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Metacognitive and Computation Skills: Predicting Students' Performance in Mathematics

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***Abstract*—** *Computation and Metacognitive skills are essential sub-skills under the domain of Critical Thinking which is a 21st Century Skill. Having acquired these skills can greatly help students to have a better performance in the Mathematics course. The purpose of this study was to determine whether computation and metacognitive skills are significant predictors of students' performance in Mathematics. Students from four sections of the course Mathematics in the Modern World which was offered during the first semester of the academic year 2018-2019 were selected as the participants of this study which was conducted at Gov. Alfonso D. Tan College, Tangub City, Misamis Occidental, Philippines. The results of this study showed that students' scores in computation and metacognitive test of skills significantly correlate with the students' performance in Mathematics in terms of Grade Point Average (GPA) and a positive direct relationship has been established. Using the Regression Analysis, the result revealed that both computation and metacognitive skills of the students were significant predictors of their performance in Mathematics. These research outcomes affirm that if students acquire these skills, they tend to perform better in Mathematics. This suggests that teachers are encouraged to be more strategic in training the students to acquire and develop computation and metacognitive skills by administering various mathematical problems that encourage students to think critically.*

***Keywords*—** *Computation Skills, Metacognitive Skills, Mathematics Performance.*

I. INTRODUCTION

In today's generation, gaining knowledge and learning facts is not enough for the students because these may easily be forgotten. Instead, they must develop skills and competencies which they can use for their future. Skill is the capability to perform something that comes from experience, training, or practice. This is the ability of a person which he can use to accomplish things, solve problems, finish tasks, achieve goals and succeed in a certain endeavor. One of the recent trends in the 21st Century Education is the idea of the 21st Century Skills which serves as the basis and guiding principle for the teachers as what specific skills they must help students gain and to develop. The 21st-century skills include collaboration, creativity, communication and critical thinking.

These skills are needed to be developed by the learners especially in today's generation where things are getting complex as the world evolves. Saxena (2015) said that the 4Cs (Creativity, Communication, Collaboration, and Critical Thinking) are the super skills for the 21st-century which can help develop the qualities that students need to possess in the 21st-century for success in college, careers, and citizenship. Critical thinking skills as one of the 4Cs can be developed alongside with problem-solving skills through learning Mathematics. Mathematics learning does not only impart mathematical content but also advance students' critical thinking skills that are essential for students to solve numerous problems in school or in social life (Firdaus et. al, 2015).

Nevertheless, as learners enroll in a more complex Mathematics course, they must first develop the skills such as computation and metacognitive skills which are under the domain of Critical thinking of the 21st-century skills needed as a prerequisite. However, not all learners were able to develop the needed skills in learning Mathematics wherein they have difficulty in solving problems. Students observe problems in mathematics and problem-solving tasks because they are ignoring an extensive series of cognitive or metacognitive processes (Grizzle-Martin, 2014). This means that there is a necessity for the students to accelerate the development of their metacognitive skillfulness to be able to increase their performance in a given task. Metacognitive activities were tangled in required components for effective problem solving such as mathematical knowledge and experience, skills in producing pertinent tools such as unraveling relevant from irrelevant info, and the ability to employ a variety of heuristics demonstrating the remaining components for successful mathematics performance (Lester, 1985). It is important to have appropriate tools to measure students' metacognitive skills in order to evaluate the relationship between the improvement of such skills and growth in achievement. However, developing instruments for measuring metacognitive skills efficiently is still a problem and such problems have been at the center of a systematic discussion about which instruments are more suitable (Schellings & Van Hout-Wolters, 2011).

Another important skill that the learners must develop is the computational thinking skill which refers to those skills or techniques which often include disintegration of a task or problem, form recognition and concept, and framing algorithms to problems (Czerkawski & Lyman 2015). Moreover, computation skill has been named as the literacy of the 21st century, which is being addressed at the tertiary level with high degrees of achievement. Nonetheless, there are still some works to be done at the primary and secondary school level to gain the vast assistance of students' progress of computation skills (Mohaghegh & McCauley, 2016).

These skills which must be developed by the students with the help of the teachers are useful so they can succeed in

solving problems or getting good grades in any Mathematics course. They can be successful in taking a certain Mathematics course once they possessed the required skills such as computation and metacognitive skills.

Gov. Alfonso D. Tan College has implemented the new curriculum starting on the first semester of the academic year 2018-2019 as required and prescribed by the Commission on Higher Education. This is to support the K-12 Curriculum in enhancing the teaching-learning process for the learners and to produce quality and skilled graduates. In the new curriculum, there are new general education courses and one of those is Mathematics in the Modern World. The topics of the said cover all the possible practical applications of Mathematics in the real world. This course is offered to all first-year students in the college.

With this scenario, the researcher determined if both computation skills and metacognitive skills acquired and developed by the students in the previous years were sufficient to succeed in taking the said course. Moreover, the researcher also identified which skills predicted the students' performance in the course. The results of this study would provide insights into the whole educational community especially in enhancing students' overall performance. Explicitly, this study would afford an opportunity for the teachers to reflect how they would innovate activities which can enhance and develop students' computation and metacognitive skills and to maximize the students' performance.

II. METHOD

Participants

The participants of this study were the selected freshmen students enrolled in Mathematics in the Modern World from the four sections comprising 138 in total during the first semester of the academic year 2018-2019 of Gov. Alfonso D. Tan College. They were given a consent form for voluntary participation and were given an hour to answer each questionnaire.

Instruments

Two sets of researcher-made questionnaires for metacognitive skills and computation skills were prepared, developed and used as the research instrument to be administered to the participants. These were presented and approved by the research panel during the proposal hearing. Each questionnaire composed of a specific number of items depending on the Table of Specifications (TOS) prepared for each topic. These were subjected to validity and reliability tests. The validity test was done by a panel of experts to establish the content, criterion and face validity of the questionnaire while the test and retest method was administered to a different group of respondents as chosen by the researcher to test its reliability. To measure the internal consistency reliability of each factor, Cronbach's alpha coefficients were computed. Items with Cronbach's Alpha value of 0.70 and above (high reliability) were retained and items with Cronbach's Alpha value less than 0.70 were discarded.

Procedure

The initial process in data gathering procedure as to obtain official permission and approval to conduct the study from the office of the Vice President for Academic Affairs of the College and getting official permission from the instructor and the registrar to push through with this study. Four sections of the Mathematics in the Modern World were chosen as participants. The validated researcher-made questionnaires for metacognitive skills and computation skills were administered. The results were collected, treated and analyzed using the established statistical tools. Correlation formula was utilized to determine whether the students' level of metacognitive skills was significantly related their level of performance in mathematics in the modern world based on their final grades and the same way to that of computation skills and to their performance of the said course. Regression Analysis was utilized to determine whether the two classified skills predicted the students' success in the said course and which between the skills was a better predictor.

III. RESULTS

The means, standard deviations, and Cronbach alpha levels were obtained for the students' level of computation skills, metacognitive skills, and performance in Mathematics. The relationships among these variables were also obtained through correlation and simple regression

TABLE 1. Level of Students' Computation Skills (N = 90)

Test	Mean Score	SD	MPS	Descriptive Equivalent
Computation Test	10.46	2.09	35%	Average

Total Items: 30
Scale: 96 – 100% = Mastered; 86 – 95% = Closely Approximating Mastery; 66 – 85% = Moving Towards Mastery; 35 – 65% = Average; 15 – 34% = Low; 5 – 14% = Very Low; 0 – 14% = Absolutely No Mastery

As shown in the above Table 1, the Mean Score of the Students from the 30-item computation test is 10.46. This has an equivalent Mean Percentage Score (MPS) of 35%. This is interpreted as Average based on the given scale.

TABLE 2. Level of Students' Metacognitive Skills (N = 90)

Test	Mean Score	SD	MPS	Descriptive Equivalent
Metacognitive Test	9.18	2.17	31%	Low

Total Items: 30
Scale: 96 – 100% = Mastered; 86 – 95% = Closely Approximating Mastery; 66 – 85% = Moving Towards Mastery; 35 – 65% = Average; 15 – 34% = Low; 5 – 14% = Very Low; 0 – 14% = Absolutely No Mastery

As shown in Table 2, the Mean Score of the Students from the 30-item metacognitive test is 9.18. This has an equivalent Mean Percentage Score (MPS) of 31%. This is interpreted as low based on the given scale.

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TABLE 3. Level of Students' Performance

Course	N	Mean GPA	Descriptive Equivalent
Mathematics in the Modern World	90	88.65	Approaching Proficiency

Scale: 95 – 100 = Advanced; 90 – 94 = Proficient; 80 – 89 = Approaching Proficiency; 75 – 79 = Developing; 75 and Below = Beginning

As shown in Table 4, the Students' Mean GPA in Mathematics in the Modern World Course is 88.65 and it has a descriptive equivalent which is Approaching Proficiency based on the given scale.

TABLE 4. Test of Relationship between Computation Skills and Mathematics Performance

Variables	Pearson "r"	Interpretation	p-value	Interpretation
Computation Skills and Mathematics Performance	.593	Moderate Positive Linear Relationship	.000	With Significant Relationship

*Scale: 0 – ± 0.29 = No Linear Relationship *N = 90*
± 0.30 – ± 0.49 = Weak Linear Relationship
± 0.50 – ± 0.69 = Moderate Linear Relationship
± 0.70 – ± 0.99 = Strong Linear Relationship
± 1 = Perfect Linear Relationship

The results showed that there is a moderate positive correlation between students' computation skills and students' Mathematics performance *(Pearson "r" = .593)* which means that when the students' computation skills are more strengthened and developed, they will perform better in Mathematics. On the other hand, if such computation skills are weak, the bigger the chance that they will have poor performance in Mathematics. Besides, a significant relationship was established between the two variables *(p-value < .05)*. Thus, the null hypothesis was rejected and the alternative hypothesis specifying that there is a significant relationship between the students' computation skills and their Mathematics performance was accepted.

TABLE 5. Test of Relationship between Metacognitive Skills and Mathematics Performance

Variables	Pearson "r"	Interpretation	p-value	Interpretation
Metacognitive Skills and Mathematics Performance	.529	Moderate Positive Linear Relationship	.000	With Significant Relationship

*Scale: 0 – ± 0.29 = No Linear Relationship *N = 90*
± 0.30 – ± 0.49 = Weak Linear Relationship
± 0.50 – ± 0.69 = Moderate Linear Relationship
± 0.70 – ± 0.99 = Strong Linear Relationship
± 1 = Perfect Linear Relationship

The results showed that there is a moderate positive correlation between students' metacognitive skills and students' Mathematics performance *(Pearson "r" = .529)* which means that when students' Metacognitive Skills are more developed, students will perform better or will have a better performance in Mathematics. On the other hand, if such Metacognitive skills are not well-developed, students will struggle to have a good performance in Mathematics. Further, a significant relationship was established between the two variables *(p-value < .05)*. Thus, the null hypothesis was rejected and the alternative hypothesis specifying that there is a significant relationship between the students' metacognitive skills and their Mathematics performance was accepted.

TABLE 6. Regression Analysis for Determining Predictors of Students' Mathematics Performance

Model	R	R^2	Adjusted R^2	SE	F-value	p-value
1	.593[a]	.352	.344	3.37086	47.735	.000[a]
2	.670[b]	.449	.436	3.12645	35.393	.000[b]

a. Predictors: (Constant), Computation Skills
b. Predictors: (Constant), Computation Skills, Metacognitive Skills
c. Dependent Variable: Performance

The data show that there is a significant overall relationship of the model wherein Computational Skills is the independent variable and Students' Mathematics Performance is the dependent variable *(R = .593, p < .05)*. Likewise, there is also a significant overall relationship of the model comprising two independent variables specifically Computational Skills and Metacognitive Skills *(R = .670, p < .05)*.

Considering the R^2 statistic, "Model 2" the better model in predicting students' performance in Mathematics with two predictors because it posted a higher value of 0.449 known as the coefficient of determination which indicates the proportion of variance of the dependent variable (Mathematics Performance) that can be explained by the variation that also occurs in both independent variables (Computation and Metacognitive Skills). In this case, approximately 45% of the variation in Mathematics Performance can be explained based on the amount of variation that occurs between the students' Computation and Metacognitive Skills. The "Std. Error of the Estimate" indicates the amount of dispersion for the prediction equation.

More importantly, a p-value of less than 0.05 indicates a significant result. In this case, the statistical value confirms that Computation and Metacognitive skills are statistically valid predictors of Mathematics performance.

TABLE 7. Statistics Associated with the Predictors of Students' Mathematics Performance in the Multiple Regression Analysis

Model		Unstandardized Coefficients		Standardized Coefficients	t	p-value
		B	SE	Beta		
1	(Constant)	76.330	1.819		41.964	.000
	Computation Skills	1.179	.171	.593	6.909	.000
2	(Constant)	73.255	1.861		39.357	.000
	Computation Skills	.897	.174	.451	5.157	.000
	Metacognitive Skills	.656	.168	.342	3.911	.000

a. Dependent Variable: Performance
**Model: Mathematics Performance = 73.255 + 0.897 Computation Skills + 0.656 Metacognitive Skills*

The unstandardized beta coefficients contain a value that indicates whether the relationship is direct or inverse. In this

case, the "Unstandardized Coefficient" for Model 2 of the Computation Skills = 0.897 and Metacognitive Skills = 0.656, both indicating a direct relationship.

The coefficient values can be plugged into the regression equation used to plot the line of regression. This equation is $Y^1=a + b_1X_1 + b_2X_2$. To determine the value of Y^1 (Mathematics performance), take sum of the constant, the product of the coefficient of computation skills and its actual value and the product of the coefficient of metacognitive skills and its actual value based on the test scores.

In this case, by following the equation, Mathematics Performance = 73.255 + 0.897 Computation Skills + 0.656 Metacognitive Skills. For a Computation Score of 10 and Metacognitive Score of 15, Mathematics Performance = 73.255 + 0.897(10) + 0.656(15), predicts a Mathematics performance (GPA) of 92.065. Thus, both Computation skills and Metacognitive skills of students significantly predict their performance in Mathematics.

IV. DISCUSSION

The study is primarily aimed to determine the significant relationship among the metacognitive, computation skills and mathematics performance. The results showed that there is a moderate positive correlation between students' computation skills and students' Mathematics performance *(Pearson "r" = .593)* which means that when the students' computation skills are more strengthened and developed, they will perform better in Mathematics. On the other hand, if such computation skills are weak, the bigger the chance that they will have poor performance in Mathematics. Besides, a significant relationship was established between the two variables *(p-value < .05)*. Thus, the null hypothesis was rejected and the alternative hypothesis specifying that there is a significant relationship between the students' computation skills and their Mathematics performance was accepted.

Philips (2007) emphasized that computation skill is essential for today's generation and posited that it empowers students to be more operative problem solvers for situations beyond the computer science realm, and inspires them to generate tools to solve problems, rather than utilize prevailing paraphernalia. This skill also has been called the literacy of the 21st century, which is being addressed at the tertiary level with high degrees of achievement. Moreover, Lunsford & Poplin (2011), said that computation skills are an important factor of student success in elementary statistics regardless of the level of mathematics presented, or the virtual emphasis on computation versus interpretation by the instructor. Since the significant relationship between computation skills and Mathematics performance has been established, this recommends that both students and teachers must help one another to strengthen the students' computation skills in order to maximize their performance in Mathematics.

There is also a moderate positive correlation between students' metacognitive skills and students' Mathematics performance *(Pearson "r" = .529)* which means that when students' Metacognitive Skills are more developed, students will perform better or will have a better performance in Mathematics. On the other hand, if such Metacognitive skills are not well-developed, students will struggle to have a good performance in Mathematics. Further, a significant relationship was established between the two variables *(p-value < .05)*. Thus, the null hypothesis was rejected and the alternative hypothesis specifying that there is a significant relationship between the students' metacognitive skills and their Mathematics performance was accepted.

Students who have high metacognitive skills achieve better in mathematics lessons (including problem-solving) than students who have low metacognitive skills (Jaafar & Ayub, 2010). Maier (2012) said that metacognitive development progresses mathematical performance. Metacognitive skills support students in understanding, planning, implementing a strategy, correcting errors, and evaluating answers to the mathematical problem solving, thus, students with high level of metacognitive skills can advance their performance, and obtaining the much-needed necessity of HOTS (Abdullah et al., 2017).

Since the significant relationship between metacognitive skills and Mathematics performance has been established, this recommends that both students and teachers must help one another to strengthen the students' metacognitive skills in order to maximize their performance in Mathematics.

Further, there is a significant overall relationship of the model wherein Computational Skills is the independent variable and Students' Mathematics Performance is the dependent variable *($R = .593$, $p < .05$)*. Likewise, there is also a significant overall relationship of the model comprising two independent variables specifically Computational Skills and Metacognitive Skills *($R = .670$, $p < .05$)*.

Considering the R^2 statistic, "Model 2" the better model in predicting students' performance in Mathematics with two predictors because it posted a higher value of 0.449 known as the coefficient of determination which indicates the proportion of variance of the dependent variable (Mathematics Performance) that can be explained by the variation that also occurs in both independent variables (Computation and Metacognitive Skills). In this case, approximately 45% of the variation in Mathematics Performance can be explained based on the amount of variation that occurs between the students' Computation and Metacognitive Skills. The "Std. Error of the Estimate" indicates the amount of dispersion for the prediction equation. More importantly, a p-value of less than 0.05 indicates a significant result. In this case, the statistical value confirms that Computation and Metacognitive skills are statistically valid predictors of Mathematics performance.

The unstandardized beta coefficients contain a value that indicates whether the relationship is direct or inverse. In this case, the "Unstandardized Coefficient" for Model 2 of the Computation Skills = 0.897 and Metacognitive Skills = 0.656, both indicating a direct relationship.

The coefficient values can be plugged into the regression equation used to plot the line of regression. This equation is $Y^1=a + b_1X_1 + b_2X_2$. To determine the value of Y^1 (Mathematics performance), take sum of the constant, the product of the coefficient of computation skills and its actual

value and the product of the coefficient of metacognitive skills and its actual value based on the test scores.

In this case, by following the equation, Mathematics Performance = 73.255 + 0.897 Computation Skills + 0.656 Metacognitive Skills. For a Computation Score of 10 and Metacognitive Score of 15, Mathematics Performance = 73.255 + 0.897(10) + 0.656(15), predicts a Mathematics performance (GPA) of 92.065. Thus, both Computation skills and Metacognitive skills of students significantly predict their performance in Mathematics.

In a particular study done by Mohamad & Mahamod (2014), it was found out that awareness in metacognitive skills can boost students' interest in a particular subject thus improving their performance. In addition, the said skills also are important in improving and training the students to maximize their ability to solve problems. Jacobs & Harkamp (2012) pointed out that the student's ability in solving mathematical problems can be improved. Furthermore, Bayat & Tarmizi (2010) showed that there is a positive and moderate significant relationship between a metacognitive overall strategy and performance in the Algebra problem-solving. On the other hand, Lunsford & Poplin (2011), found out that computation skills are an important factor of student success in elementary statistics regardless of the level of mathematics presented, or the virtual emphasis on computation versus interpretation by the instructor.

With the findings revealed, students must acquire skills in metacognition and computation since these are essential for them to maximize their performance in any Mathematics course. Teachers, with the use of sufficient resources, play a great role in it.

V. Conclusion and Recommendations

Students' computation skills and metacognitive skills are significantly correlated and have a direct relationship with the students' performance in Mathematics; however, computation skill shows a greater correlation coefficient than that of metacognitive skills. This means that computation skill has a stronger correlation than that of metacognitive. The findings of the study further show that both skills also are significant predictors of students' performance in Mathematics. This implies that if students' level of computation and metacognitive skills are both high, then they tend to perform better, thus achieving success in Mathematics. These research outcomes affirm the claim that computation skills and metacognitive skills predict students' performance in Mathematics. Students must strengthen their computation skills and metacognitive skills through constant practice in solving mathematical problems. Teachers are encouraged to be more strategic in training the students to acquire and develop computation and metacognitive skills by administering various mathematical problems that encourage the students to think critically. School administrators must help provide the students with activities to enhance their skills with sufficient resources, materials, and budget. A similar study may be conducted focusing on the factors affecting the students' acquisition of computation and metacognitive skills.

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