International Journal of Research Studies in Education
2024 Volume 13 Number 6, 1-14

Logical thinking skills and problem solving skills of the Grade 12 STEM students of University of Northern Philippines: A basis for extension plan

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ISSN: 2243-7703
Online ISSN: 2243-7711

Received: 30 November 2023
Revised: 22 May 2024
Accepted: 5 June 2024
OPEN ACCESS
Available Online: 5 June 2024
DOI: 10.5861/ijrse.2024.23077

Abstract

This study aimed to determine the logical thinking skills and problem solving skills of the Grade 12 STEM students of University of Northern Philippines during the S. Y. 2018-2019. The respondents were composed of 104 students from the three sections. It aimed to determine the profile of the students; their logical thinking skills in terms of abstract reasoning and inductive reasoning; the differences in their problem solving skills; and the factors that influence their problem solving skills. The descriptive research design was utilized in this study. Comparative and correlational methods were employed. The data gathered using the questionnaires for the profile of the students, logical thinking skills test and problem solving skills test were analyzed using the following statistical tools: frequency and percentage, mean, One-way Analysis of Variance (ANOVA) and multiple linear regression. The findings are the following: (1) Majority of the respondents are female and 18 years old. They have Php101.00 - Php200.00 daily allowance. Their fathers are mostly non-professional workers, and both of their parents are college graduates. Great majority of the respondents came from public schools. (2) The students have a satisfactory level of logical thinking skills. They are better with abstract reasoning than inductive reasoning. The students have satisfactory level of problem solving skills. (3) There are no significant differences in the level of problem solving skills of the students by section. Hence, they possess more or less the same level of problem solving skills. (4) The inductive reasoning skills of the students is a predictor of their problem solving skills. Based on the results of the study, the following are recommended: (1) The students are encouraged to solve and enjoy solving puzzles that would enhance their logical thinking skills; (2) The students are advised to practice solving math problems to further improve their skills in problem solving. They are encouraged to master the basic rules of arithmetic and properties of Algebra by reading mathematics books since these are essential elements to succeed in problem solving; (3) Students may work on solving sequences that would enhance their inductive reasoning skills; and (4) Another study could be undertaken considering other variables that would have a contribution to the performance of the students in problem solving.

Keywords: logical thinking skills, problem solving skills, basis for extension plan

Logical thinking skills and problem solving skills of the Grade 12 STEM students of University of Northern Philippines: A basis for extension plan

1. Introduction

Mathematics helps every individual to develop lifelong skills which includes the ability to concentrate in order to study, focused on tasks, being organized and the ability to stay organized. Knowing basic mathematics principles keeps one from having to carry around a calculator, because good use of mathematics allows us to do many calculations in our heads. Mathematics helps us have better problem-solving skills. Mathematics helps us think analytically and have better reasoning abilities. Analytical thinking refers to the ability to think critically about the world around us. Analytical and reasoning skills are important because they help us solve problems and look for solutions. Many students with learning difficulties in the area of mathematics demonstrate specific weaknesses with mathematics reasoning (Griffin & Jitendra, 2009).

One aspect of the mathematics curriculum that involves high levels of reasoning is solving word problems. Word problems, sometimes referred to as story problems, are used to give learners a glimpse of how mathematics is used in the real world (Bogomolny, 2009). Word problems consist of a linguistic presentation of hypothetical situations in which problems are posed that can be solved through the use of mathematical equations. Some mathematicians conceptualize word problems as part of a larger problem-solving component of the mathematics curriculum in which students must overcome barriers in order to obtain and explain a solution to a mathematical problem that is not directly apparent. Based on this conceptualization of solving word problems, the mathematical equations are sometimes hidden within multifarious, complex word usage. Sometimes the numerals and numeric operations are difficult to identify due to unforeseen or unique language structures, especially in the most advanced word problems. This results in high levels of challenge for many students, particularly those with learning difficulties in the area of mathematics. (www.shmoop.com/word-problems)

Problem solving is considered one of several desired "21st Century Skills." Learning how an art program can promote growth in problem solving can help other art organizations strengthen their programs in this realm. Logical thinking is the process in which one uses reasoning consistently to come to a conclusion. Problems or situations that involve logical thinking call for structure, for relationships between facts, and for chains of reasoning that "make sense." According to Dr. Karl Albercht (in his book Brain Building), the basis of all logical thinking is sequential thought. This process involves taking the important ideas, facts, and conclusions involved in a problem and arranging them in a chain-like progression that takes on a meaning in and of itself. To think logically is to think in steps.

Problem solving and critical thinking refers to the ability to use knowledge, facts, and data to effectively solve problems. It does not mean immediate answer is needed, it means one must be able to stand on their feet, asses problems, and find solutions. The ability to develop a well thought out solution within a reasonable time frame helps every individual, thus it is a skill that one value greatly. With these observations, the researcher decided to study problem solving performance and logical thinking skills of the students. Problem solving skill is an ability which every individual must possess in all aspects of life. The significance of the study is that through this study, students will have an assessment of their own problem solving skills which may inform them the need for improvement or enhancement. Moreover, it may provide insights to educators to plan teaching strategies to help the students improve their problem solving skills.

1.1 Statement of the Problem

This study aimed to determine the logical thinking skills and problem solving skills of the Grade 12 STEM students at the University of Northern Philippines, S.Y. 2018-2019. Specifically, it sought to answer the following

questions: 1. What is the profile of the students in terms of age, sex, daily allowance, parents' occupation, parents' educational attainment, and type of junior high school completed from? 2. What is the level of logical thinking skills of the Grade 12 STEM students in terms of abstract reasoning, and inductive reasoning? 3. What is the level of performance of the Grade 12 STEM students in problem solving? 4. Are there significant differences in the level of performance in problem solving between and among the three sections of Grade 12 STEM? 5. Is there a significant influence of the profile of the students and their logical thinking skills on their level of performance in problem solving? 6. What extension plan can be proposed to improve problem solving skills of students?

1.2 Scope and Delimitation

This study was conducted to determine the logical thinking skills and problem solving skills of the Grade 12-STEM students of University of Northern Philippines during the school year 2018-2019. It also determined the profile of the students in terms of: age, sex, daily allowance, parents' occupation, parents' educational attainment, and type of junior high school completed from. The problem solving skills of the students were measured based on their performance in solving worded problems. Primarily, it determined the significant difference by section on the performance of the students in problem solving. Furthermore, it also looked into profile of the students and their logical thinking skills that have influence on their level of problem solving skills.

2. Theoretical Framework

This section provided a theoretical justification to back up the conduct of the study, hence a review of related studies about Mathematics achievement and other related factors are hereby presented.

On Problem Solving - Kamaruddin and Hazni (2010) mentioned that mathematical problem solving is a complex and integrative task. First, this task requires a learner to understand the information that is presented in the problem. Further, mathematical problem solving requires a person to select and use cognitive strategies and processes that are necessary for task completion. Cognitive strategies and processes for mathematical problem solving are procedural methods or tools that help individual plan and solve a problem. Possible cognitive strategies and processes can include finding the algorithm, estimating the problem, or drawing a diagram. Dividing the process of problem solving into three phases: entry, attack, and review. The entry phase includes thinking about "what do I know," "what do I want," and "what can I introduce." The review phase further contains "checking," "reflecting," and "extending." However, a typical problem solving activity is seldom linear; an individual always goes back and forth when proceeding to the desired outcome. Also it is possible that the attack phase is difficult to observe or the review phase is missing. Generally speaking, this perspective could provide an overview of the entire problem solving process so that a clearer relationship between steps could be identified and studied. According also to Kamaruddin and Hazni (2010) in their studies recommended that the problem solving ability is very important especially for students. Students can improve their learning ability if the teachers teach them with the implementation of problem solving.

On Worded Problems - Word problems in mathematics education represent a set of exercise or story problems that combine words or phrases with numbers. To be successful in solving math word problems, students must learn how to decode the important information and must understand how to translate the important words or phrases into a mathematical expression or equation. Word problems play an important role in the Ontario mathematics curriculum including problems on the EQAO mathematics assessments (Barwell, 2011).

On Logical Thinking - Computer engineering depends on mathematical logic and therefore computer engineers are expected to be fluent in logical thinking. By possessing logical skill, students could think logically to solve problem and then converts into programming language in logic manner. By having good logical thinking skill too, students could gain superior performance (Al-Imamy, Alizadeh, & Nour, 2009) in this course. Technically, every desired output must be derived from input data which must be processed before it can be produced. In other words, the outputs are uniquely determined by inputs of the problems (Al-Imamy, Alizadeh, & Nour, 2009).

Besides logical thinking, students should possess another important skill in dealing with programming, that is problem solving. Problem solving is a mental activity and it helps students a lot in understanding programming concept. By having problem solving skill, students could analyze problems and synthesize a solution and thus relate to the real world problem (Coles, Jones, & Wynters, 2011). In general, we can say that there are three skills, problem solving, logical thinking and cognitive skills that the students should have in order to be good in problem solving.

On Abstract Reasoning - Abstract reasoning ability is a non-verbal measure of reasoning ability. Abstract reasoning involves the ability to think logically and to perceive relationship in abstract figure or patterns. Abstract reasoning ability is ability to identify the underlying logic of a pattern and then determine the solution; it is believed to be the best indicator of fluid intelligence and helps to learn new things quickly. Abstract reasoning is the ability to understand complex concepts and assimilate new information beyond previous experience. Abstract reasoning ability is particularly valued where the job involves problem solving, dealing with complex data or concepts, developments of strategies and designing. Thus the ability is useful in profession such designing architectural, draftsman-ship, automobile repair, computer programming, and mathematics. Thus abstract reasoning ability can predict success for all jobs, which require bringing logical analysis to bear in novel and intellectually demanding situations. (www.shodhganga.inflibnet.ac.in)

On Inductive Reasoning - Mousa (2017) found that inductive reasoning is closely connected to intelligence and the relationship between them is so far strong. In addition, acquisition of new knowledge and skills is also considered as an important role that inductive reasoning plays in enhancing and developing students' performance. There are several advantages that can be acquired by implementing inductive reasoning on school children regarding knowledge: "inductive reasoning is one of the mental tools that is used not only to acquire new knowledge, but also to make the acquired knowledge more readily applicable in new contexts". Inductive reasoning is a helpful procedure that is useful in making predictions about new hypothesis set by researchers. "Inductive reasoning involves making predictions about novel situations based on existing knowledge" (Hayes et. Al, 2010)

On Age - Querubin (2010) found out that age is not significantly related to the performance in College Algebra. In contrary, Reotutar (2011) found that age and mathematics performance has a significant relationship.

On Sex - In the study of Ballera (2010) as cited by Copio (2015), it was revealed that sex is not significantly related to the students' performance in Geometry. Abad (2009) as cited by Copio (2015) also revealed in her study that sex is not related to performance in Geometry among third year students of Ilocos Sur National High School. This implies that the male and female students performed more or less the same. In contrary, Bañaga (2015) found that sex have an influence on the performance in college algebra. According to OECD, girls fell less motivated to learn math and have less confidence in their abilities than boys. (www.theguardian.com)

On Daily Allowance - In the study of Defiesta (2012) and Tabunan (2012), they found out that there is no significant relationship between the performance in Plane Trigonometry and their daily allowance.

On Parents' Educational Attainment - Roberonta (2013) found in her study that there is no significant relationship between students' performance in Algebra and mothers' educational attainment. On the same manner, Ballerta (2010) claimed that students' performance in Geometry is not significantly related to the educational attainment of their parents. It further implies that the educational attainment of parents of the respondents do not affect their performance in mathematics. Moreover, Abad (2009) as cited by Copio (2015) revealed in her study that students' performance in Geometry is not significantly related to parents' educational attainment.

On Parents' Occupation - In the study conducted by Roberonta (2013), it was found out that the parents' occupation of the students does not affect the performance of the students in Algebra. This result was confirmed by Cabotage (2013) that there is no significant relationship between the students' mathematical ability and the means of living of their parents. This implies that whatever kind of means of living their parents it will not affect

their performance in mathematics.

On Type of High School Graduated From - Palpal-latoc (2011) found out that the type of high school graduated from has no significant relationship with mathematics performance of students and the same findings on the study of Tabunan (2012). This is contrary to the findings of Arcaparlas (2013) that the students achievement in mathematics and the type of high school graduated from are significantly related.

3. Methodology

This section presents and explains the research design that was used in the study, the respondents of the study, data gathering instrument, data gathering procedure, ethical considerations, and statistical treatment of data.

Research Design. The study used a descriptive, comparative, and correlational methods of research. The descriptive method was employed to describe the profile of the respondents and the level of performance of the students in problem solving and logical thinking skills. The level of problem solving skills was regressed on the logical thinking skills and the profile of the students.

Population. The respondents of the study were the Grade 12-STEM students from Laboratory Schools, University of Northern Philippines, Tamag, Vigan City during the S.Y. 2018-2019. Total enumeration of the population was employed. Table 1 presents the distribution of the respondents.

Table 1

Distribution of the Respondents

Section	N	n
STEM A	41	35
STEM B	39	34
STEM C	39	35
Total	119	104

Data-Gathering Instruments. The instruments used in the study were the following:

Questionnaire on Students' Personal Profile. This elicited the profile of the respondents namely: sex, age, daily allowance, parents' educational attainment, parents' occupation, and type of junior high school completed from.

Logical Thinking Skill Test. This was composed of multiple-choice type of test grouped into two dimensions.

Abstract Reasoning Test. This composed of 20 items adopted from www.psychometric-success.com.

Inductive Reasoning Test. This composed of 15 items. It entails making conclusions based upon examples and patterns.

Problem Solving Test. This tested their skills in problem solving which composed of 10 item focused on worded problems.

Scoring Mechanism. The scores of the students were determined from the rubrics adopted from Copio (2015) as follows:

- Made no attempt to solve the problem.
- Made little attempt in the form of sketches; jotting down needed relationships; jotting down needed data; or overtly explaining how to solve the problem. Showed understanding of the problem by the representations made and early attempts to solve the problem; problem solved about halfway. Made a great progress in the solution. Problem is nearly solved, solution is correct but minor errors are committed
- Problem is fully and correctly solved.

Test Validity - The test in Inductive Reasoning consisted of 20 original items and the test in Problem Solving consisted of 20 original items. For content validity, the inductive reasoning test and problem solving test were presented to three mathematics instructors of senior high school in Laboratory Schools, University of Northern Philippines to validate the questionnaire. They were requested to give their comments and suggestions for the improvement of the test questionnaire. The result of the validation of the content validity of the questionnaire is "Very Satisfactory" with mean rating of 4.24, which means that theitems represent the concepts which are meant to evaluate the Grade 12 STEM students' computational skills competence.

Item Analysis - By item analysis, the test of reliability was done by a pilot test at the San Juan National High School. Fifty-seven (57) Grade 12 - STEM A (consisted of 28 students) and STEM B (consisted of 29 students) took the test. After gathering the result of the test, Item analysis was employed. Resulting from the item analysis, the most difficult and those which yielded unacceptable discrimination indices in each content area were excluded. Originally, both Inductive Reasoning and Problem Solving Test consisted of 20 items. Five (5) items were discarded in Inductive Reasoning Test and ten (10) items were also discarded in Problem Solving Skills for the reason that items were very difficult, difficult, and very easy and with a negative discrimination index. KR20 (Kuder-Richardson Reliability) formula was used to find the reliability of the Inductive Reasoning test which yielded a reliability index of 0.73 which implies that the test is "Adequate" for a test. Cronbach's Alpha formula was used to find the reliability of the Problem Solving test which yielded a reliability index of 0.86 which implies that the test is "Good" for a classroom test based on norms from https://stats.idre.ucla.edu/stata/ado/analysis/

Data-Gathering Procedures. The researcher prepared a request letter to the principal of the respondents. The researcher coordinated with the teachers of the respondents for the actual test. The researcher prepared and submitted all necessary documents - i.e. assent forms for aged 12-18 years, study instruments, ethics approval, etc. In data gathering, 30 minutes was given to the students to answer the 35 multiple choice test in logical thinking and another 30 minutes to answer the test on problem solving. The researcher personally administered the test and retrieved the result.

Ethical Considerations. The researcher was a student from University of Northern Philippines whose only interest was to determine the problem solving skills and logical thinking skills of the Grade 12 STEM students of University of Northern Philippines. As to privacy and confidentiality, the names and scores of the respondents were not identified nor revealed. The soft and hard copies of the data gathered were kept safely by the researcher and disposed and burnt after the completion of the study. The respondents of the study were the Grade 12 STEM students who are aged 18 years and below. Assent forms were distributed to the prospective participants informing them of the purposes and importance of the study, including their rights and asking the participant if he or she would like to participate and respond to the study conducted.to withdraw from the study anytime, and make sure that when they agreed to be part of the study, they affixed their respective signatures on the form. Gandeza, C. C., & Unciano, M. J. R. (2022).

The participants were minors, Grade 12 STEM students age 18 years and below. Total enumeration of the population was used in the study. It was reiterated to them that their participation was voluntary without any form of coercion. They were also informed of their right to withdraw from the study anytime they want without penalty and that their withdrawal will in no way jeopardize their respective work assignments and positions or designations in the organization. To uphold minimal social risk, the respondents were given enough space on answering the questionnaire so the other respondents and the heads of offices will not see their responses on the items. Only the general results were presented in this study.

The study can serve as basis for enhancing instruction and also help the students for their improvement of the certain topics. Problem solving skills refers to our ability to solve problems in an effective and timely manner without any impediments. It involves being able to identify and define the problem, generating alternative solutions, evaluating and selecting the best alternative, and implementing the selected solution. Problem solving skills helps to show to the employers we have a range of other competencies such as logic, creativity, resilience, imagination,

lateral thinking and determination. Problem solving skills can make a person better in thinking critically, a person might think of certain solutions which can be used to solve such issue for a temporary basis and helps conclude with better solutions with better thinking. It can also make better in risk handling, better communication, increases understanding, encourages creative ideas and greater productive output specially when in a company or an organization.

As a sign of gratitude, there were chocolate bars given to the respondents after the conduct of data gathering. Moreover, the community and the subject organizations were benefitted from the results as their guide in the formulation and implementation of the different programs, projects, and activities.

There was no specimen used in the study.

Statistical Treatment of Data. After collecting the data needed, the researcher tabulated and analyzed the gathered data with the help of statistical tools such as follows:

Frequency count and percentage were used to determine the profile of the respondents; Mean was used to measure the level of performance in problem solving and also their logical thinking skill; The norms that were used for the interpretation of the level of students' logical thinking skills and problem solving skills were as follows:

- For the Problem solving skills test (40 items)
- For the overall Logical Thinking Skills (35 items)
- For the Abstract Reasoning (15 items)
- For the Inductive Reasoning (20 items)

Descriptive Rating

32.01 – 40.0	28.01 – 35.0	12.01–15.0	16.01 – 20.0	Excellent	(E)
24.01 – 32.0	21.01 – 28.0	9.01 – 12.0	12.01 – 16.0	Very Satisfactory	(VS)
16.01 – 24.0	14.01 – 21.0	6.01 – 9.0	8.01 – 12.0	Satisfactory	(S)
8.01 – 16.0	7.01 – 14.0	3.01 – 6.0	4.01 – 8.0	Poor	(P)
8 and below	7 and below	3 and below	4 and below	Needs Improvement	(NI)

One-way Analysis of Variance (ANOVA) was used to test the difference in problem solving skills by section; and Multiple Linear Regression was used to determine the influence of the profile of the students and their logical thinking skills on their level of problem solving skills.

4. Presentation, analysis and interpretation of data

This chapter presents, analyzes, and interprets the data gathered in the study based on the problems raised. The findings are presented in textual and tabular form.

Profile of the Respondents

Table 2 presents the profile of the Grade 12 STEM students of the University of Northern Philippines in terms of age, sex, daily allowance, parents' educational attainment, parents' occupation, and type of junior high school completed from.

Distribution of the Respondents in Terms of the Profile of the Students

Variables	Grade 12 STEM A		B		C		As a Whole	
	f	%	f	%	f	%	f	%
a. Sex								
Male	13	37.14	15	44.12	10	28.57	38	36.54
Female	22	62.86	19	55.88	25	71.43	66	63.46

Total	35	100.00	34	100.00	35	100.00	104	100.00
b. Age								
17	12	34.29	6	17.65	8	22.86	26	25.00
18	22	62.86	26	76.47	25	71.43	73	70.19
19	1	2.86	2	5.88	2	5.71	5	4.81
Total	35	100.00	34	100.00	35	100.00	104	100.00
c. Daily Allowance								
Php100.00 & below	7	20.00	5	14.71	5	14.29	17	16.35
Php101.00 - Php200.00	21	60.00	25	73.53	24	68.57	70	67.31
Php201.00 & above	7	20.00	4	11.76	6	17.14	17	16.35
Total	35	100.00	34	100.00	35	100.00	104	100.00
d. Parents' Occupation								
Father:								
Unemployed	7	20.00	7	20.59	4	11.43	18	17.31
Non-professional	20	57.14	21	61.76	14	40.00	55	52.88
Professional	8	22.86	6	17.65	17	48.57	31	29.81
Total	35	100.00	34	100.00	35	100.00	104	100.00
Mother:								
Unemployed	11	31.43	13	38.24	14	40.00	38	36.54
Non-professional	12	34.29	11	32.35	9	25.71	32	30.77
Professional	12	34.29	10	29.41	12	34.29	34	32.69
Total	35	100.00	34	100.00	35	100.00	104	100.00
e. Parents' Educational Attainment								
Father:								
No Formal Education	-	-	-	-	-	-	-	-
Elementary Undergraduate	-	-	-	-	-	-	-	-
Elementary Graduate	-	-	-	-	1	2.86	1	0.96
High School Undergraduate	-	-	1	2.94	-	-	1	0.96
High School Graduate	7	20.00	6	17.65	6	17.14	19	18.27
College Undergraduate	11	31.43	11	32	8	22.86	30	28.85
College Graduate	17	48.57	14	41.18	18	51.43	49	47.12
Masteral	-	-	2	5.88	2	5.71	4	3.85
Others	-	-	-	-	-	-	-	-
Total	35	100.00	34	100.00	35	100.00	104	100.00
Mother:								
No Formal Education	-	-	-	-	-	-	-	-
Elementary Undergraduate	-	-	-	-	-	-	-	-
Elementary Graduate	-	-	-	-	-	-	-	-
High School Undergraduate	2	5.71	2	5.88	-	-	4	3.85
High School Graduate	2	5.71	2	5.88	6	17.14	10	9.62
College Undergraduate	7	20.00	4	11.76	9	25.71	20	19.23
College Graduate	22	62.86	23	67.65	17	48.57	62	59.62
Masteral	1	2.86	2	5.88	3	8.57	6	5.77
Others	1	2.86	1	2.94	-	-	2	1.92
Total	35	100.00	34	100.00	35	100.00	104	100.00
f. Type of Junior High School Completed from								
Public	30	85.71	28	82.35	26	74.29	84	80.77
Private	5	14.29	6	17.65	9	25.71	20	19.23
Total	35	100.00	34	100.00	35	100.00	104	100.00

On Sex. Majority of the respondents are female (63.46%). Majority, also, in all the three sections are female respondents.

On Age. Majority of the respondents are 18 years old (70.19%). Similarly, all the three sections are dominated by students whose age are 18 years old.

On Daily Allowance. Majority of the respondents have Php101.00 - Php200.00 daily allowance (67.31%). In all the three sections, they have Php101.00 - Php200.00 daily allowance

On Fathers' Occupation. Majority of the respondents' fathers are non- professional workers (52.88%). Twenty-nine and eighty-one hundredth percent (29.81%) are professional workers. Seventeen and thirty-one hundredth percent (17.31%) are unemployed. Moreover, all the three sections' fathers are non-professional workers.

On Mothers' Occupation. A great percentage of the respondents' mothers are unemployed (36.54%). Thirty-two and sixty-nine hundredth percent (32.69%) are professional workers. Thirty and seventy-seven hundredth percent (30.77%) are non- professional.

On Fathers' Educational Attainment. A great percentage of the respondents' fathers are college graduate (47.12%). There are 30 (28.85%) college undergraduates, 19(18.27%) high school graduates, 4 (3.85%) masteral degree holders, 1 (0.96%) high School undergraduate and also 1 (0.96%) elementary graduate. In addition, most of all the three sections' fathers are college graduates.

On Mothers' Educational Attainment. Majority of the respondents' mothers are college graduates (59.62%). In the same way, most of all the three sections' mothers are college graduates.

On Type of Junior High School Completed From. Great majority of the respondents are from public schools (80.77%).

Level of Logical Thinking Skills of the Grade 12 STEM Students of University of Northern Philippines

Table 3 shows the level of logical thinking skills per section of the Grade 12 STEM students in abstract reasoning and inductive reasoning.

Table 3

Level of Logical Thinking Skills per Section of the Grade 12 STEM Students

Logical Thinking Skills	Number of Items	Grade 12 STEM A Mean Score	DR	B Mean Score	DR	C Mean Score	DR	Overall Mean Score	DR
Abstract Reasoning	20	11.69	S	10.56	S	9.37	S	10.54	S
Inductive Reasoning	15	7.26	S	7	S	5.94	P	6.73	S
Overall	35	18.94	S	17.56	S	15.31	S	17.27	S

Norms:

For 35 items	For 15 items	For 20 items	Rating
28.01 – 35.00	12.01 – 15.00	16.01 – 20.00	Excellent (E)
21.01 – 28.00	9.01 - 12.00	12.01 – 16.00	Very Satisfactory (VS)
14.01 – 21.00	6.01 – 9.00	8.01 - 12.00	Satisfactory (S)
7.01 – 14.00	3.01 – 6.00	4.01 – 8.00	Poor (P)
7 and below	3 and below	4 and below	Needs Improvement (NI)

On Logical Thinking Skills

- The students on section A are described to have a "Satisfactory" level of performance in Logical Thinking Skills with a mean score of 18.94.
- The students on section B got a mean score of 17.56 and also described to have a "Satisfactory" level of performance in Logical Thinking Skills.
- On the other hand, the students on section C are described to have a "Poor" level of performance in Logical Thinking Skills with a mean score of 15.31.
- The overall performance of the Grade 12 STEM students in Logical Thinking Skills is a mean score of 17.27. The Grade 12 STEM students are described to have a "Satisfactory" level of performance in Logical Thinking Skills.

On Abstract Reasoning

- The students on section A with a mean score of 11.69, on section B with a mean score of 10.56, and the students on section C with a mean score of 9.37 are described to have a "Satisfactory" level of performance in Abstract Reasoning.

- The overall performance of the Grade 12 STEM students in Abstract Reasoning is a mean score of 10.54. The Grade 12 STEM students are described to have a "Satisfactory" level of performance in Abstract Reasoning.

On Inductive Reasoning

- The students on section A are described to have a "Satisfactory" level of performance in Inductive Reasoning with a mean score of 7.26. The students on section B got a mean score of 7 and also described to have a "Satisfactory" level of performance in Inductive Reasoning.

- However, the students on section c are described to have a "Poor" level of performance in Inductive Reasoning with a mean score of 5.94.

- The overall performance of the Grade 12 STEM students in Inductive Reasoning is a mean score of 6.73. The Grade 12 STEM students are described to have a "Satisfactory" level of performance in Inductive Reasoning.

Level of Problem Solving Skills per Section of the Grade 12 STEM Students of University of Northern Philippines

Table 4

Shows the level of problem solving skills per section of the Grade 12 STEM students.

Grade 12 STEM	Problem Solving Skills Mean Score	Descriptive Rating	SD	SK
A	16.8	S	4.5	-0.10
B	16	P	9.51	1.01
C	17.14	S	5.55	1.03
Overall	16.65 (41.63)	S	6.79	0.90

Norm:
32.01 – 40.00 Excellent (E)
24.01 – 32.00 Very Satisfactory (VS)
16.01 – 24.00 Satisfactory (S)
8.01 – 16.00 Poor (P)
8 and below Needs Improvement (NI)

In Table 4, the overall performance of the students in problem solving is Satisfactory with a mean score of 16.65. The scores of the students got a standard deviation of 6.79. The distribution of their scores is positively skewed (SK=0.90) which means that there are more students who got scores below the mean. Moreover, students from STEM A and STEM C have satisfactory level of performance in problem solving with mean scores of 16.8 and 17.14, respectively. However, the level of performance in problem solving of students in STEM B is Poor ($\bar{x}$=16.00). Based on standard deviations, STEM B students have more dispersed scores. It also revealed that the scores of the students from STEM A is negatively skewed (SK=- 0.10) which means there are more students who got scores above their mean score. On the other hand, the scores of the students from the other two sections are positively skewed. Comparison of the Level of Performance in Problem Solving Between and Among the Three Sections of Grade 12-STEM students the summary of One-Way Analysis of Variance (ANOVA) which tests the significant difference between and among the three sections of Grade 12 STEM students of University of Northern Philippines is presented in Table 5.

Table 5

Difference in the Level of Performance of the Grade 12 STEM students of UNP in Problem Solving by Section

Source of Variation	Sum of Squares	df	Mean Squares	F	Sig.	Interpretation
Between Groups	23.65	2	11.83			
Within groups	4719.89	101	46.73	0.25	3.09	Not Significant
Total	4743.54	103				

Significant at 0.05 probability level

At 0.05 probability level, the computed F-computed of 0.25 is less than the F- critical of 3.09, this leads to not reject the null hypothesis. This means that there is no significant difference between and among the three sections of Grade 12 STEM students of University of Northern Philippines in the level of performance in problem solving. The three sections of Grade 12 STEM students have more or less the same level of performance in problem solving. Multiple Regression of the Profile of the Students and their Logical Thinking Skills on their Level of Problem Solving Skills.

Table 6 shows the summary of the regression of problem solving skills on profile of the students and their level of logical thinking skills.

Multiple Regression of Problem Solving Skills on Profile and Logical Thinking Skills

	Beta Coefficients	t Stat	P-value
Intercept	55.98	2.22	0.03
Age	-2.05	-1.54	0.13
Sex	0.64	0.45	0.66
Type of Junior High School Completed From			
	1.14	0.67	0.50
Mothers' Educational Attainment	-1.25	-1.57	0.12
Fathers' Educational Attainment	0.10	0.12	0.91
Mothers' Occupation	1.22	1.35	0.18
Fathers' Occupation	-0.29	-0.28	0.78
Daily Allowance	-0.50	-0.43	0.67
Abstract Reasoning	-0.03	-0.13	0.90
Inductive Reasoning	0.51	2.07	0.04*
Logical Thinking Skills	0.13	0.89	0.38

*Significant at 0.05 probability level Multiple R = 0.362; R2 = 0.131
F-value = 1.402 p < 0.05

The result of the regression showed a statistically significant regression (H0 : βi = 0) as supported by an F-value = 1.402 with a probability level of 0.05, which meant that at least one of the beta values is significant. Furthermore, the multiple correlation coefficient obtained was 0.362 which indicated a low positive relationship between the combined effects of the independent variables and the dependent variable. Also, the coefficient of determination (R2) of 0.131 showed that 13.10% was accounted for the variation of the independent variables (profile and the level of logical thinking skills) on the dependent variable (level of problem solving skills). Obviously, 86.90% can be explained by other variables not considered in the regression. The results show that among all the eleven predictors that may influence their skills in problem solving, only inductive reasoning has a significant influence on their skills in problem solving as supported by a t-value of 2.07 with p- value of 0.04 which is less than 0.05.

Extension Plan to be proposed to improve Problem Solving Skills of the Students

The extension plan to be proposed is a Mathematics Team-Building Activity focused on worded problems. It aims to improve the problem solving skills of the students. Team-building activities strengthen groups of people while working to accomplish a collective goal. Incorporating mathematical skills into team-building activity will allow students to solve subject specific problems within a group setting and strengthen analytical abilities as well as cooperative characteristics.

5. Summary, findings, conclusions and recommendations

This study aimed to determine the problem solving skills of the Grade 12 STEM students of University of Northern Philippines during the S. Y. 2018-2019. The respondents were composed of 104 students from the three sections. Furthermore, it aimed to determine the profile of the students; their logical thinking skills in terms of abstract reasoning and inductive reasoning; the differences in their problem solving skills; and the factors that influence their problem solving skills. The descriptive research design was utilized in this study. Comparative and correlational methods were employed. The data gathered using the questionnaires for the profile of the students, logical thinking skills test and problem solving skills test were analyzed using the following statistical tools:

frequency and percentage, mean, One-way Analysis of Variance (ANOVA) and multiple linear regression.

5.1 Findings

Profile of the Students in Terms of Socio-Demographic Factors; Majority of the respondents are female (63.46%) and 18 years old (70.19%). Majority of the respondents have Php101.00 - Php200.00 daily allowance (67.31%). Majority of the respondents' fathers are non-professional workers (52.88%). A great percentage of the respondents' mothers are unemployed (36.54%). A great percentage of the respondents' fathers are college graduate (47.12%). In addition, most of all the three sections' fathers are college graduates. Majority of the respondents' mothers are college graduates (59.62%). Great majority of the respondents are from public schools (80.77%).

5.2 Logical Thinking Skills

The performance of the Grade 12 STEM students in Abstract Reasoning got a mean score of 10.54. The Grade 12 STEM students are described to have a "Satisfactory" level of performance in Abstract Reasoning. The performance of the Grade 12 STEM students in Inductive Reasoning got a mean score of 6.73. The Grade 12 STEM students are described to have a "Satisfactory" level of performance in Inductive Reasoning. The overall performance of the Grade 12 STEM students in Logical Thinking Skills got a mean score of 17.27. The Grade 12 STEM students are described to have a "Satisfactory" level of performance in Logical Thinking Skills.

5.3 Problem Solving Skills

The students are described to have a "Satisfactory" level of performance in Problem Solving with a mean score of 16.8 in STEM A. In STEM B, the students got a mean score of 16 and described to have a "Poor" level of performance in Problem Solving. It shows in the Table 3 that the students are described to have a "Satisfactory" level of performance in Problem Solving with a mean score of 17.14 in STEM C. The overall performance of the Grade 12 STEM students in Problem Solving got a mean score of 16.65. The Grade 12 STEM students are described to have a "Satisfactory" level of performance in Problem Solving.

5.4 Significant Difference in the Level of Performance in Problem Solving by Section

There is no significant difference in the level of problem solving skills between and among the three sections of Grade 12 STEM students of University of Northern Philippines. Influence of the Socio-Demographic Profile of the Students and their Logical Thinking Skills on their Level of Performance in Problem Solving. On overall, there is a significant influence exist on the skills in problem solving with their profile and logical thinking skills. Only inductive reasoning has a significant influence on their skills in problem solving.

5.5 Extension Plan proposed to improve the Problem Solving Skills of the Students

The extension plan proposed is a Mathematics Team-Building Activity focused on worded problems. It aimed to improve the problem solving skills of the students. Team- building activities strengthen groups of people while working to accomplish a collective goal. Incorporating mathematical skills into team-building activity will allow students to solve subject specific problems within a group setting and strengthen analytical abilities as well as cooperative characteristics.

5.6 Conclusions

The respondents of the study composed of more female students, majority are 18 years old, have Php101.00 - Php200.00 daily allowance, whose fathers are mostly non-professional workers, both parents are college graduates and great majority came from public schools. The students have a satisfactory level of logical thinking skills. They are better with abstract reasoning than inductive reasoning. The students have satisfactory level of problem solving

skills. The three sections possessed more or less the same level of problem solving skills. The inductive reasoning skills of the students is a predictor of problem solving skills. The problem solving skills could be improved by mathematics team-building activity focused on solving worded problems.

5.7 Implications for Students, Teachers, and School Administrators

It is crucial that students practice inductive thinking by engaging in activities that strengthen their ability to see patterns and generalize. Engaging in team-based learning exercises can improve one's capacity for problem-solving and teamwork. It's also essential to regularly exercise abstract and inductive reasoning through games, seminars, and puzzles. In order to accommodate students with diverse ability levels, teachers should differentiate their training, include more inductive reasoning exercises and real-world issue situations in the curriculum, and encourage collaborative learning through team-building exercises and group projects. It's critical to pursue professional development to stay current with instructional practices in order to teach these abilities in an effective manner. The community and parents should be involved in supporting students' learning by highlighting the value of problem-solving abilities. School administrators should also regularly evaluate and modify the curriculum based on student performance and invest in ongoing teacher training. Finally, resources should be made available to support programs and activities that foster logical thinking and problem-solving.

5.8 Recommendations

The students are encouraged to solve and enjoy solving puzzles that will enhance their logical thinking skills. The students are advised to practice solving math problems to further improve their skills in problem solving. They are encouraged to master the basic rules of arithmetic and properties of Algebra by reading mathematics books since these are essential elements to succeed in problem solving. Since inductive reasoning skill greatly affects problem solving skills of the students, they may work on solving sequences that will enhance their inductive reasoning skills. The proposed mathematics team-building activity may be adopted for the teaching and learning process. Another study could be undertaken considering other variables that will have a contribution to the performance of the students in problem solving.

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