actively manipulating real items is typically how these techniques are identified, although there is a huge variety of programs that claim to be activity-based beyond that.

Activity-based instruction, as a method of instruction, entails including some sort of activity in lesson design. But under this broad heading, there are many specifics: The activities differ greatly, from having real-world experiences to cooperating with others to complete a goal. The goal of the exercise may be to inspire, introduce, reinforce, or provide youngsters practice in using a mathematical concept in the actual world. The activity may or may not entail the use of objects or manipulative materials, but it may be essential to the mathematical content or to the learning objectives.

Anyone who has ever taught math knows how challenging it can be to educate students to solve arithmetic problems out of context. When you give students a setting or a sum that they are acquainted with, they often do well; but, when you provide them with a novel challenge, things get more complicated. But we can teach students how to solve arithmetic problems in the same way we teach them other math skills. Students should be encouraged to use a generic problem-solving process while tackling arithmetic difficulties.

According to the instructor's observations, students have trouble addressing problems. The researchers consequently decided to perform this study in order to enhance both the students' cognitive abilities and their problem-solving capabilities via the use of activity-based learning.

Within these constraints, the study is thought to be the most comprehensive and in-depth analysis of the research on mathematics laboratories and other activity-based teaching strategies currently available. The researchers have made an effort to derive recommendations for mathematics across courses as well as useful findings for instructors from this study.

Research Questions

The study aimed to analyze the effectiveness of activity-based learning to the student's problem-solving skills in mathematics across courses. Specifically, it sought to answers to the following questions:

1. How is activity-based learning improves the performance of the students?
2. How are problem solving skills in mathematics of students be described after the assessment?
3. Is there a significant difference on pre-test and post-test assessment of problem-solving skills of students?
4. What intervention to be proposed based on the result of the study?

METHODOLOGY

The researchers utilized the quasi-experimental type of research. It is a systematic and scientific approach in which the researcher manipulates one or more variables, and controls and measures any change in other variables (Gall, 1996). This enable the researchers to gather data relevant to the variable under study wherein each class across courses was divided into two as experimental group and control group. Participants in the treatment group were exposed to activity-based learning in solving the problem while participants in the control group do the lecture method. The BSBA class consists of 35 students were divided into two groups placed in experimental group (17) and control group (18); while BEED class which consists of 30 students placed under experimental group (15) and control group (15); and lastly, the BSIT class consists of 34 students were divided into two as experimental group (18) and control group (16). Student-participants, instructors, student-researchers, and program chairpersons were oriented to the research purpose. The pre-test and post test results were used to determine the effectiveness of the strategy in improving problem-solving skills of the students. The performance of students was monitored weekly to determine the improvement of students in problem-solving skills. The results of the findings were made available for the participants. The names of the participants were not revealed to maintain privacy and confidentiality of their responses as per ethics in research explained by Fraenkel (2003). The researchers provide activity-based learning and instructional materials that were used during Mathematics subject. Problem-solving skills test were constructed in each course. Class records were kept for recording the improvement of students under study. In answering the problems identified in the study, tables were made for the data presentation and statistically treated for the analysis and interpretation. T-test was used to compare two means to assess whether they are from the same population. T-test presumes that both groups are normally distributed and have relatively equal variances. The t-statistic is distributed on a curve that is based on the number of degrees of freedom (df).

RESULTS

The data gathered were presented, analyzed and interpreted. Presentation was done through the use of tables.

Table 1. Test of Differences in Pretest Scores of the Two Groups in BSBA Class

Group	Mean Score	Standard Deviation	Mean Difference
Experimental Group	1.294	1.317	**-0.15**
Control Group	1.444	1.212	

Table 2. Test of Differences in Pretest Scores of the Two Groups in BEED Class

Group	Mean Score	Standard Deviation	Mean Difference
Experimental Group	1.000	1.032	**-0.200**
Control Group	1.200	1.257	

Table 3. Test of Differences in Pretest Scores of the Two Groups in BSIT Class

Group	Mean Score	Standard Deviation	Mean Difference
Experimental Group	0.611	0.825	**-0.576**
Control Group	1.187	0.949	

Table 4. Test of Differences in Post-test Scores of the Two Groups in BSBA Class

Group	Mean Score	Standard Deviation	Mean Difference
Experimental Group	5.705	1.272	**0.983**
Control Group	4.722	1.366	

Table 5. Test of Differences in Post-test Scores of the Two Groups in BEED Class

Group	Mean Score	Standard Deviation	Mean Difference
Experimental Group	5.533	0.884	**0.733**
Control Group	4.800	0.748	

Table 6. Test of Differences in Post-test Scores of the Two Groups in BSIT Class

Group	Mean Score	Standard Deviation	Mean Difference
Experimental Group	5.166	1.213	**1.104**
Control Group	4.062	1.028	

Table 7. Test of Difference Between Pre-test and Post-test Scores of BSBA Students

Group	Mean Score	

	(pre-test)	(post-test)	Mean Difference
Experimental Group	1.294	5.705	4.411
Controlled Group	1.444	4.722	3.278

Table 8. Test of Difference Between Pre-test and Post-test Scores of BEED Students

Group	Mean Score		Mean Difference
	(pre-test)	(post-test)	
Experimental Group	1.000	5.533	4.533
Controlled Group	1.200	4.800	3.600

Table 9. Test of Difference Between Pre-test and Post-test Scores of BSIT Students

Group	Mean Score		Mean Difference
	(pre-test)	(post-test)	
Experimental Group	0.611	5.166	4.555
Controlled Group	1.187	4.062	2.875

DISCUSSION

Based on the data gathered, table 1 shows the result of the pre-test with a mean score of 1.294 under experimental group, while 1.444 for the control group. This implies that the problem-solving skills of BSBA students was very low with a failed remark and there was a slight difference between the two groups with -0.15 without the aid of activity-based learning. On the other hand, table 2 shows the result of the pre-test with a mean score of 1.000 under experimental group, while 1.200 for the control group. This implies that the problem-solving skills of BEED students was very low a failed remark and there was a slight difference between the two groups with -0.200 without the aid of activity-based learning. Lastly, table 3 shows the result of the pre-test with a mean score of 0.611 under experimental group, while 1.187 for the control group. This implies that the problem-solving skills of BSIT students was very low a failed remark and there was a slight difference between the two groups with -0.200 without the aid of activity-based learning. Thus, the problem-solving skills of participants during pre-test was very low with a failed remark and there was significant difference between the two groups (experimental and control group) without the aid of activity-based learning.

Furthermore, table 4 shows the result of the post-test with a mean score of 5.705 under experimental group, while 4.722 for the control group. This implies that the problem-solving skills of BSBA students improved and there was a large increased of difference between the two groups with 0.983 after introducing different activity-based learning in the teaching and learning process during Math class. Also, in table 5, it shows the result of the post-test with a mean score of 5.533 under experimental group, while 4.800 for the control group. This implies that the problem-solving skills of BEED students improved and there was a large increased of difference between the two groups with 0.733 after introducing different activity-based learning in the teaching and learning process during Math class. Lastly, table 6 shows the result of the post-test

with a mean score of 5.166 under experimental group, while 4.062 for the control group. This implies that the problem-solving skills of BSIT students improved and there was a large increased of difference between the two groups with 1.104 after introducing different activity-based learning in the teaching and learning process during Math class. Improvement of the participants in problem-solving skills between pre-test and post-test of experimental group was evident. There is an increased in mean score brought by the utilization of activity-based learning after post-test evaluation.
Apparently, table 7 shows the improvement of the BSBA students in problem-solving skills between pre-test and post-test of experimental group with 4.411 mean difference while a larger difference between pre-test and post-test of control group with 4.722. It signifies that the increase in mean score brought by the utilization of activity-based learning seems effective for the experimental group. However, this also shows that control group, without the use of activity-based learning found out to be effective with the use of lecture method. There is a significant difference before and after the utilization of this strategy for experimental group.

Also, table 8 shows the improvement of the BEED students in problem-solving skills between pre-test and post-test of experimental group with 4.533 mean difference while a larger difference between pre-test and post-test of control group with 3.600. It signifies that the increase in mean score brought by the utilization of activity-based learning seems effective for the experimental group. However, this also shows that control group, without the use of activity-based learning found out to be effective with the use of lecture method. There is a significant difference before and after the utilization of this strategy for experimental group.

Likewise, table 9 shows the improvement of the BSIT students in problem-solving skills between pre-test and post-test of experimental group with 4.555 mean difference while a larger difference between pre-test and post-test of control group with 2.875. It signifies that the increase in mean score brought by the utilization of activity-based learning seems effective for the experimental group. However, this also shows that control group, without the use of activity-based learning found out to be effective with the use of lecture method. There is a significant difference before and after the utilization of this strategy for experimental group. In control group, without the use of activity-based learning, the study found out to be effective with the use of lecture method. There is a significant difference before and after the utilization of this strategy for experimental group.

As shown in Tables 7, 8 and 9, the problem-solving skills performance of the students across courses (BEED, BSBA, and BSIT) between the pre-test and post-test registered a highly significant difference. The test concludes that there is a significant difference after the interventions. This means that the performance of the students before and after the interventions in problem-solving skills differ significantly. There is a significant increase in the score and level of problem-solving skills of the students after the intervention has been used in the teaching-learning process. The teacher-made activity-based learning techniques was utilized to improve the problem-solving skills of the students as an intervention. Students are engaged in more problem-solving-related tasks anchored from activity-based strategy. Thus, the problem-solving skills of the students between the pre-test and post-test registered a highly significant difference for BSBA, (t=-14.81, sig.=0.577), BEED (t=-10.564, sig.=0.023), and BSIT (t=-22.589, sig.=0.729). This means that the performance of the students before and after the interventions using activity-based learning differ significantly. There is a significant increase in the score and level of problem-solving skills of the students after the intervention has been used in the teaching-learning process.

The result of the study was supported by Lazakidou and Retalis (2010) on their findings of their study advocate that students can increase their problem-solving skills in a relatively short period of time. At the same time, they can improve their approach to the solution of a given mathematical problem, performing significant signs of autonomy. In addition, Kelly (2006) explores problem solving in classrooms while focusing on how they use performance tasks and/or tools in problem solving while working on mathematical tasks. Ways for instructors to assess learning through performance-based tool use will also be examined and suggested. Current research reveals that teachers need to teach and assess mathematical knowledge in ways that will allow them to show (perform) what they really understand. Teachers must be able to see beyond obvious correct or incorrect answers into their thinking processes by testing with “tests that allow students the opportunity to show what they know” (Van de Walle, 2003).

In connection, this was supported by Eriyagama (2018) when she explained that activity-based learning as the name suggests is a process whereby students actively engaged in the learning process rather than just sitting and listening to the lesson. It is based on the core premise that learning should be based on doing some hands-on experiments and discussion, practical activities, analysis and evaluation of the topic under discussion (Azuka, 2013). The models of activity-based learning suggest that all learning activities involve some kind of learners’ experiences which emphasizes observing and doing (Kathleen, 1996). According to Kathleen (1996) the idea of active learning is based on the premise that students learn best when they are actively involved in the teaching-learning process. Also, activity-based learning derives from two basic assumptions: (1) that learning is by nature an active endeavor, and (2) that different people learn in different ways. Characteristics of activity-based learning could be identified as follows (Bonwel and Eison, 1991): Students are involved in learning activities more than listening, and less emphasis is placed on transmitting information and more on developing student’s skills. Students are involved in higher-order thinking such as analysis, synthesis, and evaluation. Greater emphasis is placed on student’s exploration on their own attitudes and values.

Emaiku (2012) stated that activity-based learning offers so many benefits for both teachers and primary students, for example, they reinforce course content, develop team building skills, enhance learners self-esteem, promote participatory learning, allow for opportunities for problem solving, promote the concept of discovery learning, strengthen learner's bond, help in practical application of course content, enhance communication with diverse learning, prepare an enjoyable/ exciting learning environment. Most importantly, in activity-based learning both the teachers and students are active in the teaching-learning processes. Hence, activity-based learning is a student-centered learning method; however, teachers should be highly prepared for this teaching environment.

Conclusions

The problem-solving skills of students during pre-test was very low with a failed remark and there was significant difference between the two groups (experimental and control group) without the aid of activity-based learning. However, improvement in problem-solving skills between pre-test and post-test of experimental group was evident and here is an increased in mean score brought by the utilization of activity-based learning after post-test evaluation. In control group, without the use of activity-based learning, the study found out to be effective with the use of lecture method. There is a significant difference before and after the utilization of this strategy for experimental group. The teacher-made activity-based learning techniques was utilized to improve the problem-solving skills of the students as an intervention. They engaged more with problem-solving-related tasks anchored from activity-based strategy. The problem-solving skills of the students between the pre-test and post-test registered a highly significant difference for BSBA, (t=-14.81, sig.=0.577), BEED (t=-10.564, sig.=0.023), and BSIT (t=-22.589, sig.=0.729). This means that the performance of the participants before and after the interventions using activity-based learning differ significantly. There is a significant increase in the score and level of problem-solving skills after the intervention has been used in the teaching-learning process.

This study shows the appropriate interventions such as engaging more the students in activity-based learning and teaching in accordance to the common problem-solving difficulties of the college students as a result of the pre-test and post-tests given. Assessing the students' problem-solving skills and difficulties is the best basis to give interventions to improve such skill. The study found that the instructors, by utilizing different activity-based learning, adapted this strategy across courses is effective in mathematics class. Therefore, it was obvious, based form the statistics, that the effectiveness of activity-based learning is applicable in mathematics accompanied with reading comprehension skills in order to solve problems at their own pace.

It also shows that activity-based teaching methods can give students a sense of participation and collaborative learning. The subject/course instructors agreed to use activity-based teaching methods as these are helpful in improving classroom interaction. This outcome is very encouraging as it will help in improving the activity-based teaching and learning process not only in primary level but in all grade levels.

In addition, the time allocated for mathematics period is not enough, however, through activity-based learning, instructors have found ways in order to maximize student interaction through this strategy. While considering the above results, instructors were directed to use activity-based teaching methods which improved their teaching skills in mathematics and gained from the strategy.

Therefore, it is imperative to create activity-based learning activities for teaching mathematics across courses based on the three-dimensional model comprising of three factors such as physical exercises, correct mathematical concepts, and pleasure in order to improve problem-solving skills.

Recommendations

Based on the summary of findings and conclusions, the researchers recommend that instructors should use standardized problem-solving skills test to be aware of their students' performance in mathematics class. They should also expose the students in different activity-based learning activities with comprehension exercises that may touch their problem-solving abilities. Administration should create a foundation in the curriculum where the students will really be exposed with activity-based learning. The department may create consistent intervention programs in mathematics in collaboration with the instructors and program chairpersons within the campus/college under the three-domain model comprising of physical exercises, correct mathematical concepts, and pleasure in learning problem-solving techniques with comprehension. Also, workshops and seminars should be organized for the training and re-training of instructors on using activity-based teaching methods in mathematics classes. Finally, there should be an open mathematics laboratory with sufficient space, all necessary materials, and equipment for the use of activity-based teaching.

Compliance with Ethical Standards

In compliance with the Data Privacy Act, the participants gave their consent to participate in the study. The confidentiality of the data was maintained private. The Philippine Data Privacy Act (DPA) of 2012 prevents the unintentional disclosure of personal data about its inhabitants (Fabito et al., 2018). There was also no misrepresentation of the study's goals. Furthermore, honesty, transparency, avoidance of incorrect information, use of unpleasant, discriminating, and objectionable language, are evident. The authors cited using the American Psychological Association (APA) reference system. Finally, objective debates and assessments were maintained (Beyman and Bell, 2007).

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