

## Conceptual and procedural understanding in general mathematics: Basis for enrichment activity

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### *Abstract*

This study assessed the level of mathematical skills along conceptual and procedural understanding of Grade-11 students at Burgos NHS during the school year 2020-2021. It determined the significant factors that may contribute to a better level of attainment of the learning competencies and mathematical performance of students in the formulation of the enrichment activities based of the least mastered competencies in General Mathematics. The level of mathematical skills along conceptual and procedural understanding were satisfactory. Data revealed that the profile of the respondents and their level of mathematics skills along conceptual understanding showed significant relationship along sex and number of apps used. Students struggle to solve issues containing logarithmic functions, equations, and inequalities, it was discovered. The created general mathematics enrichment activity may be used as instructional material to improve the students' conceptual and procedural understanding. The following suggestions are made based on the study's findings: Students should be continuously given meaningful and pertinent activities to improve their mastery of various General Mathematics competencies; Mathematics teachers should offer interactive class discussions, group projects, and technology-assisted lectures that will help both high/low-performing students grasp conceptual and procedural mathematics skills; Teachers should maximize using technological tools for students to arouse their interest and master most of the learning competencies.

**Keywords:** conceptual, procedural, problem solving

## Conceptual and procedural understanding in general mathematics: Basis for enrichment activity

### 1. Introduction

Mathematics is a body of knowledge and practice, crucial in understanding the world. It fosters higher order thinking skills such as the power of reasoning, analytical and critical thinking, problem solving and even communication skills. It is the cradle of all things, and its relevance transcends across time and space therefore, it must be learned. There are two components to achieve mathematics proficiency namely the conceptual and procedural understanding. Conceptual understanding in mathematics means that students understand which ideas were the key and that they grasp the empirical value of those ideas. Students reveal understanding of mathematical ideas are valuable and why significant, and how main ideas support in problem solving, how an idea or procedure is mathematically defensible – why we and they are justified in using it and how to flexibly adapt previous experience to new transfer problems.

On the other hand, procedural fluency is the ability to apply procedures accurately, efficiently, and flexibly; to transfer procedures to different problems and contexts; to build or modify procedures from other procedures; and to recognize when one strategy or procedure is more appropriate to apply than another. Both components are equally important in helping learners achieve better understanding of mathematical problems (Reston Va, 2014). Many students struggle in understanding the subject. Mathematical tasks often pose a challenge because they require students to read and comprehend the text of the problem, identify the question that needs to be answered, and finally create and solve a numerical equation. Respondents of the study lacked many mathematical skills, such as numerical fact, visuospatial and information skills. Information skills are the most critical. The deficiency of these mathematics skills and of cognitive abilities in learning inhibits the mathematics problem-solving. They further added that students faced difficulties in the problem solving due to incompetence in acquiring many mathematics skills and cognitive abilities of learning ( Tambychick and Meerah, 2010). Furthermore, based on scores, the researcher also observed that most students have difficulty understanding word problems. After scrutinizing their papers, she found out that some failed to finish the tasks while some arrived with wrong solutions or answers. The researcher investigated and learned that some students did not understand the problem so eventually they were uncertain of what mathematical operations or formulas to apply.

The predominance of such concern prompted the researcher to conduct this study. If teaching and learning process are not equally effective for all students, the difficulties in acquiring mathematics skills by the students could get worsened. Understanding students' difficulties in mathematics skills needed in problem solving is one way to assist them (Tambychik and Meerah, 2010). The researcher would further investigate the mathematics skills of the learners with emphasis on conceptual and procedural understanding which may lead to the formulation of enrichment activity. An enrichment activity is composed of tasks which may help students enrich their mathematics skills. Furthermore, the results may bring teaching strategies that will cater the immediate needs of students along mathematics. According to Rittle-Johnson conceptual instruction led to increased conceptual understanding and to generation and transfer of a correct procedure. Procedural instruction led to increased conceptual understanding and to adoption, but only limited transfer, of the instructed procedure. These findings highlight the causal relations between conceptual and procedural knowledge and suggest that conceptual knowledge may have a greater influence on procedural knowledge than the reverse.

**Statement of the Problem** - The study investigated the mathematics skills with emphasis on conceptual and procedural understanding of the Grade 11 students at Burgos National High School for School Year 2020-2021. Specifically, the study sought to answer the following research questions:

- What is the profile of the respondents in terms of the following: age, sex, strand, and math application

used

- What is the level mathematics skills of the respondents along: conceptual understanding, and procedural understanding?
- Is there a significant relationship between the profile of the respondents and their level of mathematics skills along conceptual and procedural understanding?
- What are the least mastered competencies on conceptual understanding?
- What are the weaknesses of the students encountered in procedural understanding?
- What is the level of validity of the enrichment activity?

## 2. Methodology

**Research Design** - This study used descriptive design employing correlational and developmental research designs. Best and Khan (2012) defines descriptive research design as a scientific method which involves observing and describing the existing phenomenon. In this study, the respondents' profile as to age and sex and their mathematics skills with emphasis on conceptual and procedural understanding was tallied and quantitatively described. This was to give a clearer picture of the current standing of the learners in terms of their mathematics skills with respect to their conceptual and procedural understanding. Meanwhile, developmental research has been defined as systematic study of designing, developing, and evaluating instructional programs, processes, and products that must meet criteria of internal consistency and effectiveness as cited by Bongolan (2018). In this study, developmental dealt on the development of enrichment activities which were validated by experts. These enrichment activities target the least attained learning competencies found. It was stated in the book of Leedy and Ormrod (2010) that correlational research design is used to establish relationships between two or more variables of the same population, or even between variables of separate populations. The profile of the student-respondents will be correlated to their mathematical skills along conceptual and procedural understanding to see either a significant or non-significant association. Lastly, developmental research design, as described by Fauziah (2018) to facilitate the study of new models, tools and procedures to address a pressing issue in a certain field, will be considered in creating enrichment activities. The said activities will be developed based on the findings of the study.

**Population and Locale of the Study** - The respondents were the Grade 11 students at Burgos National High School during the first semester, School Year 2020-2021. There were 130 students for grade 11 but only 95 willingly answered the test through module and google form.

**Table 1**  
*Distribution of Respondents*

Strands	Number of Respondent Population Sample	
GAS	53	41
TVL- HOME ECONOMICS	26	20
TVL-INDUSTRIAL ARTS	16	4
TVL- CAREGIVING	37	26
TVL ICT	5	4
TOTAL	137	95

**Research Instrument** - To establish factual results, the researcher gathered data through a survey-questionnaire divided into two parts. The first part included the profile of the respondents in terms of age, sex, strand and math application used. The second part was composed of a series of mathematical tasks which require the learners to answer through numerical and written responses. This led to the identification of their mathematics skills along with conceptual and procedural understanding.

**Data Gathering Procedure** - Prior to the conduct of this study, the researcher asked permission from proper authorities. The principals and the superintendent as well as the adviser of the students. Upon approval, the teacher made question was validated and a pilot tested at Santa Maria National High School with their math experts. After the pilot testing the questionnaire undergone item analysis and input the suggestions and comments of the validators. Then the researcher personally conducts the undertakings of the study – floating questionnaire and test questions, gathering the questionnaires through google forms and those who cannot access internet the researcher provided a hard copy. Only the student who are willing to answer is entertained. The results were tallied and sent to the statistician for analysis and interpretation. The results of the retrieved questionnaire were tabulated. Then the data was analyzed and interpreted with the most appropriate statistical procedures.

### 3. Results and discussion

This chapter presents the data gathered and collected as well as the result of the analysis and discussion of these results.

#### *Profile of the respondents*

**Age.** Most of the respondents were age between 15-17 years old with 75 or 79% of the total respondents. This implies that the respondents are at their right age to be grade 11. This finding is similar with the study of Belo (2019) and Cacabelos (2018) that majority of the Grade 11 students were age 16-17 years old.

**Sex.** Female students stand out the male students. The Grade 11 students of Burgos National High School are mostly female. They comprise 65% of the respondents. This is in consonance to the study of Owolabi and Adejoke (2014) and Naungayan (2017) that female students dominate the male students. This is in contrary to the study of Lucinario (2019) that 59% of the respondents are male. However, Escalona (2015) disclosed in his study that as to sex and age, boys' and girls' performance were equally well, establishing the fact that learning Mathematics does not depend on sex.

**Strand.** Most of the respondents are coming from General Academic Strand that comprises 43.16 % or 41 respondents. While on the other hand, TVL- ICT and Industrial Arts were both obtained 4.21% (4 out of 95) students. This implies that students are still undecided on what course they are going to take in college. Because it does not concentrate on any career path, GAS is a very versatile strand, claims AMA senior high school (2021). This allows students the freedom to consider their alternatives and provides them with a decent variety of disciplines so they can choose an undergraduate degree in the future with greater knowledge. The general academic strand is ideal for students who aren't sure which path to take because the other strands are career-specific. Under this track, you can select electives from the several academic strands. Humanities, Social Sciences, Applied Economics, Organizations and Management, and Disaster preparedness are of these topics.

**Math Application Used.** With 63 students, or 67 percent of the population, mathway was used most of the time. They employed a variety of programs, including Math Solver, Camera Math, Symbolab, Photo Math, Gaumath, and Cymath. This suggested that rather of using the step-by-step approach in checking their answers that makes it challenging for them to do, the students used technology applications to validate their answers and it gives self-fulfillment and satisfaction if they derived with the correct answer. This is like the study of Hadjinor, Asotigue, and Pangandamun, (2021) that the used of Mathway Application was effective in helping students improve their performance in mathematics. Cozad, Lauren, Riccomini, and Paul (2016) Digital-based interventions, such as programs on computers or tablet applications, are one avenue by which students can able to acquire and maintain fluency. These digital tools are becoming increasingly more common and available in today's classroom. Eight studies on digital-based fact fluency were identified through a systematic search of the literature and analyzed to determine their effects. Study participants were elementary aged students with mathematics difficulties. Results of this synthesis indicate that digital-based interventions are an effective instructional technique for increasing fact fluency with students demonstrating mathematics difficulties.

Alqashanin, & Faqihi (2022) recommended the use of mathway application and other applications in the process of teaching learning process. Zulnaldi and Zakaria (2012) encourage teachers to use technology in the teaching and learning of mathematics.

***Level of Mathematics Skills along Conceptual Understanding.***

Table 2 shows the frequency and percentage of mathematics skills along conceptual understanding of grade 11 students.

**Table 2**  
*Level of Mathematics Skills along Conceptual Understanding*

Range of Scores	Descriptive Rating	Frequency	Percentage
17-20	Outstanding	4	4.21
13-16	Very Satisfactory	11	11.58
9-12	Satisfactory	50	52.63
5-8	Fairly Satisfactory	30	31.58
	Total	95	100
Mean		10.04	
Descriptive Equivalent		Satisfactory	

The Table 2 reveals that the level of mathematics skills along conceptual understanding of the respondents was satisfactory. Given that the majority of students have a satisfactory grasp of conceptual mathematics skills, which makes it challenging for them to understand mathematical concepts, this may be the reason why they chose GAS as their academic strand. The results support Ghazali and Zakaria's (2011) study, which found that while most students demonstrate high levels of procedural understanding but low levels of conceptual understanding. High conceptual knowledge levels enable students to solve challenges they have never encountered before. As a result, teaching must be changed to increase conceptual understanding among students and reduce the demand for memorization and algorithms.

***Mathematics Skills along Procedural Understanding.***

Table 3 shows the level of mathematics skills along procedural understanding of grade 11 students.

**Table 3**  
*Level of Mathematics Skills along Procedural Understanding*

Procedures	Mean	DR
Understanding the Problem. Identify what is asked and given.	3.25	Satisfactory
Devise a Plan. Make the equation or draw the diagram	2.67	Satisfactory
Carry out the Plan. Solve the problem.	2.42	Fairly Satisfactory
Look back. Check and interpret the solution.	1.38	Fairly Satisfactory
Overall	2.54	Fairly Satisfactory

Legend: 1.81-1.60 Fairly Satisfactory  
1.61-2.40 Satisfactory

The respondents' level of mathematics skills along procedural understanding is satisfactory as disclosed by Table 3. Thus, it implies that students only possess a limited level of procedural mathematical skills. Additionally, without a basic comprehension of the problem's concept and procedures, students would find it challenging to solve it. This negates the findings of study conducted by Ali- Mutawah, et al. (2019) which revealed that students generally fared well in procedural knowledge and poorly in conceptual comprehension. The procedural knowledge problems are those types of challenges that the students are familiar with from their K-12 education in Bahraini schools. Since procedural teaching boosted conceptual understanding and adoption, but only a limited amount of the taught process was transferred, these results emphasize the connections between conceptual and procedural knowledge and imply that conceptual knowledge may have a stronger impact on procedural knowledge than the converse (Rittle-Johnson and Alibali, 2016).

***Significant relationship between the profile of the respondents and their level of mathematics skills along conceptual and procedural understanding.***

Table 4 shows the correlation between the profile of the respondents and their level of mathematical skills along conceptual and procedural understanding.

**Table 4**

*Relationship between the profile of the respondents and their level of mathematics skills along conceptual and procedural understanding.*

Relationship	Conceptual Understanding	Procedural understanding
Age	0.036	-0.043
Sex	-.329**	-.182
Track/Strand	-.035	-.193
Number of apps Use	.356**	.200

\*\*Correlation is significant at the 0.01 level (2-tailed).

The table revealed that only sex and number of apps used were significant on their conceptual understanding. This implies that female respondents have a better conceptual understanding as compared to male respondents. This like to the study of Hooda and Devi (2018) that male students have higher mathematics achievement than female students however the result contradicts to Aydin (2018) where results reveals that females have better conceptual and procedural understanding of angles, a topic under geometry. The boys are performing better than girls. This may be attributed since male students have favorable attitude towards mathematics than female students. Significant relationship exists on the number of apps used because of the features this application offers that will enhance their conceptual understanding on the given topic. Whereas profile does not affect procedural understanding of the respondents. On the contrary, Barcelona (2017) found out that the personality relates significantly with Mathematics achievement of students.

***Least mastered competencies in conceptual understanding***

Table 5 shows the mean of the least mastered competencies in Conceptual understanding.

**Table 5**

*Least mastered competencies in conceptual understanding*

Competencies	Mastery index	DR
<b>Functions and Their Graphs</b>		
Represents real-life situations using functions, including piece-wise functions.	0.53	LM
Evaluates a function	0.60	LM
Performs four fundamental operation, and composition of functions	0.33	LM
Solves problems involving functions	0.25	LM
Distinguishes rational function, rational equation, and rational inequality	0.75	M
Represents real-life situations using rational functions	0.56	M
Solves rational equations and inequalities.	0.29	LM
Finds the domain and range of a rational function.	0.52	LM
Determines the: (a) intercepts (b) zeroes; and (c) asymptotes of rational functions	0.55	LM
Determines the inverse of a one-to-one function.	0.52	LM
Graphs inverse functions.	0.56	LM
Solves exponential equations and inequalities.	0.45	LM
Solves logarithmic equations and inequalities.	0.66	M
Solves problems involving logarithmic functions, equations, and inequalities	0.21	LM
<b>Basic Business Mathematics</b>		
Solves problems involving logarithmic functions, equations, and inequalities.	0.55	LM
Computes interest, maturity value, future value, and present value in simple interest and compound interest environment.	0.36	LM
Finds the future value and present value of both simple annuities and general annuities.	0.63	M

Legend: 0.61- 1.00 Mastered (M)

0.0- 0.60 Least Mastered (LM)

It is reflected on the table that along *Function and their Graphs*, the item “Solves problems involving logarithmic functions, equations, and inequalities” got the lowest difficulty index of 0.21 described as least mastered. Meanwhile the item “Distinguishes rational function, rational equation, and rational inequality” got

the highest difficulty index of 0.75 described mastered. This implies that more attention must be given on the least mastered competencies, and it needs further discussion and guidance from the teacher for better understanding on its concepts and procedures. Some students might have failed to familiarize these concepts, thus developed poor understanding. Therefore, enrichment activities where students are expected to participate actively must be administered. This is in consonance in the study conducted by Abuda (2019) on the least mastered competencies in Mathematics should use SIM based instruction to improved mathematical skills of the students. SIM-based instruction is an effectual means in reaching mastery on least mastered competencies in General Mathematics. Hence, it is recommended not to delimit Direct Instruction in up skilling least mastered competencies alongside with SIM-based instruction. Furthermore, SIM-based instruction can be implemented to other schools to supplement its effectiveness and to maximize its use in the future, and that studies on the use of SIM-based remedial instruction in other learning areas.

***Weaknesses of the Students Encountered in Procedural Understanding.***

Table 6 presents the weaknesses of the students encountered in procedural understanding.

**Table 6**  
*Weaknesses of the Students Encountered in Procedural Understanding*

Problem Number	Competencies	Mastery index	DR
1	Represents real-life situations using functions, including piece-wise functions.	0.58	S
2	Represents real-life situations using rational functions	0.55	S
3	Solves problems involving logarithmic functions, equations, and inequalities	0.22	W
4	Solves problems involving simple and compound interests.	0.24	W

Legend: 0.00-0.50 W- Weakness  
0.51-1.00 S-Strength

The lowest difficulty index was 0.22, solves problems involving logarithmic functions, equations, and inequalities. This implies that the respondents were hard up in solving problems involving logarithmic functions, equations, and inequalities. The other weakness competencies were solving problems involving simple and compound interests with difficulty index 0.24. This implies that students had a weak comprehension on worded problems related to business math. The findings confirmed the study of Massulo (2017) as cited by Lucinario (2019) who points out that word problems tend to be complicated in part because of their descriptive language. Students often don't understand what exactly they're being asked, especially when the problem includes abstract concepts. Other issues arise when students lack the fundamentals of math and cannot formulate a plan for solving or separate an equation's step.

**Conclusions**

After careful analysis and interpretation of the findings, the following are concluded:

1. Most of the respondents are between 15-17 years old and dominated by female. Most of the respondents come from General Academic Strand, and they usually use the math way application.
2. The level of mathematical skills along with conceptual understanding and procedural understanding were satisfactory.
3. The profile of the respondents and their level of mathematics skills along conceptual understanding showed significant relationship along sex and number of apps used. However, the profile of the respondent does not have significance in their procedural understanding.
4. There were identified least mastered competencies along functions and their graphs and basic business mathematics that need more attention.

5. The respondents are hard up in solving problems involving logarithmic functions, equations, and inequalities. The other attained competencies were solving problems involving simple and compound interests.
6. The enrichment activity is evaluated as very valid and reliable and can help the students develop proficiency in the different competencies.

**Recommendation** - Based on the conclusions made, the researcher hereby recommends the following:

- Students must be continuously provided a meaningful and relevant activities to improve their mastery of various competencies in General Mathematics with the help of technology.
- Mathematics teachers must offer interactive class discussions, group tasks and technology aided lectures which benefit both the performing and low-performing students in grasping conceptual and procedural mathematics skills.
- Proper guidance and appropriate mathematical application tools will be administered so that students will be able to familiarize their features for better understanding. This mathematics application is an additional tool in improving and enhancing the performance of the students.
- Teachers should provide differentiated materials to cater diverse types of learners to help students in improving performance and for the attainment of the learning competencies.
- Teachers should maximize using technological tools for students to arouse their interest and master most of the learning competencies.
- Teachers continue to develop enrichment activities focusing on the least mastered competencies and weaknesses in the subject as a means of helping students to meet the standards set by the DepEd and further studies will be conducted not only to validate and strengthen the results and findings of this study but also to consider the interactive aspect of the material.

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