Comparison of At-risk Students' Mathematical Commognition in Geometry based on their Personal Attributes

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Abstract

Students' academic performance in Mathematics has a significant impact on their success on large scale standardized assessments as well as their eventual job choices. This study determined the level of at-risk students' mathematical commognition in high school geometry and makes comparisons when grouped according to their family environment, language proficiency, learning style, and attitude towards learning mathematics. This study employed a mixed method research design and was conducted for select Grade 10 at-risk students of Cagayan de Oro City National Junior High School. The data gathered on students' level of commognition was analyzed using frequency, percentage, mean and standard deviation. Correlation analysis was used to establish the association between students' mathematical commognition and the perceived variables. The comparison of students' level of mathematical commognition was analyzed using non-parametric tests such as Kruskall-Wallis and Mann Whitney U tests. Results reveal no significant difference of at-risk students' level of mathematical commognition based on their personal attributes. Hence, it is recommended that further explorations of other factors that might affect students' level of mathematical commognition. Students only have a basic level of mathematical commognition and therefore another study can be pursued on employing effective teaching methods on improving students' mathematical commognition not only in Geometry but also in other mathematics courses across all levels.

Key Words: mathematical commognition, at-risk students, family environment, language proficiency, learning style, attitude towards learning mathematics

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Introduction

Education is the ticket for success. Globally, the major concern in basic education is ensuring that students stay in school until they complete their education. Dropping out is a severe issue because it prevents students from asserting education as a basic human right. Many treaties and conventions, such as the 1948 Convention on the Rights of the Child and the 1990 World Conference on Education for All, purport to affirm the individual right to education (UNESCO, 2008).

However, it is a common scenario in developing countries like the Philippines that children have denied their right to education through dropping out for various reasons. Student-At-Risk of Dropping Out commonly known as SARDO is a term coined by the Philippines' Department of Education, defined as, a student who is likely to become a candidate to drop out. The National Center for Education Statistics defined dropping out as discontinuing the program and leaving school before graduation without achieving a diploma. Dropping out from school is not just a teacher adviser's issue because it will reflect his or her performance of how many students were promoted to the next grade level, nor is it just an issue of a dropout student, but it also affects the entirety of the nation (Timbal, 2019). Hence, teachers in the public school system are challenged to create interventions on how to save these at-risk students from dropping out from school.

Filipino students always lag behind in international large scale assessments comparison such as the international achievement results of Trends in International Mathematics and Science Study (TIMMS) and Programme for International Student Assessment (PISA) scores in recent years. It is evident in the current results of the 2018 PISA where the Philippines scored 353 in Mathematics below the average of the Organization for Economic Cooperation and Development countries (OECD, 2019). The National Achievement Test (NAT) results of the Grade 10 students from the school year 2015 to 2018 were all below the 75% standard criterion set by the Department of Education (DepEd) in terms of achievement level, which is the national target (Casing & Roble, 2021).

Communication is a process in which the speaker/sender constructs messages to be transmitted to the receiver to bring about a desired response. The message should be clearly delivered to elicit positive feedback. Communication is necessary in the inquiry process to verbalize the students' thoughts and is an avenue for the teachers to evaluate which of the students' needs should be reinforced. Students who are challenged to reason about their mathematical solutions are required to communicate their thinking to others either orally or in writing, and to express their thoughts with clarity (Cobb, Wood & Yackel, 1994). Thinking (Cognition) is an essential component of the learning process especially in mathematics. How students communicate their thinking in mathematics is really a challenge to mathematics teachers. A number of students suffer from mathematics anxiety; thus, just the thought of expressing how they think scares them the most. While some students can easily tackle mathematical tasks like Geometry effortlessly, others are terrified even at the thought of geometric figures (Sfard, 2008). Communication and cognition are two inseparable parts of a whole. One cannot function well without the other. Both are very important to understand and to be understood. According to Sfard (2008), thinking can be viewed as an individualized version of interpersonal communication, thereby, communication does not need to be oral, but it can take place inside the mind of an individual. However, this study

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is not limited to communication with oneself only but also communication with others using mathematical discourse. The engagement of such process requires a lot of relevant factors in order to send the message clearly; hence, good communication is an important component of the process. The impetus of this study is based on the underlying premise that if students can fully communicate the way they think, the teachers can do an excellent job in intervening at the level of their understanding and can then provide better opportunities for them to succeed. Thinking is a very private and personal act that it can only be understood if conceived as a part of wider collective activities, that is, by written and oral communication (Sfard, 2008). Hence, this present study was conducted to compare the level of mathematical commognition of at-risk students when grouped according to their personal attributes.

Students' Personal Attributes

There are numerous factors to consider why certain behaviors come into play, but in this study, the researcher limits the factors as follows:

Family Environment

The family is the basic unit of society. Children are born and nurtured in the family until such time as they grow into adults and found their own families (Ebrahim, 1982). Home is a child's first institution, and it has a tremendous impact on the student's overall life. in the study conducted by Khan, Begum and Imad (2019), they posited that home environment is the most significant factor affecting student's academic achievement. They argued that students should be provided a serene home environment for studies which could help to promote student's overall development. The most suitable mean is to give proper time to children, and an educative environment at home. Hence, it can a good point of consideration the family environment was considered in this present study.

Language Proficiency

Most of the time, teachers assume that non-native speakers who have attained a high degree of fluency and accuracy in everyday spoken English have the corresponding academic language proficiency (Cummins, 1991). As Cummins (2000) states: "Conceptual knowledge developed in one language helps to make input in the other language comprehensible." Mainstream teachers should be aware of the students' language profile so that they can help them effectively develop and learn the new language. According to the study conducted by Sinclair and Moss (2012) with 4-5 year–old children working with sketchpads, it was found out that the process of discourse change does not consist in smooth linear transition from one level to another; rather, it involves oscillating between the old and new forms of discourses, resulting in intermediary hybrid forms of geometric communications. The development of geometric thinking does not happen as a wholesale transformation of geometric discourse; rather, it occurs in "patches", that is, the levels of the discourse may vary across geometries, depending on what the discourse is all about.

Learning Style

The way a person processes and retains new information and skills is referred to as their learning style. It is believed that the way students learn impact his or her academic achievement. This was confirmed by the study conducted by İlçin, Tomruk, Yeşilyaprak, Karadibak and Savcı (2018) that learning style was associated with significantly higher academic performance. They suggested that teaching strategies that encourage more participant-style learning may be effective in increasing academic performance among students. Also, in a local study conducted by Magulod (2019) affirmed significant relationships between learning styles and academic performance of students in applied science courses. Hence, the present study includes learning style as a variable to be considered for determining the level of students' mathematical commognition based on their learning styles.

Attitude towards Learning Mathematics

Students' effective learning in mathematics can also be affected by how they perceived mathematics. The attitude of students towards learning mathematics can be a factor on how students perform in the classroom. As opined by Mensah, Okyere and Kuranchie (2013), the cognitive component of attitude is what the individual thinks or believes about mathematics. The study conducted by Sanchal and Sharma (2017) supports and found out that with an increased number of students feeling comfortable and enjoying mathematics lessons while studying mathematics, their engagement level also increased. Thus, with an increase in confidence, seeing the importance of mathematics and engagement in mathematics lessons, it can be stated that students' attitudes towards learning mathematics also improved. Furthermore, a local study conducted by Peteros, Columna, Etcuban, Almerino and Almerino (2019) also confirmed students' attitudes towards mathematics have a more significant impact on affecting their academic achievement. They recommend that teachers should be developed and enhanced the self-confidence of students in mathematics by involving them in class discussions and interactions through facilitating in any means. Hence, it is worthwhile to include students' attitude towards learning mathematics when investigating the level of mathematical commognition of students in geometry.

Materials and Methods

This study employed a Mixed Model Research Design specifically, the Concurrent Triangulation Design. In this design, quantitative and qualitative approaches are used to confirm, cross-validate, or corroborate findings within a single study. The participants were all Grade 10 at-risk of dropping out students of Cagayan de Oro City National High School, DepEd Division of Cagayan de Oro City. Majority of the students are from families of low socio-economic class. There are five research instruments used in this study namely: a) Family Environment Scale; Family Environment; b) Learning Style Inventory: Learning Style; c) Scholastic Reading Inventory: Language Proficiency; d) Mathematics Attitude Scale: Attitude towards Learning

Mathematics; and e) the Commognition Test. All of these survey questionnaires underwent validation processes for ensuring the internal consistency of the items included in these questionnaires. The data gathered on students' level of commognition was analyzed using frequency, percentage, mean and standard deviation. Correlation analysis was used to establish the association between students' mathematical commognition and the perceived variables. The comparison of students' level of mathematical commognition was analyzed using non-parametric tests such as Kruskall-Wallis and Mann Whitney U tests.

Results and Discussions

A 12- item test was administered to the students and shown in Table 1. The average performance of students was 5.38 which indicates that they are still in the basic level of mathematical commognition.

Table 1

Frequency and Percentage Distribution of the Commognition Test Results

Levels (Raw Score)	Frequency	Percentage
Advanced (11-12)	0	0
Proficient (9-10)	1	5
Nearing Proficiency (6-8)	12	57
Basic (0-5)	8	38

Mean = 5.38 (Basic)
Standard Deviation=2.36

The Table shows that 38% and 57% of the students are in the basic and nearing proficiency level, respectively. This only means that students do not have a clear mastery of geometric concepts. In the Table of Specifications, 75% of the questions are just on the comprehension level only since the study is mainly focused on how the students communicate their thinking on how they comprehend the given questions. This goes to say that the test was not mind–boggling and brain-breaking but still the students had a difficult time answering the questions. But, the study of Ombay and Roble (2021) argued that students exposed to repetition with complex variations approach had significantly higher performance scores in terms of mathematical commognition as compared to its counterpart.

Table 2

Relationship Students' Mathematical Commognition and Some Factors

Variables	Commognition r-value	p-value
Language Proficiency	0.220	0.339
Attitudes towards Learning Mathematics	0.028	0.905

Table 2 revealed no significant relationship between commognition and SRI. This is the same with the students' attitude towards learning mathematics. However, the results showed the existence of positive relationship. The associated probabilities are greater than 0.05 which led to the non–rejection of the null hypothesis. This implies that the students' mathematical commognition was independent from their level of language proficiency and attitudes towards learning mathematics.

Table 3

Comparison of Students' Mathematical Commognition based on their Learning Styles

Learning Styles	Kruska-Wallis	df	Probability
Active and Reflective	4.339	2	0.114
Sensual and Intuitive	0.064	1	0.800
Visual and Verbal	1.513	1	0.219
Sequential and Global	0.052	1	0.820

*significant at p< 0.05

Results from the Kruskall-Wallis test showed no significant differences existed on the commognition scores when grouped by learning styles. This means that the performance of the students in the commognition test is the same regardless of the type of learning styles they possess. The probabilities associated with the test are greater than 0.05 which led to the non–rejection of the null hypothesis. This implies that students' mathematical commognition was independent from their learning styles.

Table 4

Comparison of Students' Mathematical Commognition based on Family Environment

Family Environment	Mann – Whitney U	p-value
Cohesion	51.00	0.941
Expressiveness	49.50	0.693
Conflict	42.00	0.385

*significant at p< 0.05

Results from the Mann-Whitney test showed no significant differences existed on the commognition scores regardless of how cohesive or expressive their family members are and even with the presence of conflicts in their family. This means that the performance of the students in the commognition test does not change regardless of the situation in the family. The probabilities associated with the test are greater than 0.05 which led to the non–rejection of the null hypothesis. This implies that the family environment had no bearing on at-risk students' level of mathematical commognition.

Overall, based on the qualitative and quantitative data collected and the subsequent analysis, this study disclosed certain findings that at-risk students' family environment, language proficiency, learning style, and attitude towards learning mathematics do not have a significant association on students' mathematical commognition in high school Geometry. They may have some influence to some extent but the analysis shows otherwise; it may be because of the sample size of the study.

Conclusion and Recommendations

Although the sample size is too small to allow for extensive and comprehensive conclusions, the following conclusions were made based on the insights drawn from the findings that at-risk students have not really mastered the art of discourse in mathematics; hence, they have a hard time deciphering geometric problems. Although the statistics revealed that language proficiency is not one of the factors that influence their commognition, the interview and the language proficiency results clearly showed that they have limited language competence. Most of the participants are visual learners; hence, they will benefit from an environment that accommodates such learning style. Students' family environment, in one way or the other, plays a vital role in the way they view education. The respondents' favorable attitude towards learning mathematics can be a gateway for them to be successful academically. Hence, it recommended that in order to lessen the problem of not mastering the mathematical discourse and not being familiar with the endorsed narratives in mathematics, teachers should put up a word wall in their

classroom. Visibility will constantly remind them of the necessity of those words. Students should minimize using colloquial discourse during class lectures and even during casual conversations with their peers. Administrators and school principals should encourage teachers to enhance their teaching strategies in order to accommodate the needs of those visual learners. Implement more professional developments on how to incorporate graphic organizers, pictures, diagrams, illustrations, etc. to discuss mathematical concepts and problems specifically in Geometry. Development of instruments that would fit and capture the needs of the participants should be done. Intrinsic motivation should be emphasized to students as they are already familiar with extrinsic motivation. Students' only have basic level of mathematical commognition and therefore another study can be pursued on employing effective teaching methods on improving students' mathematical commognition not only in Geometry but also in other mathematics courses across all levels.

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