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Critical Thinking, Mathematical Dispositions, and Metacognitive Awareness of Students: A Causal Model on Performance

Adolf O. Odani[1], Raul C. Orongan, PhD[2]

[1]Central Mindanao University, University Town, Musuan Bukidnon, June 2020.

[2]Adviser

Abstract: ***The study sought to develop a causal model of critical thinking, mathematical dispositions, and metacognitive awareness on students' mathematics performance. Specifically, this study aimed to assess the levels of students' Mathematics performance, critical thinking, mathematical dispositions, and metacognitive awareness. Furthermore, it aimed to correlate and identify variables that best predict students' academic performance. To answer the problems posed, this study employed descriptive-correlational and causal-comparative research design. The participants of this study were randomly Grade 7 students at the public schools in the Division of Valencia City. The data were gathered using a standardized questionnaire and treated with both descriptive and inferential statistics such as frequency, percentage, mean, correlation, regression, and path analysis. The study revealed that performance of the Grade 7 students did not meet expectations. However, almost of them reached the average level in critical thinking. Students have an average level of mathematical dispositions and strong dedication to learn mathematics and they implement a variety of mathematical activity as manifested in math disposition as to sensibility, perseverance, and self-efficacy. Moreover, critical thinking, mathematical dispositions, and metacognitive awareness were significantly correlated with mathematics performance. In the same manner, critical thinking, perseverance under mathematical dispositions, and conditional knowledge under metacognitive awareness positively predicted students' mathematics performance. The best fitting causal model in students' performance is anchored on the critical thinking and mathematical disposition, particularly in perseverance. The more students think critically and logically coupled with the value of perseverance would likely improve their performance in Mathematics.***

Keywords: critical thinking, mathematical dispositions, and metacognitive awareness, causal model, and mathematics performance

1. Introduction

1.1 Background of the Study

Mathematics is not only about numbers and computations, but also a tool for understanding structures, relationships and patters needed to solve complex real life problems. The K to 10 Mathematics Curriculum provides a solid foundation for Mathematics at Grades 11 to 12. More importantly, it provides necessary concepts and life skills needed by Filipino learners as they proceed to the next stage in their life as learners and as citizens of the Philippines (DepEd, 2016).

However, the declining Mathematics performance of Filipino students both at the national and international level has become a main challenge to our country's education. This disappointing condition is evident in the performance of students in national and international surveys on Mathematics and Science competencies.The low performance of the students in Mathematics is also evident locally particularly DepEd Divison of Valencia City. Last 2017, the DepEd Region X conducted a National Achievement Test for all students in Grade10.The Division of Valencia City garnered a Mean Percentage Scores(MPS) of 33.14% in Mathematics grade 10 and ranked 12 out of 14 divisions in Region X. Ranked 1 was the Division of Tangub City with an MPS of 44.69% which is way far from 75% passing rate (DepED Region X, 2017).

Hinckley (2017) once said, one cannot build a great building on a weak foundation. One must have a solid foundation if he/she is going to have a strong superstructure. Just like Mathematics, one cannot understand higher Math without understanding basic concepts in Mathematics. One cannot understand Grade 8, 9 and 10 Math without understanding grade 7 Math. Thus, this study focuses on three (3) factors to determine if it can affect the performance of Grade 7 students in Mathematics namely: critical thinking, mathematical dispositions, and metacognitive awareness.

The twin goals of Mathematics in the K-10 basic education levels are critical thinking and problem solving (DepEd, 2016). In Mathematics, critical thinking usually comes when students ask why, rather than taking what they learn directly. As specified in the Philippine Constitution of 1986, all educational institutions in the Philippines must nurture Filipino learners to be creative and critical thinker. Aligned to this, the Department of Education aims to create critical and problem solver learners by engaging to contextualized realistic problems.

This shows that critical thinking is also considered as effective means of enhancing students' mathematics performance. This skill is considered one of the chief goals and ideals in the area of education (Siegel, 2003), including math education. Whether our focus on the field is on language, history, math, Geography or Economics, the aim of educators is to convey students to think. Critical thinking dates back to the early times of the Greek philosophers Plato and Aristotle. Dewey also put premiums on the importance of critical thinking (Lapuz & Fulgencio, 2020)

One of the several factors that affect students' learning in Mathematics is their disposition in Mathematics. According to Pearson Education, as cited by Yaniawati, Indrawan, and Setiawan (2019), mathematical dispositions include a genuine interest in learning Mathematics, persistence in findings solutions to problems, willingness to find alternative solutions or strategies and appreciation of Mathematics and its application in various fields. Mathematical disposition is an affective domain that plays an essential role in learning Mathematics. Those who have a productive disposition towards Mathematics understand the importance of effort and perseverance in Mathematics, are more likely to endure through setbacks and difficulties when learning Mathematics, and are less likely to give up the study of Mathematics(National Research Council, 2001).

Another factor that affects students' performance is metacognition. Mathematical achievement is based on students' knowledge and ability to use it. Students' ability to use their knowledge is often compromised when they encounter problems they have not seen before, such as final exams. Students must determine what the question is and what procedures to use in order to arrive at a mathematical answer (Laistner, 2016). One reason for this outcome could be that students are not taught how to examine their own thinking processes when it comes to problem solving. This leads students to second guess themselves and easily give up.

With this, there is a need to develop a causal model that best fits mathematics performance among Grade 7 students so as to address the alarming picture of Mathematics performance in the Division of Valencia City.

1.2 Statement of the Problem

The study sought to develop a causal model of critical thinking, mathematical dispositions, and metacognitive awarenesson mathematics performance of Grade 7 students. Specifically, this study desired to answer the following questions:

1) What is the level of students' Mathematics performance?
2) What is the level of students' critical thinking?
3) What is the level of students' mathematical disposition in terms of:
   a) Self-efficacy;
   b) Perseverance; and
   c) Math as sensible?
4) What is the level of students' metacognitive awareness in terms of:
   a) Declarative knowledge,
   b) Procedural knowledge, and
   c) Conditional knowledge?
5) What relationship exists between students' Mathematics performance and:
   a) Critical thinking,
   b) Mathematical dispositions, and
   c) Metacognitive awareness?
6) What are the variables that best predict students' mathematics performance?
7) What causal model best fits students' mathematics performance?

1.3 Objectives of the Study

The main purpose of this study was to develop a causal model on critical thinking, mathematical dispositions, and metacognitive awarenessrelative to students' mathematics performance. Specifically, this study aimed to:

1) Describe the level of students' Mathematics performance;
2) Ascertain the level of students' critical thinking;
3) Assess the level of students' mathematical dispositions in terms of:
   a) Self-efficacy,
   b) Perseverance, and
   c) Math as sensible;
4) Determine the level of students' metacognitive awareness in terms of:
   a) Declarative knowledge,
   b) Procedural knowledge , and
   c) Conditional knowledge;
5) Correlate students' academic performance and:
   a) Critical thinking,
   b) Mathematical dispositions, and
   c) Metacognitive awareness;
6) Identify variables that best predict students' mathematics performance; and
7) Develop causal model best fits students' mathematics performance.

1.4 Significance of the Study

This study envisions to be used by various stakeholders in education in improvingstudents' mathematics performance. The findings of this study would inform students as to how critical thinking, disposition, and metacognition can help them improve Mathematics performance. As a result, mathematics teachers, administrators and supervisors can determine what specific instructional activities may be undertaken and how instructions can be modified and paced to maximize skills in Mathematics

This study would make teachers be aware of the different factors affecting students' performance in Mathematics. As a result, teachers can demonstrate varied learning strategies by intensifying students' mathematical critical thinking, dispositions, and curiosity.

This study would also inform stakeholders such as school administrators and parents with information on critical thinking, dispositions, and metacognitionand their implication to student learning outcome. It hopes to give them a leeway to the formulation of better policies in consideration of these factors within the educational systems, based on gathered information.
Meanwhile, in the Division of Valencia City, there is a paucity of research material as regards to these factors where this attempt would be made to significantly add to the body of knowledge in educational discipline. All who invested in the welfare and success of the school and its students – the school board, administrators, teachers, staff, and parents can benefit from having pertinent information based on empirical studies about factor variables that better influence students' mathematics performance.

Lastly, the findings would add to the existing body of knowledge or serve as a stepping stone for future researchers of similar interest. It would help researchers in their quest to improve the mathematics performance of the students by strengthening theircritical thinking, dispositions, and curiosity attitudes.

1.5 Scope and Delimitation of the Study

This study employed path analysis to develop a causal model that best captures students' mathematics performance. It focused on the factors such as the extent of critical thinking, the strength of mathematical dispositions, and the vigor of metacognitionas the independent variables. The dependent variable in this study was the mathematics performance of the Grade 7 scored from the Standardized Mathematics Performance Test adapted from K-12 curriculum of the Department of Education.

The participants were delimited to the Grade 7 students of the Division of Valencia City, School Year 2019-2020.

1.6 Definitions of Terms

The following definitions are provided to ensure uniformity and understanding of terms and variables throughout the study. Critical thinking refers as the logical and reflective thought in deciding what to believe and what to do. It is the ability to clarify, the ability to seek and judge well as the basis of a view and the ability to infer.

Conditional knowledge is knowing when and why to use procedures or strategies.

Declarative knowledge is the knowledge we possess about ourselves, others, and the factors that influence our performance.

Mathematical disposition refers to the desire, consciousness, and a strong dedication of students to learn mathematics and implement a variety of mathematical activity. It is a tendency to think and act positively. It has three components namely: self-efficacy, perseverance, and math as sensible.

Mathematics performance pertains to the results of the Standardized Mathematics Performance Test adapted from K-12 curriculum of the Department of Education as taken by the Grade 7 students and it is measured through scores.

Math as sensible refers to student's belief about the degree to which mathematics is sensible, useful, and worthwhile.

Metacognitive awareness refers to the awareness of one's thinking and the strategies one is using. It enables students to be more mindful of what they are doing, and why, and of how the skills they are learning might be used differently in different situations.

Perseverance refers to the students' beliefs about the importance of persistence and diligence in determining success in solving mathematical problems.

Procedural knowledge refers to the knowledge students' possess knowing how they do things or perform functions. Self-efficacy refers to the student's beliefs about their capability of using mathematics effectively and successfully.

2. Conceptual Framework

Critical thinking is anchored on John Dewey's critical thinking theory. He describes critical thinking asactive, persistent, careful consideration of a belief or supposed form of knowledge in light of the grounds that support it and the further conclusions to which it tends (Dewey, 1933).

Dewey (1916) describes critical thinking as a reflective process and "includes the sense of the problem, the observation of conditions, the formation of rational elaboration of a suggested conclusion, and the active experimental testing" (p. 177). "He particularly stressed the role of the educational system as being responsible for preparing its students with critical thinking skills so they could be prepared to work in an ever-changing world" (Becker, 2007, p. 20).Constructivism plays a dynamic role in the relationship between how teachers teach and how children learn. One foundational premise of constructivism is that children actively construct their knowledge, rather than simply absorbing ideas spoken to them by teachers.

The philosopher of education, Robert Ennis, who has been involved in the thinking skills movement since its inception, has long recognized the importance of critical thinking dispositions. Following the philosophical tradition, Ennis defines a thinking disposition as a tendency to do something given certain conditions. Ennis argues, however, that, unlike the brittleness of glass, in order to qualify as a thinking disposition, the disposition must be exercised reflectively. In other words, given the appropriate conditions, dispositions are not automatic (Ennis, as cited by Parrouty, 2016).

Mathematical disposition a set of beliefs which influences a person's mathematical confidence, their willingness to persevere in the face of obstacles in solving mathematical problems, and their views about the understandability, usefulness, and worthwhileness of mathematics. These beliefs then guide and influence how students act with mathematics (National Research Council, 2001). On the other hand, Watson (2015), define students' mathematical disposition in three main components, namely: self-efficacy component, math as sensible component, and perseverance component.

Bandura (1986) defined self-efficacy beliefs as people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances. These personal judgments are one of the most central mechanisms of agency, influencing how people feel, think, motivate themselves, and behave.Bandura (1993) also explains that self-efficacy beliefs influence motivation in severalways. First, individuals who feel highly efficacious attribute failures to lack of effort, whereasthose with low self-efficacy attribute failures to inability or low ability. Second, self-efficacy beliefs largely influence the goals that people set for themselves. Those with high self-efficacy beliefs set challenging goals for themselves, believing that

they have the abilities to accomplish it, while those who have low self-efficacy about a specific domain will set low goals (or no goals at all) feeling that they do not have strong abilities to accomplish the goal. Third, and related to setting goals, self-efficacy beliefs have a strong impact on the amount of effort people expend in order to accomplish their goal. Finally, self-efficacy beliefs greatly affect how long people persevere towards accomplishing their goals in the face of difficulties, and how people react to those difficulties. Thus, a students' mathematics-related self-efficacy can have a profound effect upon the mathematical goals they set for themselves, how long they pursue those goals, and what the students will do in the face of difficulty, either persevering, or simply giving up because of "lack of ability."

The importance of seeing mathematics as sensible was stressed by the National Council of Teachers of Mathematics (NCTM) in the Learning Principle section of the Principles and Standards for School Mathematics (2000): "Students will be served well by school mathematics programs that enhance their natural desire to understand what they are asked to learn" (p. 21). NCTM (2000) continues by stating the importance of giving students opportunities to develop conceptual understanding and helping them develop a belief that mathematics is a subject that can be understood. By actively engaging students in tasks and experiences designed to deepen and connect their mathematical knowledge, students are encouraged to become autonomous, lifelong learners, seek understanding, persevere through difficulties when they arise, and see mathematics as personally useful. This will then increase their belief that mathematics is sensible, useful, and worthwhile.

Self-efficacy beliefs also have a large effect on persistence in problem solving, and students' beliefs about its importance. As mentioned previously in this paper, the amount of time and effort that one spends in trying to accomplish a goal (such as solving a problem) is largelyinfluenced by one's own efficacy beliefs (Bandura, 1993). A student with high self-efficacy willspend much more time, and is much more willing to persevere in the face of difficulties, than a student with low self-efficacy. Students with low self-efficacy beliefs are also much more likely to give up quickly when faced with complications while solving problems (Bandura, 1993). In other words, a students' beliefs about how successful they will be solving problems, specifically mathematical problems, affects their beliefs about how important it is for them to persevere in the face of difficulties. Self-efficacy further affects persistence through people's views about the extent to which their environment is controllable (Watson, 2015).

John Flavell's theory of metacognition is one of the best backboned of metacognitive awareness. Flavell (1979), defined metacognition as thinking about thinking and it is the knowledge you have of your own cognitive processes. He added that It is your ability to control your thinking processes through various strategies, such as organizing, monitoring, and adapting. Additionally, it is your ability to reflect upon the tasks or processes you undertake and to select and utilize the appropriate strategies necessary in your intercultural interactions.

This study exploredthe interrelationship of mathematical critical thinking, dispositions, and curiosity attitudes (exogenous variables)with students' mathematics performance (endogenous variable) using a theoretical path model.Table 1 presents the variables, codes, nature (exogenous or endogenous), and the corresponding measures to be used in this study.

Table 1: Codes, nature, and measure of variables of the study

Variables	*Code*	*Nature*	*Measure*
Mathematics Performance	PERFPER	Endogenous	Standardized Mathematics Performance Test
Critical Thinking Skills	CRITSCORE	Exogenous	Critical Thinking Test Questions
Mathematical Dispositions			
Self-efficacy	SEFF_DI	Exogenous	Mathematical Dispositions Survey
Perseverance	PERS_DI	Exogenous	
Math as Sensible	MATS_DI	Exogenous	
Mathematical Metacognition			
Declarative Knowledge	DEC_META	Exogenous	Metacognitive Awareness Inventory
Procedural Knowledge	PRO_META	Exogenous	
Conditional Knowledge	CON_META	Exogenous	

Figure 1 shows hypothesized causal model 1 showing the direct link of critical thinking, self-efficacy, perseverance, math as sensible, declarative knowledge, procedural knowledge, and conditional knowledge on students' mathematics performance.

Figure 2 illustrates the direct and indirect links of critical thinking, self-efficacy, perseverance, math as sensible, declarative knowledge, procedural knowledge, and conditional knowledge on students' mathematics performance.

Meanwhile, Figure 3 portrays the direct and indirect link of critical thinking, self-efficacy, perseverance, math as sensible, declarative knowledge, procedural knowledge, and conditional knowledge on students' mathematics performance.

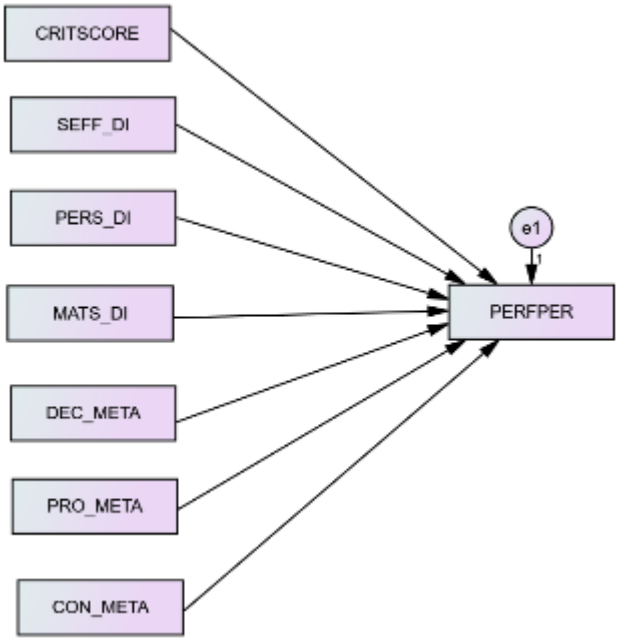

Figure 1: Hypothesized causal model 1on students' mathematics performance

LEGEND:-
CRITSCORE- Critical Thinking
SEFF_DI- Self-efficacy
PERS_DI- Perseverance
MATS_DI- Math as Sensible
DEC_META- Declarative Knowledge
PRO_META- Procedural Knowledge
CON_META- Conditional Knowledge
PERFPER- Mathematics Performance

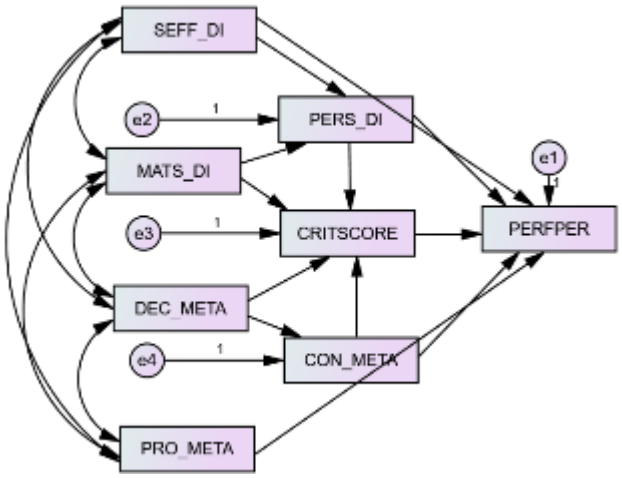

Figure 2: Hypothesized causal model 2 on students' mathematics performance

Legend:
CRITSCORE- Critical Thinking
SEFF_DI- Self-efficacy
PERS_DI- Perseverance
MATS_DI- Math as Sensible
DEC_META- Declarative Knowledge
PRO_META- Procedural Knowledge
CON_META- Conditional Knowledge
PERFPER- Mathematics Performance

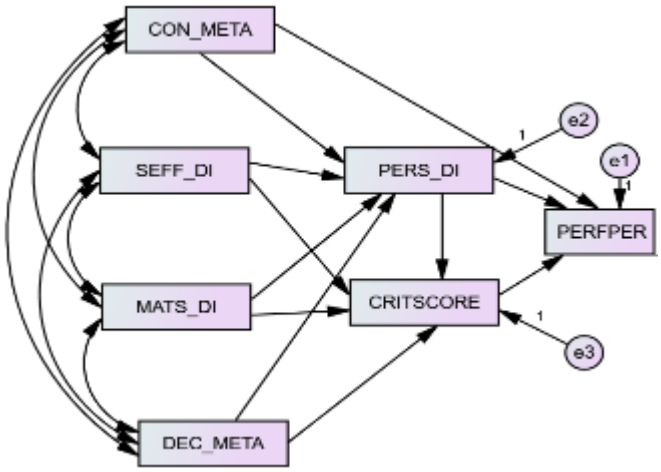

Figure 3: Hypothesized causal model 3on students' mathematics performance

Legend
CRITSCORE - Critical Thinking
SEFF_DI- Self-efficacy
PERS_DI- Perseverance
MATS_DI- Math as Sensible
DEC_META- Declarative Knowledge
CON_META- Conditional Knowledge
PERFPER- Mathematics Performance

Hypothesis of the Study
The purpose of this study was to develop a causal model that best captures students' mathematics performance. Thus, this claim leads to the following null hypothesis set at 0.05 level of significance.

Ho_1 There is no relationship existing between students' academic performance and:
a. critical thinking,
b. mathematical dispositions, and
c. metacognitive awareness.

Ho_2 There are no variables that best predict students' mathematics performance.

Ho_3 There is no causal model best fits students' mathematics performance.

3. Methodology

This chapter presents the method as to how the research study was undertaken. The presentation centers on the research design, locale of the study, respondents of the study, sampling procedure, research instrument, data gathering procedure, and statistical treatment of data.

Research Design
The study utilized the descriptive-correlational and causal comparative designs. A descriptive correlational describes the relationship among variables rather than to infer cause and effect relationship where the researcher has no control over the independent variables (Lappe, 2000) while a causal-comparative design seeks to find relationships between independent (exogenous) and dependent (endogenous) variables after an action or event that has already occurred. The researcher's goal is to determine whether the independent variable affected the outcome, or dependent variable, by comparing two or more groups of individuals (Salkind, 2010).

In this paper, it used descriptive method in describing the level of students' mathematics performance, critical thinking, mathematical dispositions, and metacognitive awareness. In addition, correlation method was applied in determining relationships among critical thinking, mathematical dispositions, and metacognitive awareness to students' mathematics performance, similarly, in finding variables that best predict students' mathematics performance. Meanwhile, causal-comparative design was used to develop a causal model best fits students' mathematics performance.

Locale of the Study

The study was conducted in the Division of Valencia City, Valencia, Bukidnon. Division of Valencia City was established in consonance with provision of the RA 8985, Sec. 49, otherwise known as "An Act Converting the Municipality of Valencia in the Province of Bukidnon into component City to be known as the City of Valencia. Sangguniang Panglungsod Resolution No. 2004-24 dated February 16, 2004 authorized the Local Chief Executive to enter into a Memorandum of Agreement (MOA) with the Department of Education relative to the establishment of the Division of Valencia City, and that the Local Finance Committee shall source out funding in the amount of Php 4,749,064.40 to constitute the 2004 budget for its operation which would include Personnel Services, MOOE and Capital Outlay. At present, the DepEd – Division of Valencia and by virtue of DepEd Order 53, series of 2013, or known as 2013 DepED Rationalization Program has grown by leaps and bounds. With this, new organizational structure was formulated based on the new staffing pattern. Thus, the Division of Valencia City has three (3) divisions, namely: the Office of Schools Division Superintendent (SDS), Curriculum Implementation Division (CID), and School Governance and Operation Division (SGOD).

Valencia City Division aims to formulate strategies and research-based interventions to improve performance on access, governance and quality; strengthen Learning Action Cell (LAC) and customized Reading Program in schools; capacitate division personnel and school leaders in providing appropriate and timely technical assistance; implement curricular reforms on anti-illegal drugs, reproductive health and disaster preparedness; contextualize curriculum that supports and appreciates local culture; install office systems for employees' welfare and efficient office operation; improve financial management systems to ensure efficient and effective delivery of services; and intensify public-private partnership to expand resources for basic education. More importantly, Valencia City Division anchored on the principle that "No Valenciano is left behind".

The call for excellence in education is still a continuing challenge for the Division of Valencia City, that whatever may hinder will still endure to give every young mind a chance for equitable, top-most education (DepEd Division of Valencia City, 2018).

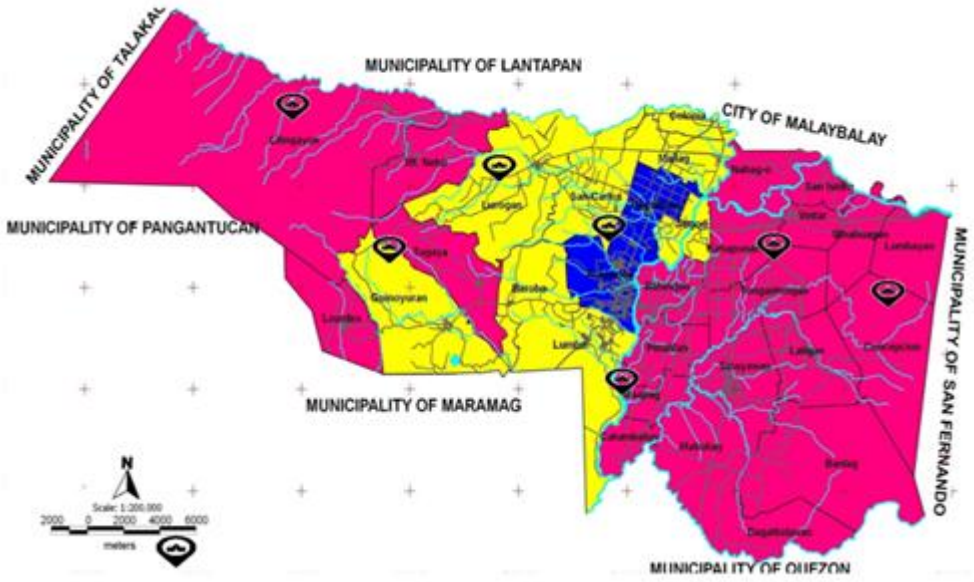

Figure 2: The administrative map of Valencia City, Bukidnon where the Division is located

Figure 2 shows the map of Bukidnon indicating the Valencia City where the Division is located.

Legend: Public National High Schools where the study was conducted

Participants of the Study

The Grade 7 students of the Junior High School Year 2019-2020 were the participants of the study, who were randomly selected among the nine (9) National and Integrated High Schools in the Division of Valencia City. As of 2016 Education for All Review, students of these schools have not attained the 75 mean percentage score target of Philippine Education for All (EFA).

Sampling Procedure

Proportionate random sampling was used in this study to capture the number of Grade 7 students from the selected schools.

Table 2: Distribution of the participants of the study by school

Schools	N	n	Percent
Catumbalon National High School	151	29	5.4
Concepcion National High School	70	14	2.5
Guinuyoran National High School	188	36	6.7
Lilingayon National High School	131	25	4.7
Lurugan National High School	250	48	8.9
Tongantongan National High School	323	62	11.6
Valencia National High School	1,682	325	60.2
TOTAL	2,795	540	100.0

Research Instrument

The researcher adopted a standardized test and questionnaire consisting of four parts. The first part is the 50-item standardized test on mathematics performance adopted from the Department of Education. It is a multiple-choice type of test which covered all the topics in the Second Grading period. It was pilot tested to Grade 7 students of Quezon National High School which yields an acceptable Cronbach's alpha of 0.815. It used the following scoring procedure.

Score Range	Level of Performance
41-50	Outstanding
31-40	Very Satisfactory
21-30	Satisfactory
11-20	Fairly Satisfactory
1-10	Did Not Meet Expectations

The second part is the test on student critical thinking skills specifically Cornell Critical Thinking Level X, adopted from the work of Javed, Nawaz, andQurat-ul-ain (2015). This test is composed of 40 items using a multiple-choice type of test. It was pilot tested to Grade 7 students of Quezon National High School which yields an acceptable Cronbach's alpha of 0.812. It used the following scoring procedure.

Score Range	Descriptive Rating
31-40	Excellent
21-30	High
11-20	Average
0-10	Low

The third part is the questionnaire on students' mathematical dispositions patterned from the work of Watson (2015). This questionnaire is composed of 31 items using a 5-point Likert scale. It was pilot tested to Grade 7 students of Quezon National High School which yields an acceptable Cronbach's alpha of 0.734. It used the following scoring procedure.

Score	Range	Descriptive Rating	Qualitative Description
5	4.51-5.00	Strongly agree	Very High
4	3.51-4.50	Agree	High
3	2.51-3.50	Undecided	Moderate
2	1.51-2.50	Disagree	Low
1	1.00-1.50	Strongly disagree	Very Low

The fourth part is the instrument in measuring mathematical metacognition similarly modeled from the work of Schraw and Dennison (2004). This questionnaire is composed of 17 items using a 5-point Likert scale. It was pilot tested to Grade 7 students of Quezon National High School which yields an acceptable Cronbach's alpha of 0.719. It used the following scoring procedure.

Score	Range	Descriptive Rating	Qualitative Description
5	4.51-5.00	Strongly agree	Very High
4	3.51-4.50	Agree	High
3	2.51-3.50	Undecided	Moderate
2	1.51-2.50	Disagree	Low
1	1.00-1.50	Strongly disagree	Very Low

Data Gathering Procedure

Prior to data gathering, the researcher wrote a letter noted by the Thesis Adviser and the Dean of the College of Education of Central Mindanao University to the Schools Division Superintendent of the Division of Valencia City and the District Supervisors to conduct the study. Assistance from the secondary school principals was requested during the administration of the questionnaires and the standardized test on mathematics performance.

Prior to the administration of the questionnaire, informed consent was secured from the participants for their voluntary participation in this study. Anonymity of responses was maintained and used for the purpose of the study only. All information provided remained confidential and was reported as aggregate data. The participant may wish to withhold any participant-identifiable information.

The researcher personally distributed and retrieved the questionnaire from the students in their respective classes as scheduled by the principal or by the class adviser. During the administration of questionnaire among the students, instructions weremade clear to avoid incomplete responses. The research questionnaires were immediately collected, checked, tallied, tabulated, and analyzed to obtain substantial information for the study.

Statistical Treatment of Data

As the study is quantitative in approach, the following statistical techniques were used to answer the problems.

To determine the level of students' mathematics performance and critical thinking skills, descriptive statistics such as frequency, percentage, and mean were used. Similarly, descriptive analysis such as mean was utilized in mathematical dispositions and metacognitive awareness. The results included the weighted scores and mean values to generalize the results of each component.

Pearson product-moment correlation was applied to determine the relationship between independent variables and dependent variable. Also, multiple regressions analysis was carried out to determine the variable that best predicts students' performance in Mathematics.

Finally, path analysis was employed for testing and estimating causal relations of the independent (exogenous) variables with mathematics performance (endogenous) using a combination of statistical data and qualitative causal assumptions. To evaluate the goodness of fit of the hypothesized path model, the following indices were computed: chi-square degrees of freedom (X^2/df), Goodness-of-Fit Index (GFI), Normal Fit Index (NFI),

Tucker Lewis Index (TLI), Comparative Fit Index (CFI), and Root Mean Square Error of Approximation (RMSEA) (Arbuckle, 2006).

4. Summary, Conclusions, and Recommendations

This chapter illustrates the summary of the study, the conclusion derived from the major findings, and the proposed recommendation.

4.1 Summary

The study sought to develop a causal model of critical thinking, mathematical dispositions, and metacognitive awareness on the mathematics performance of Grade 7 students. In particular, it aimed to describe the level of students' Mathematics performance; ascertain the level of students' critical thinking; assess the level of students' mathematical dispositions in terms of self-efficacy, perseverance, and math as sensible; determine the level of students' metacognitive awareness in terms of declarative knowledge, procedural knowledge, and conditional knowledge; correlate students' academic performance and critical thinking, mathematical dispositions, and metacognitive awareness; identify variables that best predict students' mathematics performance; and develop causal model that best fits students' mathematics performance.

The study employed a descriptive-correlational and causal-comparative research design. A total of 350 Grade 7 students of the public schools in the Division of Valencia City participated in the study in a random selection. The data were gathered through an adopted standardized questionnaire conducted locally. To treat the data, the study used descriptive statistics such as frequency, percentage, and mean while correlation, regression, and path analysis were used to analyze data for problems that require hypothesis testing.

In the light of the analysis of the data gathered, the following results identified to be prominent in this study.

Generally, Grade 7 students did not meet expectations in their mathematics performance, of which approximately 93% of them fall short, and only around 7% made it to the passing mark and over.

Almost 81% of the respondents reached the average level in their critical thinking skills while there were more than 12% of them achieved a high level, and less than 8% landed low.

Students' mathematical dispositions, desire, consciousness, and a strong dedication to learn mathematics and implement a variety of mathematical activity were average as manifested in these three indicators, namely: math as sensible (3.48), perseverance (3.45), and self-efficacy (3.44).

The way students are mindful on that they are doing and how the skills are used in different situations in approaching learning mathematics was likewise moderate as shown in these indicators: conditional knowledge (3.51) procedural knowledge (3.47), and declarative knowledge (3.44).

Critical thinking 0.377, ($p<0.01$); mathematical dispositions $r=0.340$, ($p<0.01$); and metacognitive awareness $r = 0.248$, ($p<0.01$) shared almost similar significant correlations towards mathematics performance. Thus, mathematics performance is better reinforced by these variables.

Moreover, critical thinking ($\beta = 0.429$, t (7.461), $p<0.01$, perseverance ($\beta = 2.006$, t (4.849), $p<0.01$, and conditional knowledge ($\beta = 0.863$, t (2.709), $p<0.01$ positively predicted students' mathematics performance at almost 22% total of variances explained against the dependent variable.

The indirect effects of conditional knowledge (CON_META), self-efficacy (SEFF_DI), math as sensible (MATS_DI), and declarative knowledge (DEC_META), and the direct effects of perseverance (PERS_DI) and critical thinking (CRITSCORE) captured the best fit model on students' mathematics performance as indicated by the following indices: (CMIN/DF) which is 0.720 with its corresponding p-value (0.578) showed good fit for the data. Other indices like GFI (0.998), CFI (1.000), NFI (0.998), TLI (1.004), and the RMSEA (0.000) likewise demonstrated the best fit for the data as they all fall in more than the standard criteria.

4.2 Conclusions

Based on the findings of the study, the following conclusions are drawn:

Students struggle with understanding the prerequisite and fundamental knowledge and skills as their scores do not meet the expectations based on DepEd's standard.

There is a current gap in critical thinking among the students as they have not so much cultivated these skills, such as recognizing the existence of problems, implicit and explicit assumptions, identifying relevant and irrelevant information in arguments, and making sense in the information.

Metacognitive awareness provides the way for students to become more proficient at higher-level thinking skills resulting in better problem solving and decision-making strategies.

In some fashion, critical thinking, mathematical disposition, and metacognitive awareness are viable solutions to enhance students' mathematics performance.

Critical thinking, perseverance, and conditional knowledge foster academic success among the students when it is strategically tailored in mathematics classroom.

The best-fitting causal model in students' performance is anchored on critical thinking and mathematical disposition, particularly in perseverance. The more students think critically and logically coupled with the value of perseverance, thus improving the performance in Mathematics.

4.3 Recommendations

Based on the findings and conclusion, the following recommendations are offered:

Teachers need to offer interventions for students who have not met the expectations. They may investigate the competencies where students have not been mastered so that students may exceed the core requirements in terms of knowledge, skills, and understanding and can transfer them automatically with flexibility through real-life context.

To improve students' critical thinking, teachers may develop instructional pedagogy with purposeful learning activities that encourage thinking abilities.

With utmost importance, teachers may find avenues to create a classroom that encourages acceptance, collaboration, self-beliefs, and perspectives where students can openly express their options without fear of judgment, censure, or reproach.

Furthermore, teachers may provide students with consistent, repeated practice on self-regulation to foster optimal learning through effective modeling in the classroom.

Critical thinking, mathematical dispositions, and metacognitive awareness may be integrated by administrators into both pre-service education programs, and professional development workshops for in-service teachers as these learning behaviors promise to yield favorable learning outcomes.

Future research may be commissioned, making use of experimental research design to validate the results of the study across other academic disciplines.

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