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Lessons from the Past: Limiting the Unbounded Difficulties

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Abstract: ***This study made used of case study design to identify the causes of the common errors in solving the optimal solution of the accountancy students in linear programming. Linear programming is a higher Mathematics where basic Mathematics is applied. The causes of errors were identified through interview and drew out implications to Mathematics learning. By using cluster sampling, the written solution of the respondents were subjected to identification of common errors using the similar approach to Newman Model done by Movshovitz-Hadar, Zaslavsky, and Inbar (1987). It was found out that most of the respondents had "problem solving error". Further, among the causes mentioned by the respondents, the "lack of mastery "was the common response. Through this study, the Mathematics educators, after knowing the common errors of the respondents, can use appropriate strategy that could respond to these errors. The responses of the students on the causes of errors can be minimized.***

Keywords: common errors, causes, linear programming, problem solving error, lack of mastery

1. Introduction

Many studies that has been made focused with the errors that are being committed by students in solving Mathematical problems. Common mistakes had been identified and the types had been stated to categorize the errors. Identifying these categories could be of great help in improving mathematical performance of students. As mentioned by Cohen (2010), the purposes of error analysis are to (1) to identify the patterns of mistakes that students make in their work, (2) understand why students commit errors, and (3) provide proper instruction to correct the errors. This proves that there are many errors being committed by the learners when dealing with mathematical problems. Letting the students aware of their errors will remind them not to do the same mathematical mistake. It will also be of help to their learnings to determine and overcome the causes of their difficulty and misconceptions that may had contributed to these errors. As mentioned by White (1996), Herscovics (1989) believed that learning difficulties can be of two types. The learner tries to draw new knowledge on existing structure which is not valid for the knowledge to be learned. Secondly, the learner might have no idea on structure of the new knowledge which would permit adjustment to the new knowledge.

Difficulties experienced by students are due to lack of the basic knowledge needed for the correct understanding of a given concept or procedure (Batanero,1994).

On the other hand, misconceptions of the students are actually problems since these misconceptions interfere with learning when students use them to interpret new experiences. In addition, students are emotionally and intellectually attached to their misconceptions because they have actively created it (Mestie ,1989).

A linear programming course is concerned with the problems of maximizing or minimizing a linear function whose variables must satisfy linear constraints. Most of these problems have more than two variables where graphical solution cannot be applied. An alternative way to solve such problems is the simplex method. The Simplex method is an approach to solving linear programming models by hand using slack variables, tableaus, and pivot variables as a means to finding the optimal solution of an optimization problem. The Simplex method is a technique for solving linear programs by hand.

The Bachelor of Science in Accountancy at the University of Northern Philippines covers three Mathematics which includes College Algebra, Mathematics of Investment and Quantitative technique in Business. The latter includes the topics System of linear equations and inequalities, Linear programming on graphical method and linear programming on simplex methods. A student in linear programming needs to convert the constraints into Standard form, introduce slack variables, create the tableau, identify the pivot variables, create a new tableau, check for optimality, and identify optimal values. This will make the student plan to arrive at a correct decision. Some aspects of the learning components of linear programming incorporates a teaching that uses on arithmetic. A specific strategy of identifying the optimum point is then emphasized to enhance a relational understanding of the concept (Ododa, 1992).

It was an observation by the researcher that not all students have achieved a high mathematical perception that could be applied to linear programming resulting to errors which resulted from the difficulties that the learners encounter. Some of the common difficulties are lack of manipulation on algebraic symbols and lack of determining the relationship among the existing variables.

The performance in linear programming in secondary schools is wanting. In addition, linear programming skills are not mastered by the time the learners leave high school Nakhanu (2015).

The BSA students had to pass the qualifying examwhich is done every semester. They are required to get a grade of 2.25 or better in major subjects and no more than two failing grades in minor subjects. It would be a wrong assumption

then that these students are not good in Mathematics if it is based only from their low scores in linear programming.

It is in this context that the researcher was motivated to conduct an analysis on the difficulties that caused the errors committed by the students in linear programming on the simplex method.

2. Purpose of the Study

The result of the study provides the importance of knowing the difficulties and misconceptions that have caused the common errors committed in Mathematics. This helps Mathematics teachers to deal more positive with the mathematics errors and to do some remedies so that the difficulties will be at least minimized. For the learners, this is an opportunity to give them a picture of what they need to be aware of and how to overcome the difficulties that caused the errors when dealing with Mathematics.

Specifically, it sought to: 1) identify the types of errors committed by the students; 2) investigate and describe the possible difficulties that had caused the students' Mathematical errors.

3. Methodology

Research Design

The study used the quantitative and qualitative research design. It focused on the responses of the respondents. An examination was given to the students with three items that was taken from the course book on quantitative technique in business along the topic linear programming on simplex methods particularly involving maximization problem. The papers were checked and the common errors committed by the students were identified and were categorized according to the errors they had committed. There were 11 students who were interviewed on the possible reasons of difficulties that they had encountered while solving the problems during the school year 2015-2016 and 15 students during the school year 2016-2017. Case Study design was used. The Mathematical errors found in the solutions were analyzed and identified as to 1) Miscopied numerical coefficient; 2)Computation Errors (Subtraction, multiplication and division); 3) Unfinished solution; 4.) Incomplete answer; 5.) Miscopied entry; and 6) Incorrect identification of variables.

Participants and Research Site

The study was conducted at the University of Northern Philippines, Vigan City Ilocos Sur during the second semester of school years 2015-2016 and 2016-2017. Purposive sampling was employed. There were 76 respondents wherein 39 students were taken during the school year 2015-2016 and 37 students during the school year 2016-2017.

Instrumentation and Data Collection

The instrument for this study was a set of test questions to identify the types of students' errors. For the purpose of this study, three problems were taken from the workbook of Victoriano(1990).

The scripts were scrutinized based on the errors of the students in solving the problems. The corresponding students were then interviewed so as to give explanation on the difficulties and cognitive processes they undergone while solving the problems. Permission was obtained from the respondents to do the interview and to record the interview. The researcher assured the respondents that the data will be kept confidential and it will only be used for the purpose of the study.

Analysis of Data

The papers were corrected and the errors were categorized. The quantitative design was used and analyzed. The second stage of data analyzing and coding interview transcripts and recordings. The data were compiled and at the same time transcripts of all interviews were used to start analyzing the students' responses. The transcripts were coded and were used together with the task to investigate the difficulties that caused the errors**.**

4. Results and Discussion

The results of the study have been presented and discussed in two sections. The first section talks on the common errors committed by the respondents in solving linear programming. The second section presents the causes of the errors.

Common Errors

Table I: Frequency Distribution of the Common Errors Committed by the BSA students

Common Errors	Frequency	Percentage
Miscopied Numerical Coefficient	1	3.14
Computation Error(Subtraction, Multiplication, and Division)	7	21.83
Unfinished Solution	11	34.38
Miscopied Entry	1	3.14
Incorrect Identification of Variable	6	18.75
Incomplete values of Variable in the Final Answer	6	18.75
Total	32	100.00

The table reflects the common errors by the respondents in solving linear programming problems using the simplex method. The highest number of error is on unfinished solution followed by computation error (Subtraction, multiplication and division), incorrect identification of variable incomplete final answer.The errors in miscopied numerical coefficient and miscopied entry which are the least committed errors was very minimal.

Type 1 Error: Unfinished Solution

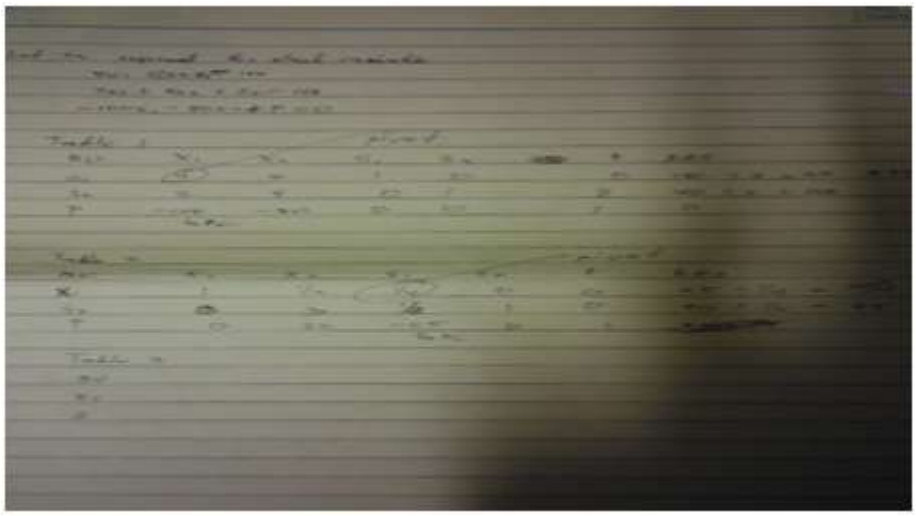

Exhibit 1

The error on unfinished solution could be seen from Exhibit 1. The respondent was not able to continue the solution. One reason that has been observed is that the respondents must have been confused in determining the pivot element. As could be seen, the respondent used 0 instead of 3. The computation is correct but not able to proceed with the next procedure. This has the same observation from the study of Abdullah (2015) who stated that the students used the wrong procedure, did not perform the calculation process carefully and wrongly applied the manipulation.

Type 2 Error: Computation Error

It could be noticed that in Computation errors, students did not have difficulty along addition. Subtraction, multiplication and division were the operations that were performed incorrectly. This could be seen from the following exhibits.

Error in Subtration

The third entry of row two table one (R_2^1)= (2 4 0 1 0 140) – 2(1 ½ ¼ 0 0 50). In performing the operation, the final answer for the third entry should have been 0 - 2(1/4) = -1/2, but the respondent's answer is -1/4.

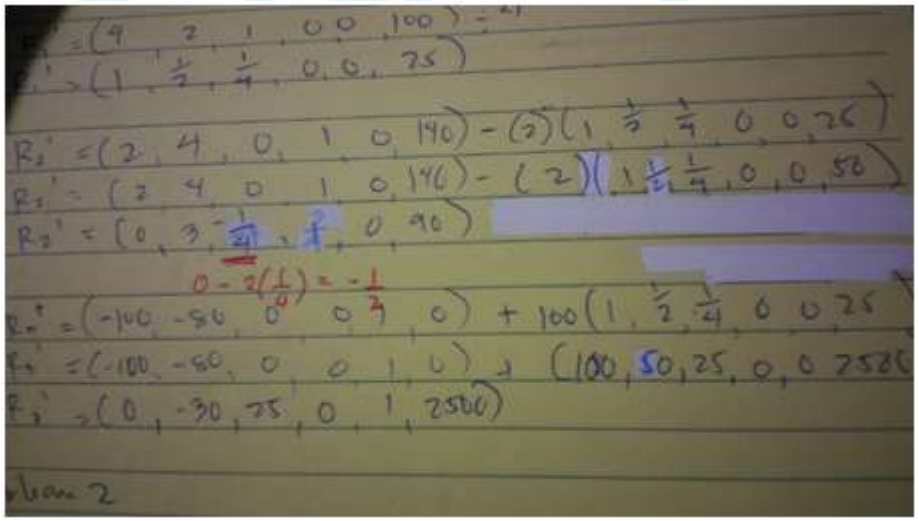

Exhibit 2

Error in Multiplication

On the other hand, in multiplying 100 x 100, the answer should be 10,000 but the respondent gave a product of 1000.

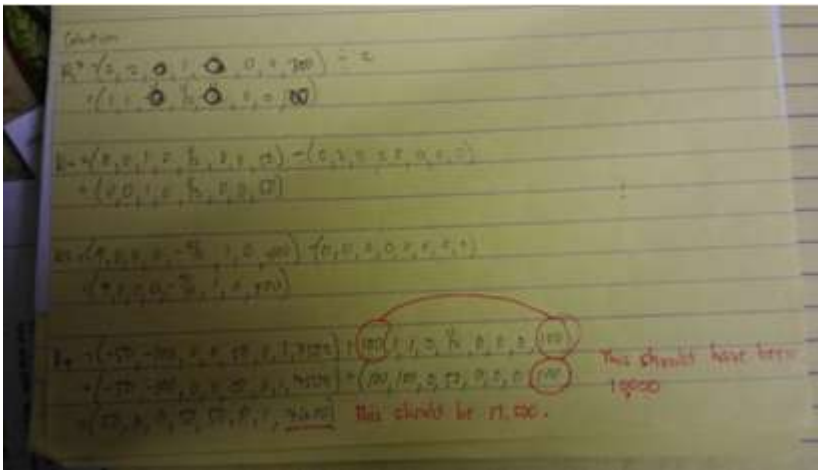

Exhibit 3

Similarly, the respondent multiplied 2 x 25 and gave a product of 12 ½ instead of 50.

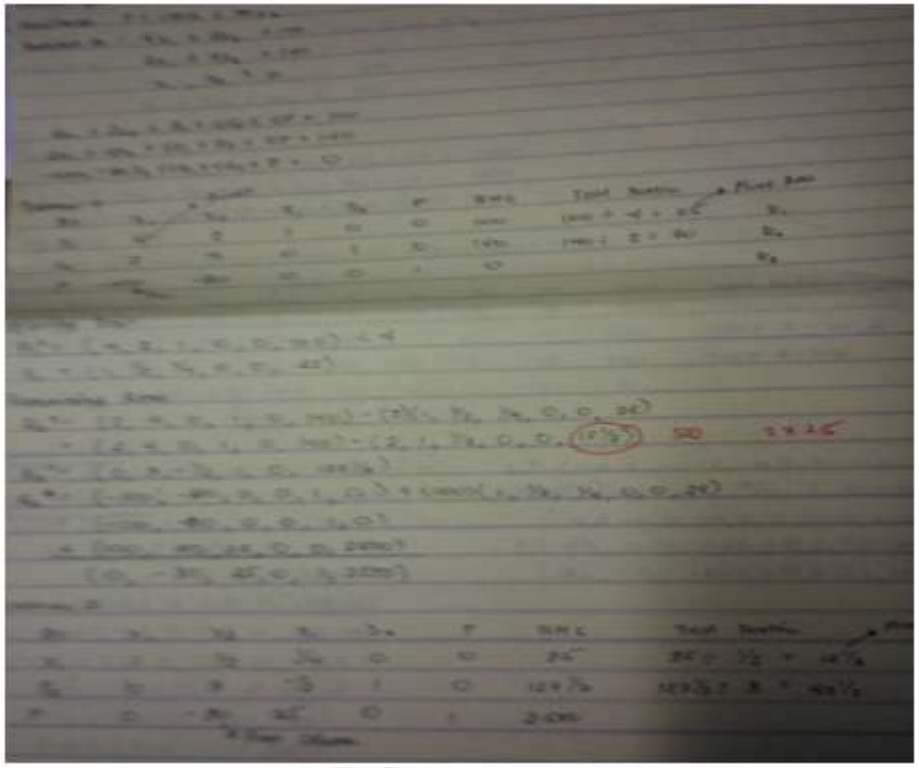

Exhibit 4

This is similar with the findings of Norasiah (2002), most students make error at the process skill level. The error type in transformation occurred during computation process especially during multiplication.

Error in Division

The respondents committed an error in dividing 4 by 4. The respondent answered 0 instead of 1

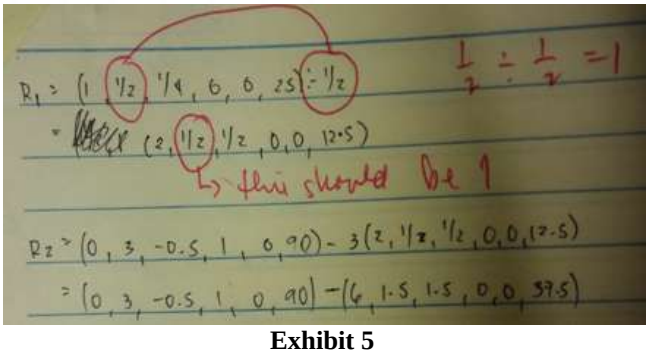

Exhibit 5

Type 3 Error: Incorrect Identification of Variable

This type of error occurs when the student did not identify correctly the entering variable and leaving variable during the process of pivoting. The study of Bayazit (2013) stated that students' ignorance of the realities of the problem

contexts appears to have some cognitive and pedagogical reasons. The priority for them is getting an answer. They do not pay attention to the underlying meaning of the rules and procedures that they use.

Exhibit 6 shows that from the tableau, is the entering variable is x_3 which should have been written on the next tableau as a replacement of the leaving variable, S_2 but the respondent wrote x_2 as the entering variable.

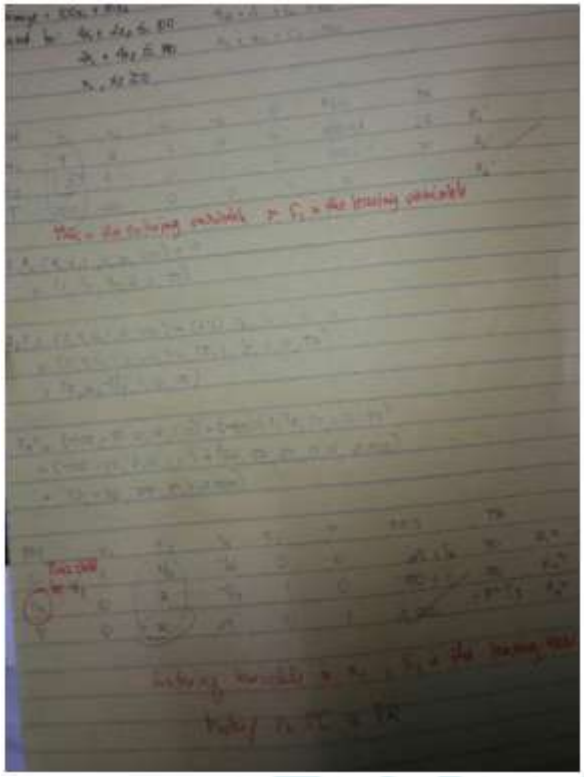

Exhibit 6

have the same frequency of 7 or 18.15%.

The variables are x_1, x_2 and the slack variables are S_1 and S_2 wherein the respondent will solve for the value of these variables. But the respondent neglected the slack variables and did not include in the final answer. This is similar with the study of Zacaria (2010) who concluded that students' often misunderstood what the question wants. This occurs when students do not understand the terms used.

Type 4 Error: Incomplete Values of Variables in the Final Answer

It could be seen that "Problem Solving Error" has the highest frequency of 15 and ranked first for both sections. As defined byIbrahim(1997), problem solving is illumination of the problem structureinformative, objective and action plan.In addition, Wood (2017) said that problem solving skills are among the most valued skills because these skill is applicable to many different situations.

Below are some sample answers of the respondents who had committed this type of error.

Exhibit 7 shows a sample of error in incomplete values of variables in the final answer. When solving algebraic problems where the variables are presented, the nonappearance of the variable implies that the value for that variable is 0 and should be written as x=0. In the final answer of the student, the variables that are visible from the final tableau were the only variables identified

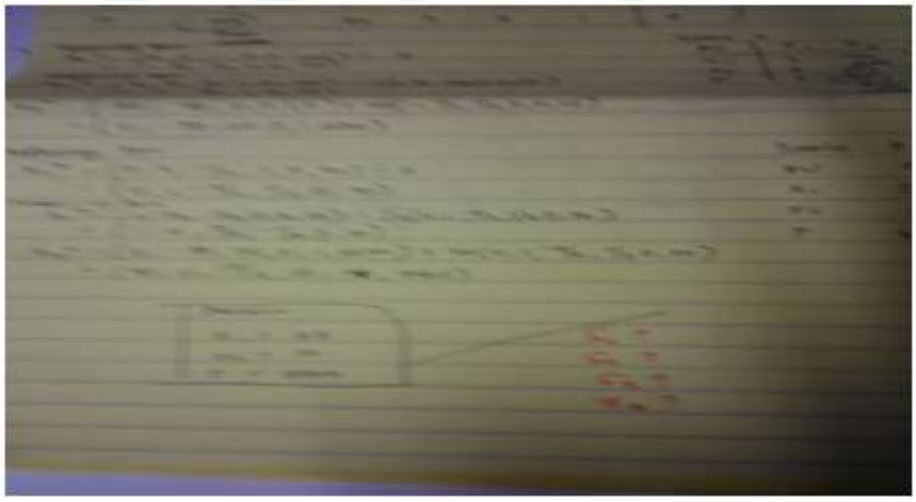

Exhibit 7

Type 5 Error: Miscopied Numerical Coefficient

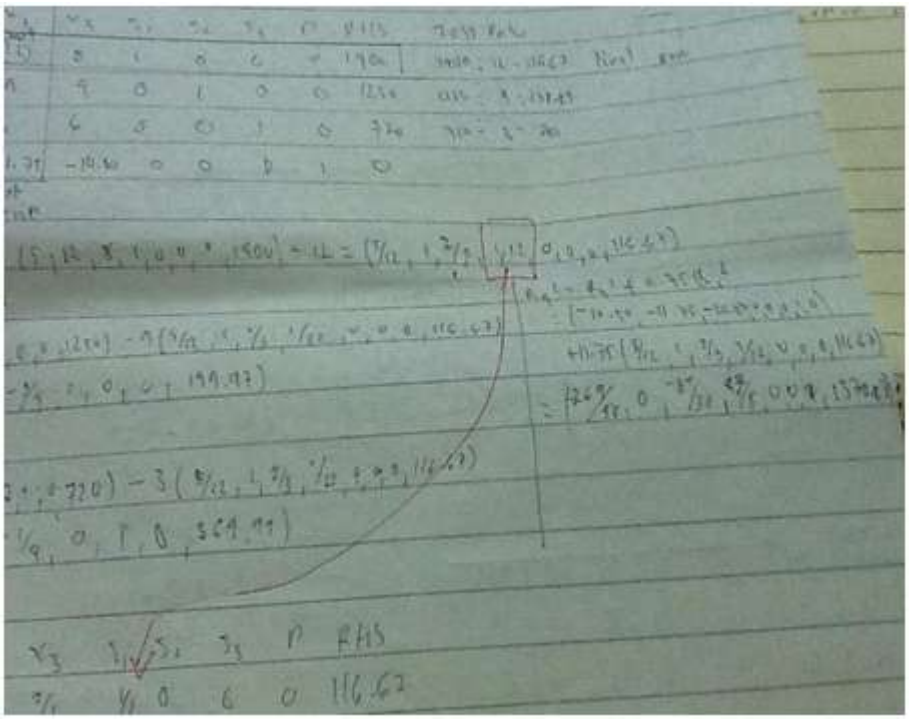

Exhibit 8

The above illustration shows a sample of a questionnaire on miscopied numerical coefficient. It could be seen from the tableau that the respondent was able to compute the value of the intersection of pivot row and pivot column, but in his computation for the next tableau, 3 was used.

Type 6 Error: Miscopied Entry in the Tableau
This error occurs when the student fails to write the desired answer correctly in the tableau. The exhibit shows that the given is 150 but the respondent wrote 1500 in the tableau.

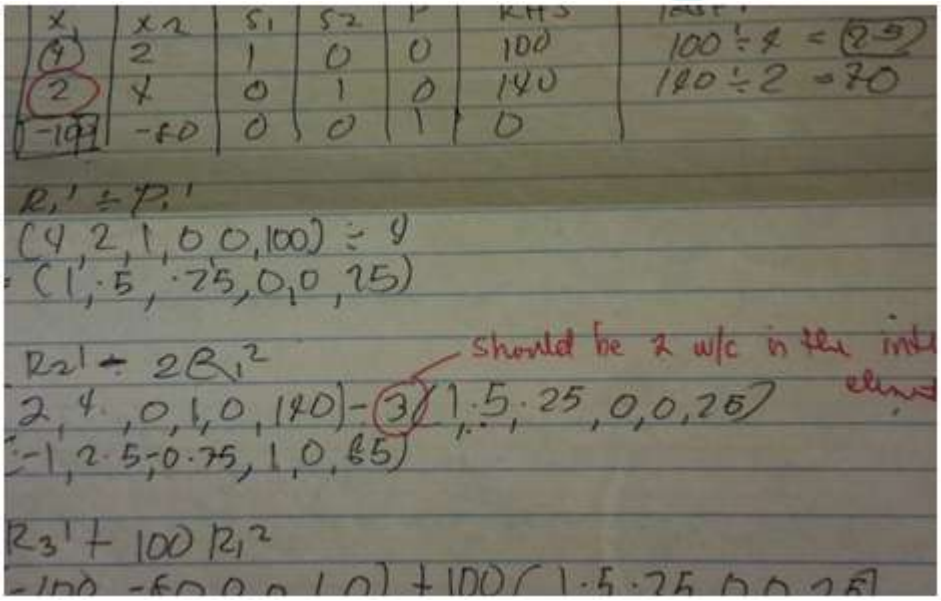

Exhibit 9

Causes of Errors
Based from the interview which was done, the following results were obtained and causes of errors were categorized.

Lack of Mastery. From the set of the students who were interviewed, more than half of the respondents said that they forgot the basic rules in performing the operations like the rules in subtracting sign numbers and performing multiplication and division on fraction.

Student 1
KL: Sa damikasi ng operations nagagamitin di konaalamanodapatmauna(Too many operations to use that I am confused of what to do first).

Student 2
CP: Dahilsiguroparangangdalidalinamankasi basic langnamanyunkasomalipala, kailangangireviewangmga rules (Maybe because I assumed that it was just simple Arithmetic that I forgot how. We really need to review the basic rules.)

Student 3
MV: Parang tama naman kaya di konarinecheck, kasomali. (It looks like it was correct that is why I did not recheck my answer which was wrong)

The students are aware that they tend to forget the basic operations in their basic Mathematics. In the study of Egodowatte(2011), he mentioned that the results of his study had a number of error under each are in Algebra. Some is due to misconceptions. Under variables, the primary reason for this was the lack of understanding of the basic concept of variables involved. This is the same with the conclusion of Chamundeswari (2014), due to misunderstanding the concepts, errors are made.

Some other evidences on lack of mastery is on sign errors. According to Schechter (2009), sign numbers are surely the most common errors. This is an implication of the students being unconcerned and careless.

Lack of Good Time Management. Among the 11 students that were interviewed, almost half stated that they do not have enough time to answer the problems due to confusion.

Student 4
JL: I am a slow learner that I am not satisfied if I will not recheck my answer (pause) .but I ran out of time.

Student 5
JV: E kasingaangdaminggagawin para makuhaang final answer ta sang igsi ng oras, nara rattle ako. (There are many operations and yet the time is too short and I am rattled)

A student need to have a good time management in solving problem. As mentioned ime management in solving problem. As mentioned by Tsekou(2013 in his article that time management skills have to do with self-monotoring and those who are more effective in planning their time tend to be more efficient.

Lack of Patience. There were 27.27% who seemed not convinced on the importance of the topic that they got impatient and bored in completing their solution. Some of the respondents had pointed out that because of the problem solving is time-taking, by the time they got the answer, they were already bored. This could result from the ability to give good concentration.

Student 6
KL: Sa damikasi ng gagawinparanganggulo kaya nakakatamad.(There are so many things to do and I find it unorganized that's why I get lazy to do it.)

Student 7
JR: Parang di ko Makita application nyasa real life kaya nakakatamad. (I do not find it useful)

Having the right attitude will motivate a student do well in problem solving. As Pimta (2009) mentioned , one of the direct factors influencing Mathematics was attitude towards Mathematics. And it was confirmed by Schechter (2009) that there is a significant relationship between attitude (patience, confidence and willingness) towards mathematics achievement.

5. Conclusions and Recommendations

Based from the results of this study, it can be concluded that the most common errors of the respondents' isthe Unfinished solution (problem solving error) and the least is the Computation error. The causes of errors found in this study based from the interview conducted were: lack of mastery, lack of good time management and lack of patience.

Based from the conclusions, the following are recommended: the mathematics teacher should use a strategy that the students will become more familiar when working with problem solving, the mathematics teacher should spend time on reviewing the basic concepts needed for the solutions of problems before the next topic so that the students will be forced to have a review and master the necessary operations and concepts; the College of Business Administration and Accountancy should conduct seminars to BSA students on the importance of patience and time management not only in solving mathematics but to their everyday chores. Future study should be done to validate the result of this study.

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