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Error Analysis of Trigonometry Students in a Technological University

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ABSTRACT

Error analysis is considered as an effective assessment approach that allows one, especially teachers, to determine whether students are making consistent mistakes when performing computations. By pinpointing the error category or pattern of a student's errors, one can directly teach the correct procedure for solving the problem or can even formulate an effectively designed instructional intervention. The purpose of the study is to analyze the different errors that students commit in Trigonometry. The sample consists of 24 teacher education students and 25 information technology students. Data were drawn from test questionnaires which were categorized as Reading, Comprehension, Transformation, Processing and Encoding error. The study utilized descriptive statistics. The results revealed greater percentage of error on Processing, however, lesser error of the students committed in the Reading part. Students have learning complexities which are attributed to the error committed. Thus, students had learned some concepts defectively. Generally, processing the error of the students needs teachers' consideration through process-focus instruction. The findings of the study can

serve best to a host of educators who are into developing instructional materials, modules and worksheets, for them to consider the different misconceptions of students and should further account the various errors committed by the students.

Keywords **–** Mathematics Education, Trigonometry, error-analysis, process-focus instruction, descriptive design, Tabango, Leyte, Philippines.

INTRODUCTION

It is common knowledge that education is aimed at the total development of the individual, that is, mentally, physically, and spiritually. One of the basic thrusts of education is mathematics education. Thus, it is expected that mental development on mathematics shall be one of its primary considerations (Ritter, Anderson, Koedinger & Corbett, 2007; Cobb, 1988; Fey, 1989).

The aims of mathematics education, like those of other learning areas, are established and formed to mirror understandings and developments that are significant, vital and beneficial to individuals and community. Just as knowledge increases, situations change, and needs increases with time, the same is the content and structure of mathematics programs attuned and polished from time to time to reflect current needs and future visions for learners (L.B. Resnick & D.P. Resnick, 1992; Asiala, Brown, DeVries, Dubinsky, Mathews, & Thomas, 1997; Remillard, 1999).

The decline in the performance in Trigonometry courses has been very clear. Evidence of this, particularly in the Philippines, is the result of the International Mathematics Olympiad (IMO). Official results from the IMO website revealed that in the 22 years of participation (from 1988 – 2010; with no participation in 1990), the Philippines has always been placed in the lower thirty percent (30%) rank. The lowest was in 1996 (ranked 74th out of 75 participating countries) and the highest was in 1993 (ranked 52nd out of 73 participating countries). Also, the results of the 2003 Trends in International Mathematics and Science Study (TIMMS) revealed that the Philippines ranked 41st out of 45 countries in Mathematics. This status is 15 ranks lower than the average 26th rank (TIMMS & PIRLS International Study Center, 2004). From this result, it may be hypothesized that the quality of mathematics instruction in the Philippines is far below from those of the other 44 participating countries. TIMSS Advanced 2008 reports achievement results for students enrolled in advanced mathematics courses in the final year of secondary school in each of the participating countries including the Philippines. It addresses the trends in mathematics achievement

over time for participants in the previous TIMSS assessment at this level in 1995. It reported that the Philippines, with an average scale score of 355, had the lowest average achievement (Mullis, Martin, Robitaille, & Foy, 2009). This means that high school graduates in the country have the lowest achievement among the participating countries.

Another report which implies that Filipino students perform poorly in Mathematics is that of the 2003 National Achievement Test where the average grade is 44% for elementary math and 36% for secondary level (Galvez, 2009). From the above results, there is strong evidence of the poor performance in mathematics of the students. This low performance of students in mathematics is not only in the international arena as shown in the IMO results and TIMSS findings but more so in the local classroom setting. The researcher observed that a significant number of students in his class in Trigonometry got very low grades in this particular mathematics subject. In fact, during the second semester (2007-2008), the average grade in Trigonometry was 1.95. Then in the second semester of SY 2008-2009, the average grade in Plane Trigonometry was 2.75 while in the 2nd semester of 2009-2010, the average was also low - 2.5. This decrease in the performance of the students alarmed the researcher to make necessary steps to solve the problem.

Scholars revealed that students in Mathematics Education showed misconceptions and make errors, and these situations display worse scenario (Lochead & Mestre 1988; Ryan & Williams, 2007).A few researchers have also mentioned students' misconceptions, errors, and related to these, learning complexities about trigonometry (Delice, 2002; Orhun, 2006). Fi (2003) stated that much of the literature in trigonometry has focused on trigonometric functions. Fi embarked on the study related to the pre-service teachers' knowledge of trigonometry. Fi developed a framework to address the fragmented understanding of preservice teachers, that is trigonometric connections to address the student - teachers' view of sine and cosine (Brown 2006, p. 228).

Meanwhile, Orhun (2006) studied the difficulties faced by students in using trigonometry in solving problems. He found out that the students' grasp of the concepts of trigonometry is lacking and is, therefore, contributes to errors of the students. The teacher-active method and memorizing methods provide students the knowledge of trigonometry only for a brief moment of time, but this knowledge is not retained by the students in the long run. Therefore, students could not learn the procedure of solving the verbal problems confidently.

Additional findings by Delice (2002) on comparison of performance of students in the adolescent age from Turkey and England in trigonometry and

comparison of the curriculum and assessment provision in each country to reveal differences in their performance showed that Turkish students did better with the algebraic, manipulative and that English students did better with the application of trigonometry to practical situations in England.

The researcher embarked on different presentation of error category using Newman's (1977) Category to view mistakes differently, cater present issue on errors and use it in advanced mathematics courses. The decline in education, though it is the primary focus, will not be solved unless we dig down to its root cause and that is, error analysis. According to Fi (2003), students have incomplete and fragmented understanding on sine and cosine. Using Newman's category, the incomplete and fragmented understanding of the respondents will be completely highlighted. The study is different from other research works for it focused on the wide category of errors of Newman's, which considers all possible issues of mistakes. The researcher thought to develop an intervention model in Trigonometry to alleviate the students' issue on learning.

FRAMEWORK

Newman's (1977) theory of errors and error categories reveals that when an individual attempts to answer mathematics question, he has to surpass consecutive stages, namely Reading (or Decoding), Comprehension, Transformation or — Mathematising, II Processing, and Encoding. Upon passing through several steps, students are vulnerable to errors. Based on the theory as cited by Ragma (2014), the Reading errors are committed when someone cannot read a clue word or figure in the written problem to the point that this hinders him from formulating anything on his answer sheet or from continuing further along a suitable problem-solving track. The comprehension errors are done when a student had read the texts in the item, but was not able to hold the exact implications of the words. Furthermore, he can only specify partly the given and the unknown in the problem.

The transformation or mathematising errors are engaged in when someone had demonstrated understanding about what are asked in the questions, but is incapable to pinpoint the operation, or order of operations or the operational equation needed to solve the problem. The processing errors are done when a learner pinpointed a fitting operation, or order of operations or the operational equation, but unable to follow the step-by-step process significant to actualize the operations or equation correctly; and, the encoding errors are done when

someone correctly answer the solution to a problem, but could not write down this solution in an standard written form.

In some cases, errors are committed if the answer is not in its accepted simplified form and does not indicate the unit (Clement, 2002; Egodawatte, 2009). As applied to the study, the students are believed to be capable of showing the desired skills after learning the contents of Trigonometry from their instructors.

OBJECTIVES OF THE STUDY

The study focused on three objectives: 1) The errors committed by students in trigonometry; 2) Possible categorization of these errors; and 3) The possible treatments of students' errors.

METHODOLOGY

The descriptive method of research was employed. The researcher conducted the techno-traditional discussion and made a survey questionnaire to gather information related to the study. The table of specification was constructed and the number of item depends on the number of teaching hours. There were 20 items on trigonometric functions, 15 items on angular measurements, 20 items on trigonometric identities and 10 items on oblique triangle.

The respondents were the First- Year Bachelor of Science in Information Technology and Bachelor in Elementary Education students of Palompon Institute of Technology – Tabango Campus for the academic year 2014-2015. The researcher utilized the total population because of the limited respondents, regardless of gender, age and location.

Table. 1 Distribution of subject

Course	Year	Population	%
BS Info Tech	1st Year	24	48.9
BEED	2nd Year	25	51.1

Research Instruments

The researcher utilized a self-made test in determining the pretest and post test scores of the two groups. Both groups were given the same sets of test and the number of items was determined after its validation. It was constructed based on

the standard form in making a self-made test. A pilot test was launched before the experiment – immediately after the approval of the proposal to validate the questionnaire. The researcher made 35 items and there was one item deleted prior to the validation of test questions as suggested by one of the panel members. There were four (4) items deleted, namely: 7, 21, 23 and 33. Thus, the final form consisted of only thirty (30) items. They were deleted because the interpretations under the index of discrimination and difficulty were categorized as "poor items" and "very hard", respectively.

Data Gathering Procedure

After subjecting the constructed questionnaire to validity and reliability tests, a letter of request to the Office of the Campus Director was properly secured in the conduct of survey. It was then collected for tabulation. All of the data gathered were collated, treated and analyzed in accordance to the research design and the aforementioned hypothesis of the study. A spreadsheet software was used for more efficient, effective and accurate treatment of data. Furthermore, the data gathered were transcribed, analyzed, and interpreted.

The study was conducted through an examination given to each subject. They were given time to answer after that is the collection, checking, identifying their errors and categorizing their errors. Data were categorized using the following.

Data Categorization For the scoring/checking of the test, the scheme below was used:

Point Assignment	Error Category
0	Reading Error
1	Comprehension Error
2	Transformation Error
3	Processing Error
4	Encoding Error
5	No Error

For the general performance in Trigonometry, the scales below were used:

Score Range	Level of Performance
80.00-100.00%	Outstanding Performance (OP)
60.00-79.99%	Satisfactory Performance (SP)
40.00-59.99%	Fair Performance (FP)
20.00-39.99%	Poor Performance (PP)
0-19.99%	Very Poor Performance (VPP)

For the level of performance in each topic in Trigonometry, the following scale systems were utilized.

Graphs of Trigonometric Functions

Score Range Level of Performance	Descriptive Equivalent Rating
13.00-15.00	Outstanding Performance (OP)
10.00-12.99	Satisfactory Performance (SP)
7.00 -9.99	Fair Performance (FP)
3.00-6.99	Poor Performance (PP)
0-2.99	Very Poor Performance (VPP)

Trigonometric Identities

Score Range Level of Performance	Descriptive Equivalent Rating
16.00-20.00	Outstanding Performance (OP)
12.00-15.99	Satisfactory Performance (SP)
8.00 -11.99	Fair Performance (FP)
4.00-7.99	Poor Performance (PP)
0-3.99	Very Poor Performance (VPP)

RESULTS AND DISCUSSION

The students had problems with prior and new knowledge about concept, process, and precept in learning trigonometry. The reasons for errors, which students commit in trigonometry lesson were mal-rule teaching or teaching concepts. It is important at the introductory level. It is caused by their study habits, as well as the advances of erroneous creations, on the part of the learner (Gur, 2009). Students commit different errors in trigonometry. Some of these errors were based on fragmented understanding of the concepts and others are repeatedly made due to partial grasp of the idea. Students persist in making both types of errors. The errors are categorized as to reading, comprehension, transformation, processing and encoding. As a result, students made higher percentage errors in the processing part, and conversely on the reading part.

Table 2. Distribution of errors committed by students in Trigonometry as categorized to reading, comprehension, transformation, processing and encoding

Subtopic	Error Category					
	R	C	T	P	E	N
Angular Measurement	4	8	5	12.3	5	5
Trigonometric Functions	6	6	4	18	8	7
Trigonometric Identities	7	5	11	12	10	4
Oblique Triangle	5.6	6	7.2	14.2	12	4
Average	5.65	6.25	6.8	14.125	8.75	5
Rate	11.53%	12.76%	13.87%	28.83%	17.86%	10.2%
Rank	5	4	3	1	2	6

Students can provide reasonable solution of a Trigonometric problem in the first part, but seems to be confused on the manipulation part/ process. This conforms to the findings of Radatz (1979, 1980), that school children have problems on information – processing mechanism. The study is limited only on the error analysis of trigonometry students of technological university.

CONCLUSION

In the world view, students share the same struggle in their quest for mastery of concepts. Information processing was viewed to be an integral part of problem solving. However, the road towards success seems to be challenging. To educators, if they carefully analyze students' writing, it is easy to understand them. To have a serious look on their symbolic presentation on their answer sheets, dictates that it is a must for every educator. The case of process-focus instruction is one of the viewed remediation. Teacher should develop careful attention on imparting process inputs.

TRANSLATIONAL RESEARCH

The findings of the study can serve best to a host of educators who are into developing instructional materials, modules, worksheets, that they may consider the different misconceptions of students and should further account the various errors committed by the students. This may give other avenues for administrators to assess their human resource, specifically, the faculty on their teaching performance, which is evidently reflected in the students' performance.

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