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Functional Approach in Teaching and Learning Plane Trigonometry

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Abstract:
Functional approach is both content and learner based approach of teaching Plane Trigonometry. As a content-based approach, it is anchored more on the concepts of circles and their applications rather than the concepts of angles. As a learner-based approach, it is based on Sticht theory of functional context learning which stresses the importance of making learning relevant to the experiences of the learners and their work context.

This study investigated the effect of functional approach in the mathematics performance of college students. It likewise looked into its effectiveness in developing conceptual understanding, computation and problem solving skills and the factors associated with the development of these skills. It employed the quasi-experimental method specifically the non-equivalent pretest-posttest control group design. Findings revealed that the functional approach is more effective in raising the performance of students to the standard level in conceptual understanding, computation and problem solving skills than the traditional approach. It was also found out that factors such as previous ratings in mathematics, scholastic aptitude, attitude towards mathematics and gender are associated with development of the three mathematics skills. Income of the family is not associated with mathematics skills development. Functional approach in teaching Plane Trigonometry is recommended since it is anchored on the concepts of circles and circular functions which offers sound background materials for the study of higher mathematics and a high potential for the development of conceptual, computational and problem solving skills because it make use of students' daily work context.

Keywords: Functional approach; teaching-learning strategy; Plane Trigonometry

1. Introduction

The Philippines, decades ago, could boast of being a South East Asian country with the highest literacy level. The enrolment rates as well as the student performance at all levels of education were higher than those of other countries with comparable or even higher income levels. However, this is no longer true, because in 2015, the Philippines was surpassed by Korea in terms of literacy level. Korea had 100% literacy level while the Philippines had 96.8%as reported by [1] UNESCO (2015). This was also shown in the Philippines' poor performance in the 2003 Trends International Mathematics and Science Studies where it placed 42nd among 46 participating countries in the world in eighth grade Mathematics. [2] (Carballo, 2015).

The poor performance of Filipino students in Mathematics, according to several studies, was brought about by several factors which produce poor inputs into the teaching learning process. According to [3] Bernardo (2000), the basic problem in learning Mathematics in the Philippines is how to facilitate the learning process. Students are usually exposed to mental computations but rarely to active construction of mathematical concepts and to allowing them to relate concepts to prior knowledge and experiences or to applying the same to real world problems. Thus, the problem sprung from implementation of instructional approaches. Despite a large number of studies of this nature, there is still a continuing search for more effective approaches to facilitate the teaching and learning of mathematics. This study is part of the search.

Findings of this study may contribute to the teaching and learning practices in field of Mathematics. Instructional delivery in tertiary mathematics may be improved through a continuous search for appropriate and effective approaches which are relevant to the needs of the times and

responsive to the needs of the students. Furthermore, this study is expected to contribute to knowledge building. Findings and results may serve as additional literatures in mathematics education.

2. Review of Related Studies and Literature

[4] Arter and Blum (1996) cited conceptual, procedural, and problem solving skills as components of mathematics skills. According to [5] Wiggins (2014), conceptual skill includes understanding of meaning of mathematical concepts and information while procedural skill deals with the students' ability to demonstrate the sequence of steps used in a frequently solved problem.

According to [6] Fusch (2015), computation skill deals with the ability to demonstrate appropriate use and application of operations to mathematical problems. Evidences include verifying and justifying the procedure used. If students have poorly developed skills in logical thinking, they will find it hard to verify and justify procedure.

[7] Taplin (2017) cited that problem solving is a process and a skill. It is a process of applying previously learned knowledge and a skill of using one's knowledge effectively and readily in real life situations.

3. Objectives

1. Determine the Mathematics performance level of the students in the experimental and control groups before and after the experiment;
2. Determine the effectiveness of functional approach in developing the following skills:
   a. Conceptual understanding
   b. Computational skill
   c. Problem solving skill
3. Identify the factors associated with mathematics skills development.
4. Develop a study guide focused on mathematics skills development using functional approach.

4. Theoretical Framework

This study was anchored on [8] T. Sticht's theory on functional context learning which stresses the importance of making learning relevant to the experience of the learners and their work context. The learning of new information is facilitated by making it possible for the learner to relate it to their previous knowledge and personal experiences. The theory further claims that an avenue where the learner displays his learning may enhance the transfer of teaching from the classroom to the real world. The theory was based on the following learning principles:

a. Instruction may be meaningful in terms of prior knowledge.
b. Performance can be improved by improving content knowledge, information processing skills or the design of the learning materials.
c. Valid assessment of learning requires content / context specific measurement.

The model of the cognitive system underlying this theory emphasizes the interaction of the three components; knowledge (long term memory); processing skills including comprehension, and problem solving; and information and process display as shown in Figure 1. Functional learning requires knowledge of the task, processing skills such as comprehension and problem solving and an avenue where the learner may display this learning.

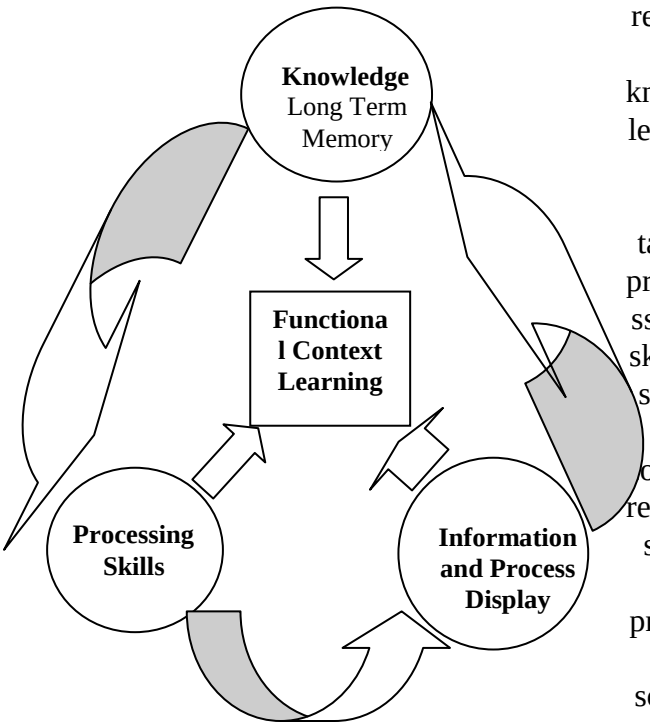

Figure 1: Theoretical Framework

5. Research Design and Procedures

This study employed the quasi-experimental research specifically non-equivalent pretest – post test control group design. This was the most appropriate design since intact classes were used as experimental and control groups. The design is illustrated in the following:

Experimental Group	Q_1	X_1	Q_2
Control Group	Q_3	X_2	Q_4

Legend: Q_1 & Q_3 – Pretest
Q_2 & Q_4 – Posttest
X1 – (Functional Approach)
X2 – (Traditional Approach- Lecture Method)

Figure 2*:* Research Design

The main sources of data were the 108 college students four classes enrolled in Plane Trigonometry at Partido State University, Philippines during the academic year 2016-2017.

This study utilized a researcher-made test consisting of three parts: conceptual understanding test, computation skill test and problem solving skill test. The test had undergone the following preliminaries in the preparation and administration of such instrument: Planning the Test, which includes syllabus scanning and constructing the table of specification; Constructing the Test; Validating the Test, which includes item analysis, reliability testing, face validation and content validation; Preparing the Final Draft based on the item analysis and validation results; and Administration of the Pretest.

In the experiment proper, lesson guides incorporating the functional approach in teaching Plane Trigonometry was used. Only one teacher handled the experimental and control classes. Two other mathematics teachers were asked to observe the actual use of strategy. They noted important details and relevant data in the experiment. The posttest was administered at the end of the experiment.

Mean was used to determine the performance level (PL) of the experimental and control groups in each of the three mathematics skills. The t-test was used to determine the effectiveness of the functional approach in developing the mathematical skills of the students.

6. Results and Discussion

6.1 Performance Level of the Students Before and After the Experiment and Effects of Functional Approach in Mathematics Performance and in Developing Mathematics Skills.

Table 1. Performance Level Before and After the Experiment and Significant Difference in Developing Conceptual Understanding, Computation and Problem Solving Skills

Parameters	Pretest		Post test	
	Control Group	Experimental group	Control Group	Experimental group
Conceptual Understanding				
Mean	3.9	3.8	10.2	11.8
PL	26.0	25.3	68.0	78.7
SD	1.6	1.4	2.6	2.9
Computed t	0.300		3.200	
Interpretation	Not Significant		Significant	
Computation Skill				
Mean	2.0	4.9	7.3	9.6
PL	13.3	18.7	48.7	64.0
SD	1.2	1.3	2.2	3.0
Computed t	0.500		4.500	
Interpretation	Not Significant		Significant	
Problem Solving Skill				
Mean	2.2	1.8	7.0	9.9
PL	14.7	12.0	46.7	66.0

SD	1.4	1.2	2.8	2.2
Computed t	2.000		5.800	
Interpretation	Not Significant		Significant	

6.1.1. Conceptual Understanding

Conceptual Understanding refers to simple recall of concepts to arrive at a correct answer without solution or use of formula. Table 1 shows that the pretest of the control and experimental group resulted to a computed t value of 0.300 which is lower than the tabular t value of 2.004. This means that there was no significant difference in the pretests of the control and experimental groups. On the other hand, the posttest has a computed t value of 3.200 which is greater than the tabular t value of 2.004. This means that there was a significant difference between the two group's posttest results.

Furthermore, findings showed that the functional approach improved the performance level of the students in the experimental group. The performance level of the experimental group had an increase of 53.35% compared to the increase of 42.00% in the control group. Consequently, the functional approach was effective in developing conceptual understanding of Plane Trigonometry.

The finding that the experimental group is significantly better than that of the control group supports the theory by which this particular study was anchored. The functional context theory suggests that learning of new information is made possible through long term memory. This is facilitated by relating the new information to the experiences of the learner. Given this view, the increased in the main gain and the performance level of the experimental group may be attributed to the functional approach.

6.1.2. Computation

Computation is a mathematical skill that requires the use of appropriate mathematical formula or operation to arrive at the correct answer. Table 1 shows that the pretest of the control and experimental groups resulted to the computed t of 0.500 which is lower than the tabular value of 2.004. This means that there was no significant difference between the two groups' pretest result. This implies that they have the same computational skill before the start of the experiment.

Further statistical treatment of the posttest resulted to a t value of 4.500 against a critical t value of 2.004. This means that a significant difference existed between the experimental and control groups' posttest result. This finding suggests that the performance of the two groups in computation skills were significantly different after the exposure to the treatments. The difference is evident in the increase in the scores of the respondents after the exposure to the treatment. Thus, it implies that both approach developed the students' computation skill. As to which one is better in developing this skill may be gleaned from the increase in PL in the experimental group (45.33%) which is greater than in the control group (35.34%).

These particular findings are affirmation of the functional context theory, one component of which is the transformation of knowledge into processing skills such as computation. The new information acquired by the students through long term memory was used in developing their computation skills. Hence, the significant difference between the posttest of the control and experimental groups and the increased in PL of the latter may be brought about by the unique pedagogy in functional approach.

6.1.3. Problem Solving

Problem Solving requires other skills such as conceptual understanding, computation, comprehension, analysis, interpretation and application. It is the ability to solve word problems with practical application to daily activities. Table 1 shows a computed t – value of 2.000. This means that significant difference did not exist between the groups in terms of pretest. On the other hand, in terms of posttest, t – test resulted to a higher value of 5.800 compared to the tabular value of 2004. This means that there was a significant difference between the two groups. This suggests that their respective performances in problem solving test were different after the conduct of the experiment. The difference is very evident in the PL. The experimental group had accumulated a higher gain (54%) than the control group (32.00%). This indicates that the experimental was better than the control group. Therefore, the functional approach is more effective in developing problem solving skill than the traditional approach.

Functional learning is focused on relating new learning to the experiences of the learners. It provides problems similar to those met by students

in their day to day activities. Thus, the findings that there is a significant difference in the posttest of the control group and the experimental group and the increase in the mean gain of the latter maybe brought about by the functional approach.

6.2. Factors Associated with Skills Development of the Students

The factors such as gender, income, scholastic aptitude, performance in previous mathematics subjects and attitude towards mathematics were examined whether each of them was associated with skills development of the respondents. The Guttmans' Coefficient of Predictability [9] (Zulueta 2006) was used to determine which of these variables could best predict the development of skills.

Income of the family was classified based on [10] National Statistics Office Report 2005. The scholastic aptitudes of the respondents were particularly gleaned from the Differential Aptitude Test (DAT) administered by Partido State University (ParSU), Camarines Sur, Philippines. The respondent's performance in previous mathematics subject was taken from their final ratings in College Algebra and their attitude towards mathematics was gleaned from their responses in the Suydam Trueblood Attitude towards Mathematics Scale Test as cited by [11] Sisson (2011).

Table 2 shows that performance in previous mathematics subject ranks first (1st) with 0.58 coefficient of predictability described as "High predictability". This is followed by attitude towards mathematics with 0.38 described as "Substantial Predictability". Scholastic aptitude and Gender have "Slight predictability" with 0.27 and 0.20 respectively. Income of the family has zero predictability, thus has no bearing with the development of mathematics skills of the respondents.

Table 2 Factors Affecting Mathematics Skills Development

Factors	Predictability of Mathematics Skills	
	Coefficient of Prediction (Lambda Coefficient)	Interpretation
Gender	0.20	Slight Predictability
Income of the Family	0.00	Zero Predictability
Scholastic Aptitude	0.27	Slight predictability
Performance in Previous Math Subject	0.58	High Predictability
Attitude Towards Mathematics	0.38	Substantial Predictability

The finding that gender is related to the development of mathematical skills could have been brought about by what [12] Trow's (1994) claim regarding psychological learning. He posited that performance in any skill maybe judged in relation to the learner's sex and other factors. This simply means that sex has bearing in the development of mathematical skill.

The finding that scholastic aptitude has a bearing with the development of skills is an affirmation of Theory of Neuronal Group Selection (TNGS) discussed in [13] Schwarts (2006). This theory implies that learning is a result of natural selection. Learners bring with them unique and innate ability and use them in meaningful learning. Thus, learners' scholastic aptitude is an important factor in determining his efficiency and effectiveness in the acquisition of knowledge and development of mathematics skills.

6.3. Study Guide in Plane Trigonometry: Focused on Mathematics Skills

The Study Guide in Plane Trigonometry: Focused on Mathematics Skills was developed as an output of this study. It features Chapter Objectives, Chapter in Brief, Key Terms Review, Mastery Test, Self-Test, Think-it-Through: A Challenge, and Answers to Selected Problems. Functional Approach was utilized in presenting the lessons included in this study guide.

7. Findings and Conclusions

1. There was significant difference in the posttest in conceptual understanding skills of the control and experimental groups as evidenced by the computed t-value of 3.200 which is greater than the critical t-value of 2.004.

2. There was significant difference in the posttest in computation skill as supported by the computed t-value of 4.500 which is greater than the tabular t-value of 2.004.
3. There was significant difference in the posttest in problem solving skill as evidenced by the computed t-value of 5.800 which is greater than the critical t-value of 2.004.
4. Mathematics skills development was associated with performance in the previous mathematics subject, attitude towards mathematics, scholastic aptitude and gender with predictability coefficients of 0.58, 0.38, 0.27 and 0.20 respectively. Income of the family had zero predictability.

The following conclusions were drawn from the above findings:

1. The functional approach was effective in raising the over-all performance of the students in Plane Trigonometry.
2. The functional approach was effective in developing student competencies along conceptual understanding, computation and problem solving.
3. The factors associated with mathematics skills development of the students were performance in previous mathematics subject, scholastic aptitude and attitude towards mathematics. Income of the family could not predict the development of the three skills.
4. The Study Guide in Plane Trigonometry: Focused on Mathematics Skills may be used to enhance the mathematics skills of the students. This instructional material was granted by the National Library of the Philippines a copyright registration number A2009-1366 and ISBN 978-971-93682-4-3.

8. Recommendations

1. Teachers are encouraged to use varied and creative teaching approaches that provide avenue for the understanding of higher mathematics and development of mathematics skills.
2. The use of functional approach in teaching Plane Trigonometry is recommended.
3. College mathematics teachers are encouraged to conduct researches to know their students' needs in skills development and devise strategies to address them.
4. Other factors perceived to be associated with mathematics skills development maybe further looked into.
5. Mathematics bridge program may be proposed as an intervention to address the skills not mastered by the students.

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10. Author Profile

Marita S. Magat received her Master of Arts in Education and Doctor of Philosophy degrees at University of the Philippines Diliman and Bicol University respectively. Currently, she is Professor V and designated as Dean of the College of Education of Partido State University, Philippines. Previously, she was Director for Planning and Quality Management System representative of the same university.