Metacognitive Awareness, Motivational Beliefs and Mathematics Performance of Junior High School Students: An Investigation of Mediating Effects

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Abstract
Metacognition and motivational beliefs are crucial components of self-regulated learning. Effective learners are expected to exhibit the ability to plan, evaluate, regulate, and control their attitudes and behaviors during the learning process. Thus, this study investigated whether students' motivational beliefs significantly mediate the relationship between students' metacognitive awareness and mathematics performance. The study was conducted on 146 junior high school students. Quantitative data were obtained using online survey questionnaires on metacognition, motivational beliefs, and achievement test on mathematics. The study utilized descriptive correlational research, and the mediating effects were investigated using a set of regression analyses. Results showed that the respondents have above average metacognition in terms of metacognitive knowledge (M=3.80, SD = 0.38) and metacognitive regulation (M=3.79, SD = 0.36). Students' motivational beliefs components were described as above-average except for the test anxiety. Students also showed very good performance in Mathematics. Furthermore, correlation analysis showed that metacognitive awareness ($r=0.369$, $p<0.01$) and extrinsic goal orientation ($r=0.326$, $p<0.01$) were highly significant with respondents' mathematics performance. Regression analysis also revealed evidence of the partial mediation effect of extrinsic goal orientation between metacognitive awareness and mathematics performance. These findings indicates that external goal orientation plays an important role in metacognitive awareness and mathematics performance. Extrinsic goal orientation causes changes in both metacognition and mathematics performance. The results also emphasize that educators should consider the motivational beliefs and metacognition of students in mathematics.

Keywords: Metacognition, Motivation, Mathematics Performance, Mediation

Introduction

Throughout the years, Mathematics has always been perceived as one of the most challenging courses. Researchers assume that it is imperative to establish the factors that influence students' attitudes towards learning mathematics, what promotes learning mathematics, and what hinders the process of learning mathematics. Braza and Supapo (2014) states that one of the problems that can inhibit student mastery of math concepts and skills is the lack of mastery of basic concepts, skills, and procedures. This would be alarming in the K to 12 Curriculum, in which Mathematics lessons are arranged in the spiral matter. Failure to understand the basic concepts might probably bring difficulty in learning higher mathematics. Teaching instructions and practices have also been the factors that educators have been studying as it also affects learning. However, Kleden (2015) argues that students' academic success is determined when they can self-evaluate and comprehend their cognitive abilities. These outcomes are highly variable. Therefore, it is imperative to explore the cognitive and affective attributes that impact the learning process.

In recent years, the success of Filipino students in mathematics subjects has prompted concern. The low performance and decreasing literacy rate of Filipino students' mathematical skills have been emphasized in several local and international assessments. This was evident from the recent result of the International Student Assessment Program (PISA). Based on the result released last 2019, the Philippines ranked second lowest in mathematical literacy. The country scored 353 in mathematics, below the Organization for International Cooperation and Development (OECD) average of 487 points. According to the Third International Mathematics and Science Study (TIMSS) reported that the Philippines ranked as 39th out of 41 participating international countries (as cited in Cordova & Tan, 2018, p.103). Moreover, the National Achievement Test results in 2019 reveal that Filipino students are not equipped with the ability to do mathematics. Pagtulon-an and Tan (2018) cited that most schools and academic institutions failed to reach the criterion set by the National Educational Testing and Research Center (NETRC). In different local test administered in different divisions in the Philippines also shows the same challenges. Moreover, different institutions implement various strategies such as online distance learning, modular learning, and blended distance learning to assist the learners and adapt to the ongoing crisis. It is another struggle for learners to cope with the new normal. Students must be motivated, know how to manage their study time and environment effectively, and be aware of the critical role of knowledgeable others in their learning.

Numerous studies demonstrate the importance of students' metacognition and motivational beliefs in their academic achievement. Effective learners are expected to demonstrate the ability to plan, monitor, regulate and control their learning processes concerning their attitudes and behaviors. Hence, to engage successfully in learning, students must have good metacognition skills. It can also be noted that academic success is reliant on students' innate academic motivation which guides students in their learning and personal growth activities (Abdelrahman, 2020). In education, it has a major impact, particularly for students of junior and senior high school. Student's academic emotions can potentially impact academic achievement because it increases the affective attributes of student so that academic achievement of students can be improved with such motivations. Also, several studies have been conducted to probe student metacognition and motivational belief toward academic performance. Prior studies concluded that metacognition is related to mathematics performance (Desoete, Roeyers, & Buysse, 2001), and the student motivation is the factor that directs students' attitude towards the learning process. The findings of Öz (2016) showed

that metacognitive awareness has a significant relationship with academic motivation. Results showed that the components of metacognition are both predictors of academic motivation. For instance, Tian, Fang, and Li (2018) evaluated the participation of students in self-regulated learning on the impact of metacognitive knowledge on the performance of mathematics. Results showed that metacognitive knowledge, self-efficacy, and inherent motivation could predict mathematical performance. Skaalvik, Federici and Klassen (2015) added that self-efficiency and motivation in mathematics could affect motivated behavior such as initiatives, determination, and the quest for assistance through intrinsic motivation in mathematical learning. Based on the results generated, metacognition influences mathematical performance indirectly by its own efficiency and its intrinsic motivation. With these findings, it was found that studies have been formulated with regards to the effect of motivational beliefs in metacognition and mathematics performance. Several components of motivational beliefs significantly affect the relationship between the two variables.

Relative to this condition, the role of both metacognition and motivational beliefs in the learning process has been identified. The two concepts might necessarily intertwine. This study aimed to determine the relationship of the two constructs of self-regulated learning: metacognitive awareness and the respondents' motivational beliefs. Specifically, the study will investigate the mediating effect of motivational beliefs on the relationship between metacognitive awareness and mathematics performance. The study will significantly contribute to understanding the needs, interests, and skills of the students. Specifically, the study sought to answer the following questions.

1. What is the level of metacognitive awareness, motivational beliefs, and mathematics performance of the respondents?
2. Is there a significant relationship between metacognitive awareness, motivational beliefs, and the respondents' mathematics performance?
3. Is the students' motivational beliefs a significant mediator between the relationship of metacognitive awareness and the respondents' mathematical performance?

Methods

Research Design

The study used a descriptive correlational research method. The correlational research design is also used in the study. In this study, the correlation analysis focused on finding the relationship between metacognitive awareness, motivational beliefs, and the respondents' mathematical performance. This study also determined whether the respondents' motivational beliefs mediate the relationship between metacognitive awareness and the respondents' mathematical performance.

Instrument

This study utilized an online questionnaire, which consisted of an adopted inventory and achievement test in mathematics as an instrument. These were both administered through google forms, a survey administration software. The "Metacognitive Awareness Inventory (MAI)" adopted from Schraw and Dennisons (1994) was used to determine the respondents' metacognitive awareness. The "Motivated Strategies for Learning Questionnaire (MSLQ)" of Pintrich & DeGroot (1990) was used to determine the motivational orientations of the students. In this study, the motivational components of MSLQ was only used, which was also

modified in mathematics class. The last part of the questionnaire involves the mathematics Achievement test which assessed the students' mathematics performance.

Participants

The participants of the study was consisted of 146 junior high school students from a public school. The mean age of junior high school students is 13.76 with a standard deviation of 0.11. Specifically, most of the respondents were 14 years old (27.40%), and only two respondents (1.37%) was 17 years old. Moreover, more than half of the respondents were females (60.96%), and there were only 57 (39.04%) were males. In terms of the grade level, most of the respondents were Grade 7 students (26.71%) and Grade 8 has the lowest number of the students (21.92%).

Data Analysis

The researcher used various statistical tools for analyzing gathered data that are aligned with the study's objectives. The respondents' demographic profile, metacognitive awareness, motivational beliefs, and mathematics performance were described using frequency, percentage, weighted mean, and standard deviation. Moreover, correlational analysis involves Pearson's r and regression analysis determine the significant relationships, the possible predictors, and the mediating effects of the three variables. Different regression analyses were used to tests the mediation effect. The study used the Baron and Kenny (1986) four-step approach using regression analysis. The first step involves testing whether metacognitive awareness predicts the students' mathematics performance. The second step includes determining if metacognitive awareness predicts motivational belief. The third step involves exploring whether motivational beliefs predict students' mathematics performance. And the last step focuses on testing complete mediation across the variables.

Results

Respondent's Metacognitive Awareness, Motivational Beliefs and Mathematics Performance

The respondents' level of metacognitive awareness was "above average metacognition," (M= 3.79, SD=0.35) which indicated that the levels of metacognition of individual respondents did not vary from the mean. Also, their metacognitive knowledge (M=3.80, SD = 0.38) and metacognitive regulation (M=3.79, SD = 0.36) were both described as "above average metacognition" (refer to Table 1).

Table 1. Level of Metacognitive Awareness of the Respondents

Metacognitive Awareness	Mean	SD	Description
Metacognitive Knowledge	3.80	0.38	Above average Metacognition
Metacognitive Regulation	3.79	0.36	Above average Metacognition
Overall	3.79	0.35	Above average Metacognition

The mean score for each subscale of the respondents' motivational beliefs is ranged from 3.53 to 4.02. The respondents' results are over 3.41 for each subscale of all the components of the motivational beliefs indicating that the respondents were described as having above-average motivational beliefs except for the test anxiety (refer to Table 2).

Table 2. Motivational Beliefs of the Respondents

Motivational Beliefs of the Respondents	Mean	SD	Description
Intrinsic goal orientation	3.80	0.56	Above Average
Extrinsic goal orientation	4.02	0.61	Above Average
Task Value	3.81	0.51	Above Average
Control of Learning Beliefs	3.85	0.48	Above Average
Self-efficacy	3.53	0.59	Above Average
Test Anxiety	2.26	0.70	Below Average

The achievement test results shows the students' mathematics performance. The students' mean scores on the achievement test was 34.88 (69.75%), described as "very good" remarks. Grade 7 students had the highest mean score of 36.26 (72.51%), followed by the Grade 9 students with a mean score of 34.76 (69.52%), Grade 10 mean score was 34.41 (68.81%), and grade 8 students got the lowest mean score of 33.88(67.75%). They were all considered to have a very good performance for their first quarter on mathematics.

Relationship between Metacognitive Awareness, Motivational Beliefs, and Mathematics Performance

Correlation analysis showed that metacognitive awareness (r=0.369, p<0.01) and extrinsic goal orientation (r=0.326, p<0.01) were highly significant with respondents' mathematics performance. Also, the students' task value (r= 0.170, p<0.05) was correlated with mathematics performance. The following results suggest a potential direct and indirect effect of metacognition on mathematics performance and some motivational beliefs components.

Table 3. Relationship between Metacognitive Awareness, Motivational Beliefs and Mathematics Performance

Variables	1	2	3	4	5	6	7	8
1. Metacognitive awareness	1							
2. Intrinsic	.587**	1						
3. Extrinsic	.580**	.415**	1					
4. Task Value	.488**	.578**	.594**	1				
5. Control of learning beliefs	.447**	.340**	.391**	.311**	1			
6. Self-efficacy	.479**	.516**	.293**	.673**	.214**	1		
7. Test Anxiety	-.319**	-.249**	-.333**	-.052	-.314**	-.062	1	
8. Mathematics Performance	.369**	.131	.326**	.170*	.137	.134	-.154	1

**. significant (p<0.01)
*. significant (p<0.05)

Test for Mediation Models

This study's main objective was to investigate whether motivational beliefs are a significant mediator of the relationship between metacognitive awareness and mathematics performance. Several steps were performed to examine the mediating effects using the Statistical Package for Social Sciences (SPSS). Sets of regression analysis were tested, exploring the mediation

variables of the relationship between metacognitive awareness and mathematics performance. Following the Baron and Kenny's (1998) approach, a set of regression analyses was undertaken, and four conditioned were examined.

The first condition involves examining whether metacognitive awareness is significantly related with mathematics performance. A simple regression analysis was performed to determine whether the metacognitive awareness of the respondents predict mathematics performance. The result shows that the model was significant, R^2=0.136, Adjusted R^2 =0.130, $F_{(1,145)}$ = 22.761, p<0.001. The metacognitive awareness is a positive predictor of mathematics performance of the respondents, (β =0.369, $t_{(1,145)}$ =4.771, p< 0.001). The coefficient of determination R^2 = 0.136 means that about 13.6% of the variance of the respondent's mathematics performance is explained or accounted for by their metacognitive awareness. Hence, the remaining 86.4% is explained or accounted for or by other variables included in the model. These findings also indicate that students who have high metacognition tend to have outstanding mathematics performance. Thus, the first condition was satisfied.

The second condition includes examining the association of the independent variable metacognitive awareness) and the possible mediator (components of motivational beliefs). A series of simple regression analyses were performed to determine whether metacognitive awareness predicts motivational beliefs components. Result shows that the regression model for metacognitive awareness and intrinsic goal orientation is significant, R^2= 0.344, Adjusted R^2= 0.340, $F_{(1,1445)}$ = 75.611, p < 0.001, which indicates that the metacognitive awareness is a positive predictor of intrinsic goal orientation (β =0.587, $t_{(1, 145)}$ =8.695). The coefficient determination R^2 = 0.344 means that about 34.40% of the variance in the intrinsic goal orientation is explained or accounted for by their metacognitive awareness. The model is also significant for metacognitive awareness and intrinsic goal orientation, R^2 = 0.337, Adjusted R^2 = 0.332, $F_{(1,1445)}$ = 73.149, p < 0.001, indicating that the metacognitive awareness is a positive predictor of extrinsic goal orientation, (β =0.580, $t_{(1, 145)}$ =8.553). The coefficient determination R^2 = 0.337 means that about 33.70% of the variance in the extrinsic goal orientation is explained or accounted for by their metacognitive awareness. The results also shows that the model for metacognitive awareness and task value is significant, R^2 = 0.238, Adjusted R^2 = 0.233, $F_{(1,1445)}$ = 45.091, p < 0.001, which indicates that metacognitive awareness is a positive predictor of task value of the respondents, (β =0.488, $t_{(1, 145)}$ =6.715). The coefficient determination R^2 = 0.238 means that about 23.80% of the variance in the respondent's task value is explained or accounted for by their metacognitive awareness. In terms of the respondents metacognitive awareness and control of learning beliefs, the model is also significant, R^2 = 0.200, Adjusted R^2 = 0.194, $F_{(1,1445)}$ = 35.957, p < 0.001, indicating that metacognitive awareness is also a positive predictor of the students' control of learning beliefs, (β =0.447, $t_{(1, 145)}$ =5.996). The coefficient determination R^2 = 0.200 means that about 20 % of the variance in the task respondent's control of learning beliefs is explained or accounted for by their metacognitive awareness. Moreover, metacognitive awareness and self-efficacy model is significant, R^2 = 0.229, Adjusted R^2 = 0.224, $F_{(1,1445)}$ = 42.778, p < 0.001, which denoted that metacognitive awareness is a positive predictor of the students' self-efficacy, β =0.479, $t_{(1, 145)}$ =6.541). The metacognitive awareness of the respondents explains 22.9% of the variance in students' self-efficacy. Finally, a significant model was also found on metacognition and test anxiety, R^2 = 0.319, Adjusted R^2 = 0.102, $F_{(1,1445)}$ = 16.318, p < 0.001, which states that metacognitive awareness is a negative predictor of test anxiety, (β =-0.319, $t_{(1, 145)}$ -4.040,p<0.001). The metacognitive awareness of the respondents explains

31.9 % of the variance in respondents' test anxiety. These findings indicate that all of the respondents' motivational beliefs satisfied the second condition.

The third condition examines the possible mediator (components of motivational beliefs) that predicts the dependent variable (mathematics performance). Since the respondent's metacognitive awareness was found to be significant with all of the motivational components, all of the effects of these variables were tested. A series of simple linear regression was conducted to determine whether the components of motivational beliefs predict mathematics performance. Results shows that the model is significant with extrinsic goal orientation and mathematics performance, $R^2 = 0.107$, Adjusted $R^2 = 0.100$, $F_{(1,1445)} = 17.170$, $p < 0.001$, indicating that extrinsic goal orientation is a positive predictor of mathematics performance, ($\beta = 0.326$, $t_{(1,145)} = 4.144$). The extrinsic goal orientation explains only 10 % of the variance in the respondents' mathematics performance. Also, the model for task value and mathematics performance is significant, $R^2 = 0.029$, Adjusted $R^2 = 0.022$, $F_{(1,1445)} = 4.299$, $p = 0.040$, indicating that task value of the respondents is a positive predictor of mathematics performance, ($\beta = 0.170$, $t_{(1,145)} = 2.074$). The task value beliefs of the respondents explain only 2.9% of the variance in mathematics performance. Hence, extrinsic goal orientation and task value satisfied the condition and tested for the mediating effects.

The last condition implies that the mediation is supported if the mediating variable's effect remains significant when regressed with the independent variable. Also, it must be satisfied that the predictor's effect on the dependent variable must be less when regressed with the mediator than regressed without it. A multiple regression analysis was conducted to determine the possible mediators of mathematics performance. Results show that the model is significant, $R^2 = 0.155$, Adjusted $R^2 = 0.144$, $F_{(1,1445)} = 22.76$, $p < 0.001$. Mathematics performance was significantly predicted by extrinsic goal orientation ($\beta = 0.169$, $t_{(1,145)} = 1.789$) when extrinsic goal orientation was regressed with metacognitive awareness. This result supports the mediation hypothesis.

Table 4. Multiple Regression Analysis

Step	Independent Variables	Mathematics Performance				
		R^2	Adjusted R^2	*t*	β	Sig
1	Metacognitive Awareness	0.155	0.144	2.876	0.271	0.005
	Extrinsic Goal Orientation			1.789	0.169	0.046
1	Metacognitive Awareness	0.137	0.125	4.222	0.376	0.000
	Task Value			-0.150	-0.013	0.881

However, task value is not a significant predictor of mathematic performance when regressed with metacognitive awareness. Furthermore, the effect of metacognitive awareness on mathematics performance was significant when regressed with extrinsic goal orientation ($\beta = 0.271$, $t_{(1,145)} = 2.876$, $p < 0.01$). A reduced absolute size was also found on the effect of metacognitive awareness on mathematics performance when regressed with extrinsic goal orientation. Hence, partial mediation of extrinsic goal orientation was found on the relationship between metacognitive awareness and mathematics performance. Approximately 15.5% of the variance in the mathematics performance was accounted for by the predictors. Figure 1 shows the summary of the regression analysis.

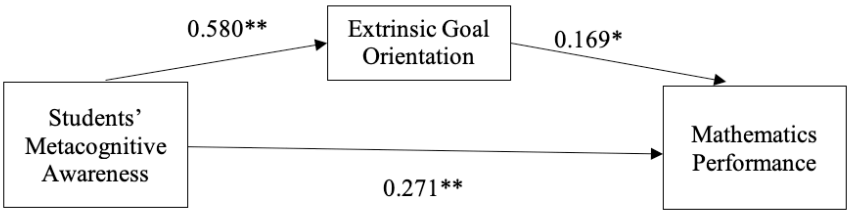

Figure 1. Extrinsic Goal Orientation as mediator between Metacognitive Awareness and Mathematics Performance

Discussion

As the study quested to describe the respondents' metacognition, findings revealed that the respondents have above average metacognition. Students with above-average metacognition have shown concentrated attention, research intentionally, make study plans, correctly measure their results, and ask questions to ensure comprehension (Sperling, Miller & Murphy, 2002). This also indicates that the respondents are highly aware of how they think. Students with high metacognition are aware of their knowledge of the task, subject, thinking, and self-management consciousness of associated cognitive responses. Meanwhile, findings also found that the students have above the average mean in terms of the motivational beliefs components. Also, the students have below average test anxiety. This result indicates that the respondents are not highly test-anxious. Test anxiety occurs among learners if they experience substantial disagreement between their current behaviors and their progress on their desired goal (Carver & Scheir, 1991). Findings also showed that the respondents have very good mathematics performance. Their good mathematics performance revealed that they can perform mathematics tasks for the first quarter.

A significant positive correlation was found on metacognitive awareness and extrinsic goal orientation with respondents' mathematics performance. Also, task value and test anxiety were related to mathematics performance. These findings indicate that students with high metacognition tend to have high mathematics performance. This result is similar to Young and Fry (2008), which revealed that if the students have well-developed metacognition, they will excel academically. Extrinsic goal orientation is also highly correlated with mathematics performance. This implies that students who are externally goal-orientated tend to have high mathematics performance. Students who are predominantly motivated by external factors such as having high grades, comparing with others, seeking recognition or rewards in mathematics studies tend to have high success in mathematics. Task value beliefs are also related to mathematics performance. This indicates that students' perceptions of the attractiveness of a particular task or content in mathematics class are related to their mathematics performance.

The foremost aim of this study was to examine the mediating effects of motivational beliefs between the relationship of metacognitive awareness and mathematics performance. A series of regression analyses using Baron and Kenny's (1986) approach was utilized to determine the mediation effect of the motivational components. The overall results of regression analysis provide evidence of the partial mediation effect of extrinsic goal orientation on the relationship between metacognitive awareness and mathematics performance. Partial mediation is seen as the metacognitive awareness that has both direct and indirect effects on mathematics performance. This result indicates that external goal orientation plays an important role in metacognitive awareness and mathematics performance. Extrinsic goal

orientation causes changes in both metacognition and mathematics performance. These results also emphasize that teachers should consider the extrinsic goal orientation of students in mathematics subject which is useful to adopt metacognition more actively and effectively. These findings contradict the study that metacognitive knowledge exerted its effect on mathematics performance through the indirect mediating effect of self-efficacy and intrinsic motivation (Tian, Fang, & Li, 2018). The study found that extrinsic goal orientation do not mediate metacognition and mathematics performance. Similarly, Eklides (2011) demonstrate that self-efficacy is the complexly linked with metacognition. Moreover, the study also found that metacognitive experience has a direct effect on mathematical problem-solving performance (Ozcan, 2016). Lai, Zhu, Chen, and Li's (2015) study indicated that anxiety in mathematics has an adverse impact on mathematical problem solving through metacognition. The only non-cognitive construct that had a direct influence on mathematical problem-solving success was metacognitive activity; it also mediated the effects of self-efficacy, motivation, and performance anxiety in mathematics. Motivation and anxiety in mathematics have had an indirect effect on the performance of mathematical problem solving through self-efficacy (Ozcan & Gumus, 2019). Also this result suggested that external goal-orientation should be taken into consideration as it has direct and indirect effect on mathematics performance.

Conclusion

The findings of this study shows the crucial role of metacognition and motivational beliefs among students' mathematics performance. It is therefore recommended that teachers plan activities in which students can develop their awareness and reflect on their thoughts. It is suggested that teachers use educational strategies including providing explicit instruction in both metacognitive regulation and metacognitive knowledge, and activities that make student beliefs and conceptions visible to support metacognition. It is also suggested that teachers implement strategic practices that improve their skills academically and improve some of their affective attributes. It is important that every students must develop holistically. Mathematics teachers should implement teaching strategies that will strengthen the students' performance. Mathematics teachers should provide activities and learning tasks to assist their students in a deeper understanding of mathematics concepts. With these results, it can be noted that the following construct are crucial in mathematics class. The results suggested that the following construct needs to strengthen inside the mathematics classroom associated with mathematics performance. Teachers should provide appropriate learning experiences that might help in improving mathematics performance. The result of this study were gathered based on the Baron and Kenny (1986) approach of testing the mediation. This approach has dominated the mediation analysis within social science research. However, experts argued that this strategy holds many limitations. Therefore, the relationships indicated in this paper need to be tested and further studies with more enormous or disparate samples need to be carried out. In addition, the study's findings should not be generalized due to the limited scope of the study. The students who are involved in this study may not represent all the adult learners as this was also limited to mathematics class. Finally, additional variables which were not included in this study may confuse the associations between various variables using different measures within this study. With the following results, the future researchers are advised to make further related research to affirm the findings of this study.

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