METACOGNITIVE AWARENESS AND MATHEMATICS ANXIETY OF GRADE 10 STUDENTS I[1]N MEIKHTILA TOWNSHIP

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Abstract

The main aim of this study was to investigate metacognitive awareness and mathematics anxiety of Grade 10 students in Meikhtila Township. Participants were 994 students from eight schools in Meikhtila Township. The descriptive research design and quantitative survey method were used. In this study, Metacognitive Awareness Inventory (MAI) consisting of 44 items (r=0.881) was used to measure the metacognitive awareness of the students. The inventory contained eight dimensions; declarative knowledge, procedural knowledge, conditional knowledge, planning, information management strategies, comprehension monitoring, debugging strategies and evaluation. And, the next instrument, Mathematics Anxiety Rating Scale developed by Sharia et al. (2015) was used to measure mathematics anxiety of students. It includes 26 items (r=0.879) and consists of two dimensions; cognitive dimension, the worry component and affective dimension, the emotional component. The result of *t* test showed that there was a significant difference in metacognitive awareness by gender. The metacognitive awareness of female students was higher than that of male students. The result also showed that there was no significant difference in metacognitive awareness by subject combination. The ANOVA result revealed that there were significant differences in metacognitive awareness by schools. Besides, there was no significant difference in mathematics anxiety by gender and by subject combination. As the ANOVA result, there were significant differences in mathematics anxiety between school 2 and school 3, between school 2 and school 4, and between school 3 and school 7. According to the Pearson product-moment correlation, there was a significant negative correlation between metacognitive awareness and mathematics anxiety of Grade 10 students ($r = -.162$, $p < .01$). Thus, it can be concluded that the higher level of students' metacognitive awareness, the lower level of their mathematics anxiety.

Keywords: Metacognition, Metacognitive Awareness, Mathematics Anxiety

Introduction

Importance of the Study

There is a growing evidence that metacognition is an important component of intelligence and cognition as well as a major influence on academic success (Panaoura, 2005). Metacognition has been one of the most concentrated concepts in the field of psychology. It has long been an important area of research that has had growing numbers of applications within education (Erickson, 2015). Mathematics anxiety has been the focus of much psychological and educational research in the past few years. Math anxiety is a real issue that can impact a young person's goals, many career-related decisions they may make in life and their overall future. Metacognitive training has been shown to be a very effective method which can overcome mathematics problem-solving difficulties and rather, can lead to a lesser impact of mathematics anxiety on performance (Legg, 2009).

Metacognition plays an important role in education because it helps learner to be capable of developing a plan, monitoring and evaluating how much it's effective that means metacognition helps the learner to be more involved in learning process (Costa & Kallic, 2001, cited in Abdellah R, 2015). In addition, it can guide cognitive processes which are crucial in learning setting through a deliberate and conscious memory search.

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In addition, it is important for adolescents to be aware of their strengths and limitations as learners. As they are not usually aware of the limitations of their knowledge, this lack of awareness is likely to present difficulties for them in effecting monitoring and regulating school tasks. Success of metacognitive awareness affects students' academic performance as well as their ability to communicate what they know about a particular problem. Being able to communicate their level of understanding to instructors is crucial to the learning process (Erickson, 2015).

Metacognition is of importance to academic performance, problem solving and student learning. Although students who are utilizing metacognitive skills can easily recall and use their past knowledge to challenging problems, on the other hand individuals with anxiety have difficulty storing and retrieving information (Nelson & Harwood, 2011, cited in Saricam & Ogurlu, 2015).

For all age groups, metacognitive awareness is crucial for efficient independent learning, because it fosters forethought and self-reflection. Good metacognitive thinkers are also good intentional learners. That is, they are able to direct their learning in the proper ways to build understanding. They know when to use strategies and how to use them. They are able to redirect the normal frustration that occurs when things are confusing or are not initially productive into further learning and research strategies. They are able to control their academic stresses that occur due to their teachers, peers, exams, results, and self-inflicted. Although metacognitive awareness has a positive influence on learning, math anxiety has a negative effect on academic performance.

Students' anxiety in response to mathematics is a significant concern for educators in terms of the perception that high anxiety will relate to avoidance of mathematics. Mathematics is an importance subject in school curriculum in every country. It has been taught so that children can understand the numerical data presented to them, and able to perform simple and complex calculations in day-to-day encounters. It is also common belief among students that mathematics is a hard subject and difficult to learn. In mathematics education, many researchers propose innovative ways of teaching, linking concept and real-life applications and motivating the students to take more interest in the subject to overcome mathematics phobia. To improve students' mathematics ability, decreasing their anxiety can also affect in their academic performance (Hemmings, Grootenboer, & Kay, 2011, cited in Mutawah, 2015).

Mathematics anxiety can also affect students' motivation to learn in mathematics classes. It is related to student's feeling, tense or anxious when working with numbers or solving mathematical problems. It can be found in all ages, from pre-school to graduate students and beyond. Defined as feelings of tension and anxiety that interfere with the solution process and manipulation of mathematical problems in a wide variety of real-life applications, academic and non-academic situations, math anxiety may be manifested in both cognitive and effective processes; and it has been linked negatively to various indices of success and to detrimental effects on future career and professional development (Elbedour, 2018).

Math anxiety can negatively impact cognition in a variety of ways. Thus, it is necessary to reduce math anxiety in classroom setting. However, awareness of metacognitive knowledge helps individuals to solve mathematical problems effectively and decrease their anxiety (Homayouni & Alvai, 2012).

Thus, the present study emphasizes on investigating the relationship between metacognitive awareness and mathematics anxiety of Grade 10 students. The result will provide useful information for improving mathematics skills.

Purpose of the Study

The main aim of this study was to investigate metacognitive awareness and mathematics anxiety of Grade 10 students in Meikhtila Township. The specific objectives are as follows;

(1) To explore metacognitive awareness of Grade 10 students by gender, subject combination and schools
(2) To examine mathematics anxiety of Grade 10 students by gender, subject combination and schools
(3) To find out the relationship between metacognitive awareness and mathematics anxiety of Grade 10 students

Definitions of Key Terms

Metacognition **:** Metacognition is the ability to reflect upon, understand and control one's learning (Schraw & Dennison, 1994).

Metacognitive Awareness : Metacognitive awareness is defined as all learning processes and behavior involving any degree of reflection, learning strategies selection, and intentional mental processing that can result in a student's improved ability to learn (Conley, 2014).

Mathematics Anxiety **:** Mathematics anxiety is defined as a feeling of tension, apprehension, or fear that interferes with Mathematics performance (Ashcraft, 2002).

Related Literature

Meaning and Nature of Metacognitive Awareness

The essence of metacognition is awareness of how individuals acquire knowledge, and how to control the process in acquire knowledge (Schraw & Dennison, 1994). Metacognitive awareness refers to feelings and experiences we have when engaging in cognitive process (Flavell, 1979). Dr. David Conely (2014) also defined metacognitive awareness as all learning processes and behavior involving any degree of reflection, learning strategies selection, and intentional mental processing that can result in a student's improved ability to learn.

Metacognitive awarenessrelates to an individual's awareness of where they are in the learning process, their knowledge about content knowledge, personal learning strategies, and what has been done and needs to be done (Wilson, 1999). It also relates to individuals' awareness of where they are in the learning process or in the process of solving a problem, of their content specific knowledge, and of their knowledge about their personal learning or problem solving strategies. It also includes their knowledge of what needs to be done, what has been done, and what might be done in particular learning contexts or problem solving situations. Metacognitive awareness encompasses an individual's cumulative knowledge of acquired competencies and on-going knowledge of mental processes in progress.

Schraw & Dennison (1994) defined metacognitive awareness as the ability to reflect upon, understand, and control one's learning. Their account divides metacognitive awareness into

two components, which themselves further divide into subcomponents. The first component of metacognitive awareness is knowledge of cognition, which includes three sub-components that facilitate the reflective aspects of metacognition; declarative knowledge, procedural knowledge and conditional knowledge. The second component, regulation of cognition, includes five sub-components that facilitate the control aspect of learning. Five component skills of regulation have been discussed extensively, including planning, information management strategies, comprehension monitoring, debugging strategies, and evaluation (Baker, 1989, cited in Schraw & Dennison, 1994).

Knowledge about Cognition

Knowledge about cognition is how learners know about themselves as learners, and about their own ability to use appropriate strategies to achieve their goals (Schraw & Dennison, 1994).

(1) **Declarative knowledge*;*** It is how learners know about themselves as a learner, about their own weaknesses and strengths, and about their relationships with the tasks that they want to accomplish, such as learning or problem solving.
(2) **Procedural knowledge*;*** It is to know how and what strategies learners can use to accomplish their tasks.
(3) **Conditional knowledge;** It is to know when and under what conditions learners can use a particular strategy to achieve their goals (Schraw & Dennison, 1994).

Regulation about Cognition

Regulation about cognition is to control the cognition in terms of planning, implementation and evaluation (Schraw & Dennison, 1994).

(1) **Planning;**It is to set goals and allocate resources before beginning the task.
(2) **Information Management Strategies;** It includes skills to process information, such as organizing, elaborating etc.
(3) **Comprehension Monitoring**; It entails assessing one's comprehension and learning process, whether the reading materials make sense or not.
(4) **Debugging Strategies;** It is to look for help when encountering difficulties.
(5) **Evaluation;** It is to assess oneself to see whether he or she has accomplished his/her jobs (Schraw and Dennison, 1994).

Two-factor Theory of Mathematics Anxiety

In spite of the many theories concerning mathematics anxiety, the researcher used the two-factor theory of mathematics anxiety.

Mathematics is also a gateway to engineering, scientific and technological fields (Mahmood, 2011, cited in Shaira et al., 2015). Mathematics, either can be a major subject or a minor subject to college students significantly gives anxiety especially in school (academic setting) when doing activities such as home works, board works in a class discussion and seat works after a series of lessons in Mathematics. Mathematics is a subject which elicits many different attitudes and feelings. Among these attitudes are general feelings towards the subject, such as liking or enjoyment, and more specific attitudes such as confidence and anxiety.

As anxiety and mathematics have been combined to for a one construct which what we call mathematics anxiety, we can simply define that this mathematics anxiety often leads to avoidance of math by those who experience it and it is noticeable that students who are anxious,

bored and fearful towards math or who do not comprehend the importance of math in professional and personal life are the once most likely to avoid the study of math. Math Anxiety is found to have a no single underlying theory. There is a noticeable lack of any clear theoretical basis for mathematics anxiety, in either the research or the treatment literature. Parallel to this, there also no single and fixed definition that could describe Math Anxiety. However, considerations to these many applicable theories lead the researchers to define mathematics anxiety with two dimensions; cognitive and affect.

Test anxiety and mathematics anxiety were among the different types of anxiety being studied in the 1950's and since that time mathematics anxiety research has grown in parallel with, although lagging slightly behind, research in the field of test anxiety. In spite of an apparently close relationship between mathematics anxiety and test anxiety there has been less cross-fertilization between these two fields than would be expected. Libert and Morris (1967, cited in Shaira et al., 2015) were first to propose a two-factor model of test anxiety that distinguished between an affective "emotionality" and a cognitive worry dimension of test anxiety. According to Richardson and Suinn (1972), feelings of tension and anxiety interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations.

Liebert and Morris (1967, cited in Shaira et al., 2015) distinguished two components of mathematics anxiety; affective and cognitive. Affective anxiety refers to the emotional component of anxiety, feelings of nervousness, tension, dread, fear, and unpleasant physiological reactions to testing situations. Cognitive anxiety refers to the worry component of anxiety, which often displayed through negative expectation, preoccupation with and self-deprecatory thoughts about an anxiety-causing situation.

Major Causes of Mathematics Anxiety

Many students claim not to like math. But for some, the issue with math is more than simply disliking algebra or fractions. For some students, doing math can cause negative emotions like fear of failure. This harms their ability to perform. This is called mathematics anxiety.

(1) Parent's Role

(2) Teacher's Role

(3) Classroom Experience

(4) Attitude on Performance

Sample of the Study

The participants used for this study were Grade 10 students from Meikhtila Township. By using simple random sampling technique, the students were selected as the sample from eight high schools. The total of the students were 994 from the selected schools.

Table 1 Number of the Students for the Selected Schools in Meikhtila Township

No.	School	Subject Combination	Number of Students		Total
			Male	Female	
1.	B.E.H.S (1)	Combination-1	21	18	39
		Combination-7	57	58	115
2.	B.E.H.S (2)	Combination-1	30	28	58
		Combination-7	29	27	56
3.	B.E.H.S (3)	Combination-1	28	24	52
		Combination-7	25	31	56
4.	B.E.H.S (4)	Combination-1	56	63	119
		Combination-7	20	23	43
5.	B.E.H.S (5)	Combination-1	36	50	86
		Combination-7	23	38	61
6.	B.E.H.S, Taw Ma	Combination-1	30	28	58
		Combination-7	26	29	55
7.	B.E.H.S, Ye Wai	Combination-1	25	25	50
		Combination-7	28	28	56
8.	B.E.H.S, Chi Sat	Combination-1	25	16	41
		Combination-7	24	25	49
Total			483	511	994

Male = 483, Female = 511
Combination 1= 503, Combination 7= 491
Combination 1 = Myanmar, English, Mathematics, Chemistry, Physics, Economics
Combination 7 = Myanmar, English, Mathematics, Chemistry, Physics, Biology

Research Design and Method

The descriptive research design and quantitative survey method were used in this study.

Instrumentation

In this study, the researcher used two instruments to investigate metacognitive awareness and mathematics anxiety of Grade 10 students in Meikhtila Township. To examine metacognitive awareness of students, Metacognitive Awareness Inventory (MAI) developed by Schraw and Dennison (1994) was used. To measure mathematics anxiety of students, the research used Mathematics Anxiety Rating Scale developed by Sharia et al. (2015).

Metacognitive Awareness Inventory (MAI) originally consists of 52 items and is divided into eight subscales. After conducting pilot test, some items were repaired and defeated to get higher Cronbach's alpha and so 44 items remain in Metacognitive Awareness Inventory. Mathematics Anxiety Rating Scale includes 30 items and is divided into two dimensions. After pilot testing, there were 26 items in this questionnaire. Cronbach's alpha reliability coefficients were 0.881 for metacognitive awareness questionnaire and 0.879 for mathematics anxiety questionnaire respectively.

Data Analysis and Finding

The main purpose of the present study was to investigate metacognitive awareness and mathematics anxiety of Grade 10 students in Meikhtila Township. By using the statistical analyses, findings and results were presented in this section.

1. Metacognitive Awareness of Grade 10 Students

Descriptive statistics were used for mean, standard deviation, minimum and maximum scores of metacognitive awareness of Grade 10 students. The result can be seen in Table 2.

Table 2 Descriptive Statistics for Metacognitive Awareness

Variable	*N*	Minimum	Maximum	Mean	*SD*
Metacognitive Awareness	994	77	171	130.20	14.51

According to the result, the minimum and maximum scores were 77 and 171 respectively. The value of standard deviation was 14.51. The value of mean score was 130.20 and higher than the theoretical mean score 110. So, it may be said that metacognitive awareness of most students was satisfactory to some extent.

Mean and standard deviation for metacognitive awareness of Grade 10 students by gender were reported in Table 3. The mean score of female students was higher than that of male students in metacognitive awareness.

Table 3 Descriptive Statistics of Metacognitive Awareness by Gender

Variable	Gender	*N*	Mean	*SD*
Metacognitive Awareness	Male	484	127.74	14.24
	Female	510	132.54	14.39

The result showed that there were differences in metacognitive awareness according to gender. To make sure these differences, independent sample *t* test was conducted.

Table 4 The Result of Independent Sample *t* test on Metacognitive Awareness by Gender

Variable	Gender	*N*	*t*	*df*	*p*	Mean difference
Metacognitive Awareness	Male	484	**-5.287*** **	992	**.000**	-4.804
	Female	510				

*****p<.001*

As the result, there was a significant difference between male and female students in metacognitive awareness at 0.001 level.

Again, descriptive statistics were used for mean percentage and standard deviation for each dimension of metacognitive awareness by gender.

Table 5 Descriptive Statistics for Each Dimension of Metacognitive Awareness by Gender

Variables	Gender	*N*	Mean%	*SD*
Declarative Knowledge	Male	484	73.50	10.19
	Female	510	75.08	9.13
Procedural Knowledge	Male	484	72.72	10.28
	Female	510	74.68	9.65
Conditional Knowledge	Male	484	74.65	10.73
	Female	510	76.80	10.89
Planning	Male	484	73.79	11.47
	Female	510	75.50	11.51
Information Management Strategies	Male	484	71.33	10.29
	Female	510	74.19	10.50

Variables	Gender	*N*	Mean%	*SD*
Comprehension Monitoring	Male	484	71.73	11.24
	Female	510	74.95	10.27
Debugging Strategies	Male	484	74.16	11.41
	Female	510	78.76	11.03
Evaluation	Male	484	71.19	11.14
	Female	510	75.00	10.98

According to the result, the mean score of male students was highest in conditional knowledge and lowest in evaluation dimension. For female students, the mean score was highest in debugging strategies and lowest in information management strategies.

To know whether the two groups were significantly different or not, independent sample *t* test was computed.

Table 6 The Result of Independent Sample *t* test on Dimensions of Metacognitive Awareness by Gender

Variables	Gender	*N*	*t*	*df*	*p*	*MD*
Declarative Knowledge	Male	484	**-2.582****	992	**0.010**	-1.58
	Female	510				
Procedural Knowledge	Male	484	**-3.090****	992	**0.002**	-1.95
	Female	510				
Conditional Knowledge	Male	484	**-3.142****	992	**0.002**	-2.16
	Female	510				
Planning	Male	484	**-2.352***	992	**0.019**	-1.71
	Female	510				
Information Management Strategies	Male	484	**4.333*****	992	**0.000**	-2.86
	Female	510				
Comprehension Monitoring	Male	484	**4.726*****	992	**0.000**	-3.22
	Female	510				
Debugging Strategies	Male	484	**6.461*****	992	**0.000**	-4.60
	Female	510				
Evaluation	Male	484	**5.433*****	992	**0.000**	-3.81
	Female	510				

**p<.05, **p<.01, ***p<.001*

According to the result, there was a significant difference in all dimensions between male and female students. The mean scores of females were significantly higher than that of males in all dimensions.

To find the differences in metacognitive awareness of the students by subject combination, descriptive statistics was conducted.

Table 7 Descriptive Statistics of Metacognitive Awareness by Subject Combination

Variable	Subject Combination	*N*	Mean	*SD*
Metacognitive Awareness	Combination 1	503	129.36	14.16
	Combination 7	491	131.06	14.83

Combination 1 = Myanmar, English, Mathematics, Chemistry, Physics, Economic
Combination 7 = Myanmar, English, Mathematics, Chemistry, Physics, Biology

To know whether the two groups varied significantly, independent sample *t* test was computed.

Table 8 The Result of Independent Sample *t* test on Metacognitive Awareness by Subject Combination

Variable	Subject Combination	*N*	*t*	*df*	*p*	*MD*
Metacognitive Awareness	Combination 1	503	**-1.855**	992	**0.064**	-1.705
	Combination 7	491				

According to the *t* test result, there was no significant difference in metacognitive awareness by subject combination.

Next, mean and standard deviation for metacognitive awareness of Grade 10 students by schools were presented in Table 9. The mean score of students from school 7 was highest and that of students from school 8 was lowest among all schools.

Table 9 Descriptive Statistics of Metacognitive Awareness by Schools

Variable	School	*N*	Mean	*SD*
Metacognitive Awareness	School 1	154	127.95	14.84
	School 2	114	130.33	15.81
	School 3	108	133.46	13.93
	School 4	162	132.05	15.35
	School 5	147	127.67	12.73
	School 6	113	127.88	10.57
	School 7	106	138.24	13.66
	School 8	90	124.23	14.48

To know whether these differences in mean scores were statistically or not, one-way analysis of variance (ANOVA) was conducted.

Table 10 ANOVA Results for Metacognitive Awareness by Schools

Variable	Region of Group	Sum of Square	*df*	Mean Square	*F*	*P*
Metacognitive Awareness	Between Groups	14089.649	7	2012.807	10.176***	.000
	Within Groups	195033.510	986	197.803		
	Total	209123.160	993			

***p<.001

According to the ANOVA result, there was a significant difference in metacognitive awareness by schools.

Then, to find out the mean comparison in metacognitive awareness of students by schools specifically, Post-Hoc test was computed by Tukey HSD method and students' metacognitive awareness were interpreted by using the multiple comparison method. (See Table 11)

Table 11 Result of Tukey HSD Multiple Comparison for Metacognitive Awareness by Schools

(I)School	(J)School	Mean Difference (I-J)	P
School 3	School 1	**5.515***	**.048**
	School 5	**5.796***	**.018**
	School 6	**5.587***	**.021**
	School 8	**9.230*****	**.000**
School 4	School 8	**7.816****	**.002**
School 7	School 1	**10.288*****	**.000**
	School 2	**7.903****	**.002**
	School 4	**6.186***	**.015**
	School 5	**10.596*****	**.000**
	School 6	**10.360*****	**.000**
	School 8	**14.003*****	**.000**

**p<.05, **p<.01, ***p<.001*

According to the result, there was a significantly difference in metacognitive awareness by schools. This might be due to the fact that schools differ depending on the instructional strategies, learning environments and learning styles of the students.

2. Mathematics Anxiety of Grade 10 Students

Descriptive statistics were used for mean, standard deviation, minimum and maximum scores of mathematics anxiety of Grade 10 students. The result can be seen in Table 12.

Table 12 Descriptive Statistics for Mathematics Anxiety

Variables	No of Items	Mini	Maxi	Mean	Mean %	*SD*
Cognitive	14	14	56	36.17	64.62	13.86
Affective	12	12	48	30.46	63.51	12.66
Overall Mathematics Anxiety	**26**	**28**	**104**	**66.63**	**66.63**	**12.95**

According to the result, the minimum and maximum scores of mathematics anxiety were 28 and 104 respectively. The value of standard deviation was 12.95. The value of mean score was 66.63 and higher than the theoretical mean score 65.

Mean and standard deviation for mathematics anxiety of Grade 10 students by gender were reported in Table 13. The mean score of female students was higher than that of male students in mathematics anxiety.

Table 13 Descriptive Statistics of Mathematics Anxiety by Gender

Variables	Gender	*N*	Mean	*SD*
Cognitive	Male	484	64.25	13.79
	Female	510	64.97	13.93
Affective	Male	484	63.63	12.81
	Female	510	63.40	12.52
Mathematics Anxiety	**Male**	**484**	**66.47**	**12.90**
	Female	**510**	**66.77**	**13.01**

The result showed that there were differences in mathematics anxiety according to gender. To make sure these differences, independent sample *t* test was conducted.

Table 14 The Result of Independent Sample *t* Test on Mathematics Anxiety by Gender

Variables	Gender	*N*	*t*	*df*	*p*	*MD*
Cognitive	Male	484	**-0.817**	992	**0.414**	-0.719
	Female	510				
Affective	Male	484	**0.284**	992	**0.284**	0.777
	Female	510				
Mathematics Anxiety	Male	484	**-0.372**	992	**0.710**	-0.306
	Female	510				

As the result, there was no significant difference between male and female students in mathematics anxiety and also in its dimensions. So, it might be said that mathematics anxiety was not influenced by gender, and both male and female students have the same level of mathematics anxiety.

Mean and standard deviation for mathematics anxiety of Grade 10 students by subject combination were reported in Table 15. The mean score of combination 1 students was higher than that of combination 7 students in mathematics anxiety and also in its two dimensions.

Table 15 Descriptive Statistics of Mathematics Anxiety by Subject Combination

Variables	Subject Combination	*N*	Mean	*SD*
Cognitive	Combination 1	503	65.49	13.54
	Combination 7	491	63.73	14.14
Affective	Combination 1	503	64.13	11.93
	Combination 7	491	62.87	13.34
Overall Mathematics Anxiety	**Combination 1**	**503**	**67.41**	**12.31**
	Combination 7	**491**	**65.82**	**13.54**

To know whether the two groups significantly varied or not, independent sample *t* test was computed.

Table 16 The Result of Independent Sample *t* test on Mathematics Anxiety by Subject Combination

Variables	Subject Combination	*N*	*t*	*df*	*p*	*MD*
Cognitive	Combination 1	503	**2.007***	992	**0.045**	1.762
	Combination 7	491				
Affective	Combination 1	503	1.565	992	0.118	1.255
	Combination 7	491				
Overall Mathematics Anxiety	**Combination 1**	**503**	**1.944**	**992**	**0.052**	**1.595**
	Combination 7	491				

**p<.05*

According to the result, there was no significant difference in mathematics anxiety and affective dimension, but there was a significant difference in cognitive dimension according to subject combinationat 0.05 level.

And finally, mean and standard deviation of mathematics anxiety by schools were reported in Table 17. Students from school 2 had highest mathematics anxiety level and students from school 7 had lowest mathematics anxiety level.

Table 17 Descriptive Statistics for Mathematics Anxiety by Schools

Variable	School	*N*	Mean	*SD*
Mathematics Anxiety	School 1	154	66.34	12.90
	School 2	114	70.54	13.38
	School 3	108	65.16	12.31
	School 4	162	64.83	14.80
	School 5	147	67.24	12.70
	School 6	113	67.74	6.29
	School 7	106	64.51	12.42
	School 8	90	67.24	13.69

To know whether these differences in mean scores were statistically significant or not, one-way analysis of variance (ANOVA) was conducted.

Table 18 ANOVA Results for Mathematics Anxiety by Schools

Variable	Region of Group	Sum of Square	*df*	Mean Square	*F*	*P*
Mathematics Anxiety	Between Groups	3213.818	7	459.117	2.779**	0.007
	Within Groups	163276.962	986	165.595		
	Total	166490.781	993			

**p<.01

According to the result, there was a significant difference in mathematics anxiety by schools. To find out the mean comparison in mathematics anxiety of students by schools specifically, Post-Hoc test was computed by Tukey HSD method and students' mathematics anxiety was interpreted by using the multiple comparison method.

Table 19 Result of Tukey HSD Multiple Comparison for Mathematics Anxiety by Schools

(I)School	(J)School	Mean Difference (I-J)	*P*
School 2	School 3	5.378*	.042
	School 4	5.702*	.022
	School 7	6.026*	.015

*p<.05

According to the result, there was a significant difference in mathematics anxiety by schools. This may be due to teaching styles, teachers' strategies, classroom size and parents' aspirations of the students concerning mathematics.

3. Relationship Between Metacognitive Awareness and Mathematics Anxiety of Grade 10 Students in Meikhtila Township

In order to find out whether there was a significant association between students' metacognitive awareness and their mathematics anxiety or not, Pearson product-moment correlation was conducted. The relationship between metacognitive awareness and mathematics anxiety was shown in Table 20.

Table 20 Correlation Matrix Between Metacognitive Awareness and Mathematics Anxiety of Grade 10 Students

Variables	Mathematics Anxiety
Metacognitive Awareness	-.162**

Note: **Correlation is significant at the 0.01 level (2-tailed).

According to the result, there was a statistically significant negative correlation between metacognitive awareness and mathematics anxiety (r = -.162, p< 0.01). This result is consistent with the previous research of Tableb & Hoofar (2014) in which metacognitive awareness is negatively correlated with mathematics anxiety (r =-.48, p< 0.001). Besides, this result is also consistence with the research of Saricam & Ogurlu (2015), in which there was negative significant relationship between metacognitive awareness and mathematics anxiety (r = -.47, p>0.01). So, it can be interpreted that the higher metacognitive awareness level of the students, the lower mathematics anxiety level. Besides, the dimensions of metacognitive awareness were negatively related with those of mathematics anxiety.

Conclusion, Discussion and Recommendation

The main purpose of this research was to investigate metacognitive awareness and mathematics anxiety of Grade 10 students in Meikhtila Township. Moreover, the researcher investigated whether there was a significant difference between metacognitive awareness and mathematics anxiety or not.

Metacognitive Awareness by Gender: In the comparison of metacognitive awareness between male and female students, the mean scores were 127.74 and 132.54 respectively and the mean score of female students was higher than that of male students. According to the independent sample *t* test result, there was a statistically significant difference between male and female students at 0.001 level. This might be due to the fact that female students want to get higher marks in academic subjects, want to compete each other in the classroom and can check their mistakes more than male students. And so, they are more careful in selecting their strategies suitable to achieve expected goals, more specific in planning, monitoring their academic progress than male students. Thus, the teacher should try to help male students to management their time effectively, to regulate their own behaviour to adapt to academic situations, to set academic goals, and to plan effectively for academic work.

Metacognitive Awareness by Subject Combination: After conducting the differences in metacognitive awareness by subject combinations, it was found that the mean score of combination 7 students was 131.06 and that of combination 1 students was 129.36. Hence, the mean score of combination 7 students is higher than that of combination 1 students. According to the independent sample *t* test result, there was no significant difference in metacognitive awareness by subject combinations. This might be because all students, whatever they take any combination, have the same level of metacognitive awareness about the lessons. Besides, it may be interpreted that students know their own abilities, try to understand the lessons and, can evaluate and get information after their activities whether they are combination 1 or combination 7 students. So, the teacher should assist students in developing their abilities to monitor and regulate their cognition. And, it was found that there was a significant difference only in information management strategies among all dimensions. So, it can be interpreted that that combination 1 students are weak in using which strategies are suitable to excepted goals to achieve. Thus, the students should be provided strategic questions which are designed to encourage students to think about which strategy might be appropriate for a given task and to provide a reason or rationale for that strategy choice.

Metacognitive Awareness by Schools: The descriptive statistics revealed that the mean score of students from school 2 was 138.24 and highest in all school. The mean score of students from

school 8 was 124.23 and lowest among all schools. The result of ANOVA showed that there were significant differences by schools concerning metacognitive awareness ($F=10.176$, $p<0.001$) at the 0.001 level. This mean that the metacognitive awareness of students differed by schools. And then, Post-Hoc test was again employed by Tukey HSD method and the students' metacognitive awareness were interpreted by using the multiple comparison method. The result showed that there were significant differences in all schools. This might be due to the fact that schools differ depending on the instructional strategies, learning environments and learning styles of the teachers. Teachers should design the conducive learning environments in which students can enjoy the learning process and produce better results.

Mathematics Anxiety by Gender: According to the descriptive result, the mean score of male students was 66.47 and that of female students was 66.77 in mathematics anxiety. The mean score of female students was slightly higher than that of male students. But, the independent sample *t* test result showed that there was so significant difference in mathematics anxiety by gender. Thus, it can be interpreted that both male and female students showed the same level of mathematics anxiety. Besides, it can be said that the students showed higher anxiety in worry component than in emotional component. To reduce the mathematics anxiety of students, the teacher should help them to plan their study habits, to manage their time effectively, and to try best for exam and academic results. As the mean score of male students was higher in affective dimension, the teacher should often make solving math problems on the board, asking math quiz, and sitting mathematics tests frequently to reduce their anxiety in testing situation.

Mathematics Anxiety by Subject Combination: The descriptive statistics showed that the mean score of combination 1 students was higher than that of combination 7 students in mathematics anxiety and in both dimensions. The independent sample *t* test result revealed that there was no significant difference in mathematics anxiety and affective dimension, but, there was a significant difference in cognitive dimension. Thus, it can be assumed that the mathematics anxiety of combination 1 students was significantly higher than combination 7 students in worry component. It may be because of the fact that mathematics is more complicated, more experiment and more difficult than other subjects like arts and it is solved by steps, and so combination 1 students have more anxiety in worry component than combination 7 students. Thus, the teacher should help combination 1 students to plan their study habits, to manage their time effectively, to try best for exam and academic results, to look for their weakness in the ways they learn.

Mathematics anxiety by Schools: According to the descriptive statistics, the mean score of students from school 2 was highest and that of students from school 7 was lowest among all schools. Again, to reveal the significant differences in mathematics anxiety of the schools, one-way analysis of variance (ANOVA) was computed. The result of ANOVA showed that there were significant differences by schools concerning mathematics anxiety ($F=2.78$, $p<0.01$) at the 0.01 level. This mean that the mathematics anxiety of students differed by schools. The result of Post-Hoc test showed that there were significant differences between school 2 and school 3, between school 2 and school 4, and between school 2 and school 7 at the 0.05 level. This may be due to teaching styles, teachers' strategies, and parents' aspirations of the students concerning mathematics. Students should be exposed to relevant instructional strategies to overcome the anxiety of the students.

The Relationship Between Metacognitive Awareness and Mathematics Anxiety of Grade 10 Students in Meikhtila Township: According to the Pearson product-moment correlation result, there was a significant negative correlation between metacognitive awareness and mathematics anxiety (r = - 0.16). This is consistent with the result of Tableb & Hoofar (2014) (r = -.48, p< 0.001) and also consistent with the previous research of Saricam & Ogurlu (2015) (r = -.47, p>0.01). So, it may be interpreted that the higher level of students' metacognitive awareness, the lower level of their mathematics anxiety and metacognitive awareness can moderate mathematics anxiety of students to some extent.

Based on the finding of the Pearson product moment correlation, the following suggestions and recommendations were drawn to improve metacognitive awareness and to reduce mathematics anxiety of Grade 10 students.

- Metacognition or awareness of the process of what thinking strategies to use and when, how and why to apply them is important both for teachers and for students, it is critical ingredient to successful learning.
- Teaching strategies of mathematics teachers should place an emphasis not on memorizing problem solving procedures but on developing students' thinking skills.
- Students should be taught to talk themselves through the activities they are engaged in, asking themselves or each other the questions a teacher would ask.
- The teacher should train the students with higher level of anxiety to use a checklist with entries for planning, monitoring and evaluation, with sub-questions included under each entry that needs to be addressed during the course of instruction to be more systematic and strategic during problem solving.
- For developing metacognitive behaviors, teachers should use paired problem solving method.
- The teacher should encourage students to keep a note on their thinking. Such notes are worth taking since they can reflect their thinking, their awareness of ambiguities and inconsistencies, and comment on how they have dealt with difficulties.
- Changing students' learning style from depending too much on teacher's instruction to self-monitoring and self-questioning is indispensable to make them self-regulated learners. Parents' participation in such effort is essential to achieve their goal.
- Students should be provided with sets of metacognitive questions, including comprehension questions designed to encourage students to reflect on a problem before solving it, strategic questions designed to encourage students to think about what strategy might be appropriate for a given task and to provide a reason for that strategy choice, and connection questions designed to encourage students to identify and recognize deep-structure task attributes so that they could activate relevant strategy, to be completed during the task.
- Students should be given the opportunity to observe skilled experts using the skills and should access to an experts' reflection on what he or she is doing and how well it is being done.
- Students should spend a sufficient amount of time applying the targeted skills to reduce their anxiety concerning mathematics.

- Students should be trained to become strong problem solvers because their anxiety may increase if they cannot solve a problem.
- Teachers should be aware of the needs and capabilities of the students with different mathematics anxiety levels when designing teaching strategies for them.
- The mathematics teachers should use effective teaching strategies in mathematics because this subject is a fundamental to an understanding of all science subjects.
- Finally, Students should be trained to have a habit of awareness about their cognition to reduce their anxiety.

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Reference

Abdellah, R. (2014). Metacognitive awareness and its relation to academic achievement and teaching performance of pre-service female teachers in Ajman University in UAE.*Journal of Social and Behavioral Sciences, 174, 560-567.*

Ashcraft, M. H. (2002). Math anxiety: personal, educational and cognitive consequences. *Current Directions in Psychological Science, 11 (5), 181-185.*

Conley, D. (2014). Metacognition and learning: strategies for instructional design. Available from http://theelearningcoach.com/learning/metacognition-and-learning/.

Elbedour, S. (2018). Math anxiety: Trends, issues and challenges. *Journal of Psychology and Clinical Psychiatry, Vol 9 (1).*Available from http://medcraveonline.com.

Erickson, S. L. (2015). Math anxiety and metacognition in mathematics education.*Doctoral Dissertation, University of California, Merced*.Retrieved from https://escholarship.org/uc/item/26w5j72t.

Flavell, J. (1979). Metacognition and cognitive monitoring: A new area of cognitive developmental inquiry. *American Psychology, 34 (10), 906-911.*

Homayouni, A. &Alvai, S. Z. (2012).Investigation the role of metacognitive processes and learning styles in mathematics anxiety.*Paper presented in World Conference on Design, Arts and Education, Antalya, Turkey.*

Legg, A. M. (2009). Metacognition moderates math anxiety and affects performance on a math task. *Electronic Theses & Dissertations. 428*. Available from http://digitalcommoms.georgiasouthern.edu/etd/428.

Mutawah, M. A. A. (2015). The influence of mathematics anxiety in middle and high school students math achievement. *International Education Studies; Vol. 8, No. 11;2015*.Retrieved from http:// dx. doi. org/ 10.5539/ies.v8n11p239.

Panaoura, A. (2005). Young pupils' metacognitive ability in mathematics.*European Research in Mathematics Education III.*

Richardson, F. C., &Suinn, R. M. (1972). The mathematics anxiety rating scale: psychometric data. *Journal of Counseling Psychology, Vol (19) 6, 551-554.*

Saricam, H. &Ogurlu, u. (2015). Metacognitive awareness and math anxiety in gifted students. Cypriot Journal of Educational Science, Vol 10, issued 4, 338-348. Retrieved from http://sproc.org/ojs/index.php/cjes/.

Schraw, G. & Dennison, R. (1994).Assessing metacognitive awareness.*Contemporary Educational Psychology, Vol 19, 460-475.*

Shaira et al. (2015).Development of math anxiety rating scale.Retrieved from http://www.academia.edu.

Siebers, W. M. (2015). The relationship between math anxiety and student achievement of middle school students.*Dissertation in partial fulfillment of the requirements For the Degree of Doctor of Philosophy.*

Wilson, J. (1999). Defining metacognition: a step towards recognizing metacognition as a worthwhile part of the curriculum.*Paper presented at the AAREConference, Melbourne.*