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EXCEEDING MATHEMATICS: AWARENESS IN MATHEMATICAL SYMBOLS AND ALGEBRAIC EXPRESSIONS OF FRESHMEN STUDENTS IN NAVAL STATE UNIVERSITY

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ABSTRACT

This study assessed the awareness in mathematical symbols and algebraic expressions of freshmen students in Naval State University. Employing the descriptive-survey design, there were 150 respondents who answered the questionnaires and also evaluated through a test of their mathematical symbols comprehension skill and ability on assessing algebraic expression.The respondents' profile revealed that most of them are female with an average age of 17 years old in which they are expected to think abstractly, ideally, logically and presumed to possess skills on recognition symbols according to Piaget, but showed a weak symbolic thinking greatly influenced by their biological build up. Although they did not exhibit a very good level of understanding of algebraic expression, they were still successful in manipulating this competency, because knowing algebraic expression does not require deeper recognition of the symbol itself. It was found that a significant relationship existed between the respondents' profile and their comprehension skill of mathematical symbols. It was recommended that curriculum, instructional materials and teaching strategies should be designed in accordance to gender equality since Mathematics was found to be one of the male-dominated subjects and those factors contributory to the weakness of the female group in this area could be addressed.

KEYWORDS: mathematical symbols; algebraic expressions; gender equality; teaching strategies; naval state university

INTRODUCTION

Mathematics is acknowledge as one of the ingredients for success in all fields of life. Commonly referred to as the mother of all subjects because it prepares students for practical life. Students can develop their knowledge, skills; logical and analytical thinking while learning Mathematics and all these can lead them for enhancing their curiosity and to develop their ability to solve problems in almost all fields of life. This problem solving nature of Mathematics can be found in sub-disciplines of Mathematics such as in geometry, calculus, arithmetic and Algebra. Algebra is an important area of Mathematics. Algebra is a generalized form of arithmetic and for the purpose of generalization of arithmetic; the letters and signs are used. No doubt, the use of letters and signs make it an abstract subject. Because of nature of generalization and abstraction, Algebra is considered to be a difficult area of Mathematics.

According to Booth (2006), the main purpose of algebra is to learn how to represent general relationships and procedures; for through these representations, a wide range of problems can be solved and new relationships can be developed from those known. However, students tend to view algebra as little more than a set of arbitrary manipulative techniques that seem to have little, if any, purpose to them (Booth, 2006). Perhaps the typical algebra curriculum focuses too heavily on simplification and manipulation, rather than the generalized ideas that create the basis of algebra.

To some people algebra is a collection of symbols, rules and procedures, while to Mathematicians; it is much more than that. From the perspectives of Kieren (2002), algebra is conceived as a branch of Mathematics that deals with symbolizing and generalizing numerical relationships and mathematical structures, and with operation within those

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structures. From other perspectives, algebra is about identifying patterns and generalizing those patterns. Generalization involves seeing a pattern, expressing it clearly in verbal terms, and then using the symbols to express the pattern in general terms.

Many of the difficulties that school students face in learning algebra may have their source in the poor understanding of two important concepts – the variable and the algebraic expression. Sfard (2001) and Tall (2009) have pointed to the difficulty in understanding the process-product duality of algebraic expressions, which encode both operational instructions as well as denote a number that is the product of these operations. The difficulty in understanding the multiple meanings encoded by expressions may underlie the inability of many students to operate with unclosed expressions (Booth 2004).

It has been recognized that students' understanding of arithmetic and algebraic expressions are interconnected. For example, students who make errors in manipulating algebraic expressions repeat some of these errors when dealing with arithmetic expressions (Linchevski and Livneh, 2009). Many students have a poor sense of the structure of arithmetic expressions and are unable to judge the equivalence of expressions like 685–492+947 and 947–492+685 without recourse to computation (Chaiklin and Lesgold, 2004). Algebra, as generalized arithmetic, symbolizes and exploits the structural aspects of arithmetic. However, it is not clear whether instruction oriented to developing the structure sense of arithmetic expressions transfers to algebra. It might well be the case that learning algebra paves the way for a better understanding of arithmetic expressions since the algebraic symbolism enhances the structure of the expression. Linchevski and Livneh (2009) have recently raised doubts about whether focusing on teaching structured arithmetic as a preparation for algebra is a good pedagogic strategy.

More analysis is necessary in order to develop a clear understanding of what factors help students to be successful in algebra and how schools and other systems can assist in achieving this goal. We already know that even very basic mathematical concepts such as addition of whole numbers involve complicated cognitive processes. Since teachers are already very familiar with those basic concepts, this leads them to ignore or underestimate the complexity by taking a naïve approach to teaching those concepts (Schoenfeld, 1985). Without adequate knowledge about students' learning of basic mathematics concepts or operations, teachers could underestimate the complexity of the individual learning process of mathematics.

Teachers or experts in the field often have differences of opinions about students' conceptions and misconceptions. This is not only because the amount of quantitative reasoning that experts use is greater than what novices use in a problem solving situation. It is also because of the qualitative nature of the reasoning that experts use in a situation. Frequently, experts do not realize that this quality is important to disseminate to their students. Students should be allowed to use this information that is sometimes not in the textbooks. For experts, this knowledge is structured in their heads as informal, imagistic, metaphoric, and heuristic forms (Kaput, 2005).

It has been observed that such is the case of freshmen students in Naval State University. They have difficulty in answering algebraic concepts and consume more time in comprehending what the problem is all about. The reason for this struggle could be that the symbols which they encountered were unfamiliar, confusing, and sometimes contradictory.
The researcher intends to find out if the analysis on algebraic will become easier if the students are well versed in reading and comprehending the notations, symbols and signs on mathematical formulas used in algebraic problems. The main objective of the study was to assess the awareness in mathematical symbols and algebraic expressions of freshmen students in Naval State University.

METHODS

The descriptive survey methodology was used to find out the awareness in mathematical symbols and algebraic expressions of freshmen students in Naval State University. The survey questionnaire was design to get the profile of the respondents and an evaluation were given to them to test their mathematical symbols comprehension skill and ability on assessing algebraic expression.

The study was conducted at the College of Arts and Sciences, Naval State University, Naval, Biliran, where the respondents are enrolled.

The study involved one hundred fifty (150) freshmen students of the College of Art and Sciences in Naval State University.

The main instrument to be used in this study was a researcher-made questioner comprised of two (2) parts: Part I will gather the students' profile; Part II made up of ten (10) questions to determine the mathematics symbols comprehension skills; and ten (10) questions to find out the level of understanding of algebraic expression.

Frequency distribution with underlying percentage was determined from the respondents' profile, math symbols comprehension skills, and level of understanding of algebraic expressions. The frequency distribution with underlying percentage were applied.

To determine the relationship between respondents' profile and math symbols comprehension, respondents' profile and level of understanding of algebraic expression, and math symbols comprehension and level of understanding of algebraic expression, Chi – Square and Pearson Product-Moment Coefficient of Correlation were employed.

To test the significance of r value and if there had been a significant relationship between the two variables, T-test was used. It was the basis for the rejection or acceptance of the null hypothesis at 0.05 level of significance.

RESULTS AND DISCUSSION

Profile of the Respondents

The profile of the respondents is presented in Table 1. The table shows the profile of the respondents who are the selected freshmen students of Naval State University. This includes their age and sex.

Table 1. Profile of the Respondents

Variables	f	%
Age		
16 - 18	112	75
19 - 21	29	19
22 - 28	9	6
Total	**150**	**100**
Sex		
Male	51	34
Female	99	66
Total	**150**	**100**

Age. The respondent's age ranges from 16 years old – 28 years old. 37 percent of them belongs to 17 years old, while .67 percent or 1 of the respondents is 28 years of age. This implies that most of the respondents are now on the Formal Operational Stage according to Jean Piaget's Cognitive Theory in which individuals think abstractly, ideally and logically. Furthermore, Piaget also stressed out that mastery on the recognition of symbols should occur during the Pre-Operational stage or during 2-7 years of age. Thus most of the respondents is presumed to possess skills on recognition of symbols.

Sex. As to the sex of the respondents, result showed that 66 percent were female while the remaining 34 percent were male. These findings coincide with the program's characteristics of the locale of the study which is the College of Arts and Sciences. CAS has five programs namely; Bachelor of Science in Criminology, Bachelor of Science in Business Administration, Bachelor of Arts in Communication, Bachelor of Arts in Economics, and Bachelor of Science in Nursing. Apart from BS in Criminology, the mentioned programs are female dominated.

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Mathematical Symbol Comprehension skill of the respondents

Table 2 presents the mathematical symbol comprehension skill of the respondents. As revealed in Table 2, a total of 150 freshmen students were given
survey questionnaire to determine their comprehension skills in math symbols. 31 percent or 46 of the respondents have fair comprehension skill of mathematical symbols, while 69 percent or 104 of them have poor mathematical symbol comprehension skills.

Table 2. Mathematical Symbols Comprehension skills of the respondents

Math Symbol Score	f	Adjectival Description
0	1	Poor
1	3	Poor
2	16	Poor
3	48	Poor
4	36	Poor
5	28	Fair
6	12	Fair
7	6	Fair
TOTAL	**150**	

Mean	**3.85**	Poor
SD	**1.37**	

The implication of this is that the respondents have weak ability on recognition of symbols and decoding their meaning in contrary to Jean Piaget's
Cognitive development theory wherein adults are expected to manifest symbolic thinking.

Item Analysis on the level of difficulties of the Mathematical Symbols Comprehension skill of the respondents

As seen on Table 3, mostly of the respondents does not have any difficulties when it comes to identification of simple symbols such as the symbol for universal set, null set, greater than, lesser than or equal to. 50% or more of them were seen to have no problem remembering basic signs since these are commonly use on all concepts of mathematics especially during the introduction of Algebra. One reason for this is that, symbols to be identified on these items were presented individually. However, when it calls for analytical thinking that allows the respondents to test their awareness on various symbols at the same time, they showed weak discrimination skill. 97% of the respondents cannot distinguish one symbol from another if they are presented together with similarity. Item No. 3 shows four different symbols ($\supset, \cup, \subset, \cap$) but have been defined by the respondents as one symbol only rotated four times. This attest the study of Calles (2010) citing Luna and Fuscablo (2002) that mathematical symbolism should be integrated at the beginning of every course and sustained through any mathematics course at all levels to improve the problem solving skills of Filipino students to become critical and analytical thinker which is the ultimate goal of mathematics education.

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Table 3. Item Analysis on the level of difficulties of the Mathematical Symbols Comprehension skill of the respondents

Topic	No. of respondents who got Correct Answers	Percentage	No. of respondents who got Wrong Answers	Percentage
Identification of symbol that represents Universal Set	146	97%	4	3%
Identification of symbol that represents an Empty Set	119	79%	31	21%
Expressing the concept of greater than and lesser than from words to symbol	81	54%	69	46%
Interpretation of the symbols for proper subset (⊂) and superset (⊃)	25	17%	125	83%
Discrimination of the symbols for subset (⊆), lesser than or equal to (≤), element of (∈), and universal set (ε)	7	5%	143	95%
Comparison of the symbols for superset (⊃), union of sets (∪), proper subsets (⊂), and intersection of sets (∩)	4	3%	146	97%

Level of understanding of Algebraic Expression of the respondents

This table presents the level of understanding of algebraic expression and the results indicate a varied level among the respondents. Two percent or 3 respondents have a very good level of understanding when it comes to algebraic expression, while 8 percent or 12 of them are at the poor level and the rest of them have fair and good grasp on algebraic expression. The mean value of 4.98 means that most of the respondents have no difficulties in terms of understanding algebraic expressions though they did not show any excellent understanding as
well. It is because algebraic expression is mostly composed of letters called as the variables and numbers as the constant brought together using the basic mathematical operations.

Table 4. Level of understanding of Algebraic Expression of the respondents

Algebraic Score	f	Adjectival Description
1	5	Poor
2	7	Poor
3	13	Fair
4	29	Fair
5	31	Fair
6	40	Good
7	22	Good
8	3	Very Good
TOTAL	**150**	

Mean	**4.98**	Fair
SD	**1.59**	

The presentation of this expression mainly calls for plain substation of letters and numbers only and does not requires advance decoding of symbols. Thus, respondents are expected to have a mastery level of understanding of the said expression.

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Item Analysis on the level of difficulties of the Respondents' understanding of algebraic expressions

Table 5 presents the item analysis on the determination of the level of difficulties of the respondents on their algebraic expression is presented on table 5. The data shows the topics covered on the measurement of the level of understanding of algebraic expression of the respondents which includes Introduction to Algebra and operations on algebraic expressions. After a thorough analysis on the survey results, it appeared that the respondents have no problem on identifying how many terms are there in an algebraic expressions as well as with its evaluation using the four basic operations of mathematics which are multiplication, division, addition and subtraction. More than 70% of them are table to perform these with less hesitations since it does not require critical thinking skill yet. They just have to identify the variables needed in the operation without a deeper understanding on what these variables stands for. However, same findings from table 3 has been observed in here. When it comes to operations and assessment of algebraic expression that calls for higher thinking, respondents displayed a weak ability on this competency.

Table 5. Item Analysis on the level of difficulties of the Respondents' understanding of algebraic expressions

Topic	No. of respondents who got Correct Answers	Percentage	No. of respondents who got Wrong Answers	Percentage
Identification of the an algebraic term	117	78%	33	22%
Operations on Algebraic Expression	114	76%	36	24%
Simplification of Algebraic Expression	111	74%	39	26%
Factoring	39	26%	111	74%
Differentiation of algebraic terms	37	25%	113	75%
Degree of polynomials	25	17%	125	83%

Relationship of Variables

This section presents the results and discussion on the relationship of variables involved in this study which are respondents' profile, respondents' mathematical symbol comprehension skill and level of understanding of algebraic expression. In this study, relationship sought are as follows: The significant relationship between the profile and mathematical symbols comprehension skills, the profile of respondents and level of understanding of algebraic expression, and the respondents' mathematical symbols comprehension skills and level of understanding of algebraic expressions.

Table 6. Relationship of respondent's profile and mathematical symbol comprehension skills

Variable	r-value	X^2	Df	p-value	Decision
Age	0.003	---	---	0.973	Accepted
Sex	---	15.015	7	0.036	Rejected

As reflected in table 6, the result shows that the strength of the profile age reached to r - value 0.003 it means that the null , is accepted and that the p-value of 0.973 (almost negligible relationship) conclude that there is no sufficient evidence of a relationship between the respondents' age and their mathematical symbol comprehension skill. On the other hand, a computed chi-square of 15.015 with a degree of freedom of 7 and a p – value of 0.036 revealed a positive relationship between the sex of the respondents with their mathematical symbol comprehension skill. This means that comprehension skill on mathematical symbol is affected by the biological build-up of the person relative to their gender.

This is further explained by MohebCostandi in his book "*50 Human Brain Ideas You Really Need to Know"*, that men tend to be more aggressive and outperform women on mental tasks involving spatial skills such as mental rotation, whereas women tend to be more empathetic and perform better on verbal memory and language tasks. This also accord

to the study of American Association of University Women, 1992 that learning experiences among females in science, technology, engineering, and mathematics (STEM) disciplines are impacted by a pattern of socialization that often differs from males despite comparable ability. In addition Kimbal (1989) states that girls do better when dealing with situations such as classroom exams, whereas boys do better when dealing with novel situations such as standardized tests. According to Gallagher & Kaufman (2006) as cited by Asante (2010) said that changes in mathematic-related attitudes are associated with developmental change in gender identity. During this stage, girls begin to firmly establish their feminine identity and thus become susceptible to social and environmental pressures that undermine their self-confidence and performance in male dominated subject like mathematics.

Table 7. Relationship of respondent's profile and level of understanding of algebraic expression

Variable	r-value	X^2	df	p-value	Decision
Age	0.019	---	---	0.817	Accepted
Sex	---	19.809	7	0.006	Rejected

On the relationship of the respondents' profile and level of understanding of algebraic expression, the table above showed that the r-value of profile age is 0.019, and p-value of .0817 which means that insignificant relationship exist between the age and their algebraic expression. Opposite findings can be observed in the relationship between the profile sex of the respondents and their level of understanding of algebraic expression. This is supported in the computation of the chi square of the profile sex that is 19.809 with a degree of freedom of 7 and a p-value of .006. These outcomes coincide with the results discussed in the table 4: Respondents' Level of Understanding of Algebraic Expression.

Table 8. Relationship between Mathematical Symbol Comprehension skills and level of understanding of Algebraic Expression

Variable	N	Mean	SD	r-value	p-value	Decision
Math Symbol	150	3.85	1.37	0.032	0.697	Accepted
Algebraic expression		4.98	1.59			

There is no significant relationship between the respondents' mathematical symbol comprehension skill and their level of understanding of algebraic expression as revealed in table 6. It only shows that regardless of the ability of the respondents to comprehend on the mathematical symbol, their level of understanding of algebraic expression is not affected. Mathematical symbols comprehension skill requires advanced level of understanding since this covers the whole branch of mathematics which involves not only algebra but also other branch in mathematics. Whereas understanding algebraic expression only requires a familiarization on the operations of symbols which involves the basic operation of mathematics such as addition, subtraction, multiplication and division. Identification of mathematical is not a perquisite in performing the operation in algebraic expression. This explains why there is no relationship has been established between the mathematical symbols and algebraic expression.

CONCLUSION

The freshmen students of Naval State University have found to have awareness on algebraic expression regardless of their profile and regardless of their mathematical symbol comprehension skill. However, when it comes to their comprehension skill on mathematical symbol, it was found out that freshmen students of the said university exhibited weak awareness as it was influenced by their sex profile.

RECOMMENDATIONS

Based on the findings of the study, in order to enhance the respondents' mathematical symbol comprehension skill, teachers handling mathematics subjects should consider classroom activities that involves mostly of the female respondents since this subjects is known to be male dominated.

Furthermore, curriculums, instructional materials and teaching strategies should be designed in accordance to gender equality. In this way, sex related issues will be addressed on the academe level. Teachers then should analyze the

achievement data of the students by gender in order to examine strength and weaknesses. Benefit of an awareness and implementation of gender-specific strategies is seen by the researcher.

Although the respondents exhibited awareness in algebraic expression, it is strongly suggested that respondents' exposure in this competency should be longer through the use of classroom activities involving application of theories often.

Future research can be done to address on what are the factors contributory to the weakness of female in male dominated subjects. Since the locale of the study is on gender mainstreaming, another study can also be done to find out if the assessments that measure the achievement of the respondents in male dominated subjects could have gender-bias.

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