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Development and Validation of the Mathematics Attitude Scale (MAS) for High School Students in the Southern Philippines

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This study developed an instrument that measures the attitude of Filipino high school students towards mathematics, with reliable predictors and factors. Using the responses of 300 high school students from Zamboanga Sibugay, the validity and reliability of the Mathematics Attitude Scale (MAS) was tested using Exploratory Factor Analysis (EFA) and reliability analyses. The EFA showed that four-factor structures of the instrument, regarding the mathematics attitude for high school students, explained 27.48% of the variance in the pattern of relationships among the items. The Average Variance Extracted (AVE), Composite Reliability, and Cronbach's Alpha coefficients were reported. They proved that the extracted constructs have obtained and satisfied convergent validity. Thirty-three items remained in the final questionnaire after deleting the twenty-seven items with factor loadings of less than 0.4 (Students' Perceived Motivation and Support in Learning Mathematics: twelve items; Students' Perceived Anxiety in Learning Mathematics: ten items; Students' Perceived Self-Efficacy in Learning Mathematics: six items; and Teachers and Parents' Influences to Students in Learning Mathematics: five items). This study has confirmed the four-factor structure of the MAS. Educators and researchers can use the MAS to better understand the attitudes of Filipino high school students towards mathematics.

Key words: *Mathematics attitude scale, exploratory factor analysis, reliability analyses, construct validity.*

Introduction

Mathematics is a challenging and interesting subject. Mathematics teachers have the problem of learners' negative attitudes towards mathematics. Moreover, the declining interest in studying mathematics in university becomes more acute, generating a vicious circle (Holton, 2009). Several studies report different factors that lead to students' poor performance in mathematics. Tudy (2014) studied Filipino students, and discovered that only attitudes towards mathematics manifested significant influence to academic performance of the students. Students with a positive attitude towards the subject tend to perform well. Therefore, developing a positive attitude towards mathematics can improve the mathematics performance of students in the Philippines (Tudy, 2014).

Several studies show what affect students' attitudes towards mathematics. These factors are math-self efficacy, math anxiety, motivation, parental influences, effective teacher support, and classroom instruction (Vukovic et al., 2013; Kerr, 2007; Mahamood et al., 2012; Marchis, 2011; Sakiz et al., 2012; Reyes & Stanic, 1988; Singh et al. 2002; Chamman & Callingham, 2013). Teachers have the strongest impact on students' attitudes towards mathematics. Attitudes are not stable, and can vary in every teacher. Teachers who engage students in hands-on activities with real-world applications, who make students feel supported, who demonstrate passion for the subject, and who provide one-on-one attention have a positive effect on attitudes towards mathematics (Kelly D., 2011).

To improve students' attitudes towards mathematics, teachers employed different strategies. For instance, technology aided-instruction improved students' attitudes towards the subject (Choi et al., 2013). Even social networking sites helped improve students' performance. For instance, Gregory, Gregory & Eddy (2014) found that Facebook group participants are more engaged in mathematics. Using a drawing activity positive affects students' performance in mathematics (Arhin & Osei, 2013). The guided hyper-learning method was also effective (Fathurrohman et al., 2013). Walkington, Petrosino & Sherman (2013) discovered that context personalisation improves academic performance in mathematics. Nonetheless, the problem of low performance still emerges. One reason why students performed poorly in mathematics was their attitude towards the subject. Some research proved that the students' attitude strongly related to their academic performance (Parker et al., 2013).

Educators should attend to students' attitudes towards mathematics when teaching it, if serious about advancing student performance. In this, a healthy environment is significant (Tran, 2012). In addition the attitudes, beliefs, and style of a teacher, and parental attitudes were explained students' attitudes towards mathematics (Asante, 2012; Vukovic et al., 2013). Hence, there should be a positive learning environment, so that students can develop a positive attitude towards the subject that would lead to better performance (Tran, 2012). The opposite is fatal. For example, negative feedback from teachers is the strongest predictor of students' self-efficacy in mathematics (Thomas, 2013). If students are anxious about the subject, this will likely affect them. Ma (1999) saw a significant relationship between anxiety towards mathematics and achievement in mathematics.

The concept of attitudes towards an object is very important in researches involving students' academic performance. To understand the impact of students' attitudes towards mathematics in the Philippines, it is essential to assess the construct reliably and validly. Measuring their attitudes towards mathematics is a complex process that involves many different variables. Hence, choosing a rigorous measurement model, to construct a valid scale of student attitudes towards mathematics, is crucial. Moreover, instruments that measure attitudes to mathematics were not validated among high school students in the Philippines but college students (Guce et al., 2013). The other available instrument measuring attitudes towards mathematics were validated to foreign countries. One of the most popular foreign instruments utilised in research for the last three decades is The Fennema – Sherman Mathematics Attitude Scales. It consists of a group of nine (9) instruments, developed in 1976. These nine instruments are as follows: (1) Attitude Toward Success in Mathematics Scale, (2) Mathematics as a Male Domain Scale, (3) and (4) Mother/Father Scale, (5) Teacher Scale, (6) Confidence in Learning Mathematics Scale, (7) Mathematics Anxiety Scale, (8) Effect Motivation Scale in Mathematics, and (9) Mathematics Usefulness Scale. These instruments are too old, posing concerns for researchers in the Philippines. Researchers in this country have been dependent on the adoption of foreign instruments to measure students' attitudes in their educational researches, for example see (Tudy R., 2014). The items like "My parents pressure me to do my math assignment", and 'I don't want to attend math classes with a strict teacher' were not included in the popular attitude instrument of Fennema – Sherman Mathematics Attitude Scales (1976). However, these items were validated for Filipino high school students and included in the Mathematics Attitude Scale developed by this study. Furthermore, putting the diverse cultural heritage of Philippine society with many ethnic groups into consideration, coupled with the fact that attitudes towards mathematics are influenced by societal norms (Mata, Monteiro, & Peixoto, 2012), it became paramount to develop an instrument using indigenous data for measuring the attitude of high school students.

This research contextualised the instrument, to obtain useful and reliable information about the mathematics attitudes of Filipino high school students. This study, therefore, stemmed from the measurement of students' attitudes towards mathematics using indigenous data. This instrument has different components compared with existing mathematics attitude scales. For this research, the Exploratory Factor Analysis and Reliability Analyses were chosen, to develop an attitude scale towards mathematics, to obtain the most useful information about the attitudes of the Filipino high school students towards mathematics. The purpose of this research is to develop and validate an instrument that measures the attitude of Filipino high school students towards mathematics.

This study developed a contextualised Five-Point Likert Scale that measures the attitude of Filipino high school students towards mathematics. The researcher used Exploratory Factor Analysis to uncover the underlying structure of a set of variables, and to identify a set of latent constructs underlying measured variables. The reliability analyses were also applied in this study to determine the reliability of the measure. The result of this study is helpful in measuring the mathematics attitude of Filipino high school students, giving feedback to teachers, and improving both the teaching-learning process and mathematics performance among students.

Methodology

This study is develops and validates the instrument by applying Exploratory Factor Analysis (EFA) and reliability analyses; this instrument measures the mathematics attitude of Filipino high school students. The instrument is designed as a Five-Point Likert Scale. The options of this scale are the following: strongly agree, agree, undecided, disagree, and strongly disagree.

Existing literature related students' attitudes towards mathematics, to math-self efficacy, math anxiety, motivation, parental influences, effective teacher support, and classroom instruction. These six factors guided the identification of the real constructs or factors. The instrument was developed around these six factors. Each factor was constructed with 10 statements. The respondents of this study checked the following options: strongly agree, agree, undecided, disagree, or strongly disagree. This Five-Point Likert Scale underwent the following procedures: content validation, face validation, EFA and descriptive statistical analysis, and reliability analyses.

The study was conducted at Alicia National High School, whose students were the respondents. This high school is in the municipality of Alicia, Zamboanga Sibugay, in the Philippines. This school has enrolled students from various tribes. These tribes are Subanen, Cebuano, Ilonggo, Maranao, Maguindanao, Tausug, etc. The participants were 300 high school students. 250 ninth-grade students and 50 tenth-grade students, enrolled this school year 2018-2019.

The researcher asked permission from the School Division Superintendent, through the principal, to authorise the distribution of the Five-Point Likert Scales to the students. The researcher also asked the consent of each student in the study, through consent letters to their parents. After obtaining all the permissions from the school and participants, the researcher asked the class adviser/subject teacher of each section for permission to administer the questionnaires to the respondents. The participants responded to the questionnaires on how they agreed or disagreed with each statement. Their responses were examined, tallied, and subjected to the statistical process.

Results and Discussion

The exploratory factor analysis involved checking the univariate and multivariate normality within the data, because it is the requirement for factor analysis (Child, 2006). The outliers and the normality of the distribution were also examined by inspecting the Normal Probability Plot of the regression standard residuals, as part of the analysis, to determine which outliers were to be deleted. In the Normal P-P Plot, the expected value was compared to the value actually seen in the data set or observed value. The expected value is the straight diagonal line whereas the observed values are plotted as individual dots. In this study, the data is normally distributed and linear because the dots fall almost exactly on the straight line. This means that the observed values are the same as any normally distributed set. Moreover, based on the Box Plot, there are 64 outliers. These 64 respondents were not included in the further analysis. The responses of these 64 students were deleted, and 236 respondents remained (Tabachnick and Fidell, 2007). Further, the additional independent variable can improve prediction of the dependent variable to have its correlation not only to the dependent variable, but also to the correlations of additional independent variables to the independent variables already in the regression equation (Tabachnick and Fidell, 2007). Multicollinearity reduces any single independent variable's predictive power, by the extent of its association with other independent variables. Multicollinearity was identified by examining the correlation matrix. In this study, there was no presence of high correlation (0.90 and higher). This means no indication of multicollinearity (Hair et. al, 2007).

After the outliers, normality of data and multicollinearity were checked, the Exploratory Factor Analysis was initially run. Principal Components analysis extracted maximum variance from the data set with each component. This reduced the large number of variables to a smaller number of components (Tabachnick & Fidell, 2007). Principal Components analysis is a technique of data reduction, raising issues of whether it is truly a factor analysis technique (Costello & Osborne, 2005). For a better interpretation, factors were rotated since unrotated factors were ambiguous. This study used the orthogonal rotation which was the Varimax rotation. Varimax rotation minimised the number of variables with high loadings on each factor and made small loadings even smaller. Items with factor loadings below 0.4 were eliminated (Hair et al., 2010). Hence, out of 60 items, 27 were deleted items and 33 were remaining items.

Table 1 presents the test for sampling adequacy and pattern relationship. As shown in the table, the Kaiser-Meyer Olkin Measure is 0.704 and the Bartletts Test of Sphericity, Approx.

Chi-Square is 4028.83, $p< 0.05$.

Table 1: Test for Sampling Adequacy and Patterned Relationship

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.704
Bartlett's Test of Sphericity	Approx. Chi-Square	4028.83
	df	1770
	p-value	0.00

Note: KMO > 0.6 = the sample is adequate
Bartlett's Test of Sphericity, significant level of $p < .05$

In this study, several tests were performed before factors were extracted, to assess the suitability of the respondent data for factor analysis. The tests were Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Bartlett's Test of Sphericity. The Kaiser-Meyer Olkin Measure validated the sampling adequacy for the analysis. In this study, the KMO=0.704 which is above Kaiser's suggested threshold of 0.6 (Kaiser, 1974). Hence, the research sample was adequate. The Bartlett's Test of Sphericity, Approx. Chi-Square =4028.83, $p< 0.05$ indicated that correlations between items were sufficiently large for EFA.

The responses of the three hundred high school students to the questionnaire were sufficient to conduct an EFA. In addition, a relationship between questionnaire items was found. Thus, the requirements for conducting factor analysis were met. High communalities indicate that the extracted components represented the variable well. Items exceeding 0.5 communality were considered in further analysis while those less than 0.5 were dropped (Hair et al., 1995).

The fifty-nine items represent well the attitude of the high school students towards mathematics, while item 43 did not represent the variable well. Thus, the item 43 "I like to learn math with my approachable teacher" was not included in the further analysis. The eigenvalues and the Final Four-Factor Structure are reflected in Table 2. The Scree Plot Criterion is also shown in Figure 2. Eigenvalue actually reflects the number of extracted factors whose sum equals the number of items subjected to factor analysis.

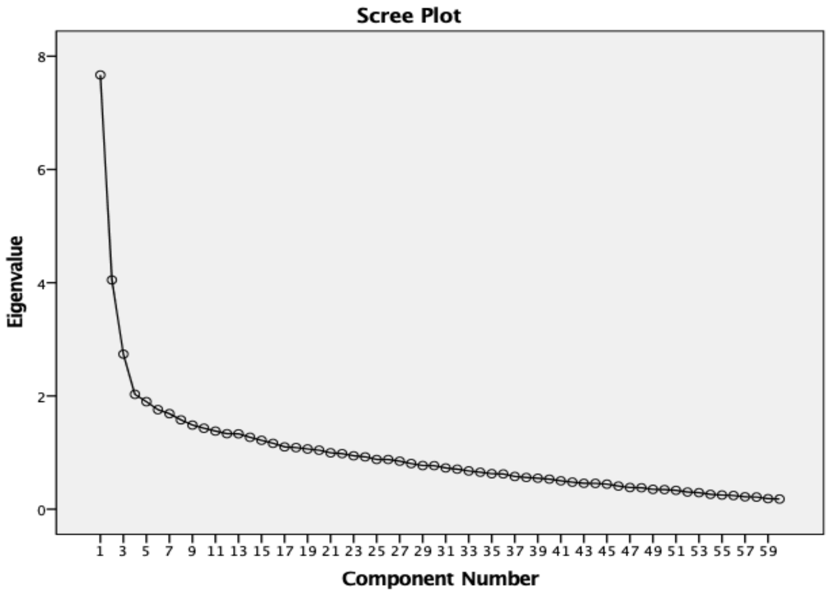
The eigenvalue table has been divided into three sub-sections, which are Initial Eigenvalues, Extracted Sums of Squared Loadings and Rotation of Sums of Squared Loadings. For analysis and interpretation purposes, we are only concerned with Extracted Sums of Squared Loadings. The eigenvalue determines the number of factors in factor analysis. Based on Table 2, it shows 20 initial factors whose eigenvalues exceeded or equalled one (Kaiser, 1960), and their variance totalled 27.48%. That is the percent of variability explained by these 20 factors, with nearly 72.52% loss of information.

Table 2: Eigenvalues, Total Variances Explained for the Final Four-Factor Structure

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.67	12.78	12.78	7.67	12.78	12.78
2	4.05	6.75	19.53	4.05	6.75	19.53
3	2.74	4.56	24.10	2.74	4.56	24.10
4	2.03	3.38	27.48	2.03	3.38	27.48
5	1.90	3.17	30.64	1.90	3.17	30.64
6	1.76	2.93	33.57	1.76	2.93	33.57
7	1.69	2.81	36.38	1.69	2.81	36.38
8	1.58	2.63	39.01	1.58	2.63	39.01
9	1.49	2.48	41.49	1.49	2.48	41.49
10	1.43	2.38	43.87	1.43	2.38	43.87
11	1.38	2.30	46.17	1.38	2.30	46.17
12	1.33	2.22	48.39	1.33	2.22	48.39
13	1.33	2.22	50.61	1.33	2.22	50.61
14	1.27	2.12	52.73	1.27	2.12	52.73
15	1.22	2.03	54.75	1.22	2.03	54.75
16	1.16	1.94	56.69	1.16	1.94	56.69
17	1.10	1.83	58.52	1.10	1.83	58.52
18	1.09	1.81	60.34	1.09	1.81	60.34
19	1.06	1.77	62.11	1.06	1.77	62.11
20	1.04	1.74	63.84	1.04	1.74	63.84

Note: Extraction Sums of Squared Loadings, Total, ≥ 1 = retained factors

Figure 2. Scree Plot Criterion



In this study, the researcher used three approaches to determine the factors to retain. The Scree Plot Criterion and eigenvalues were utilized to determine how many factors to retain. The first criterion used in this study was the eigenvalues. This criterion used in this study to determine the number of retained factors is Kaiser's criterion which is a rule of thumb. This criterion recommends retaining all factors above the eigenvalue of 1 (Kaiser, 1960). The second criterion used to determine the factors was the Scree Test. The Scree Test (see Figure 2) consists of factors and eigenvalues (Cattell, 1978). To determine the number of factors in the Scree Plot Criterion, the researcher drew a horizontal line and a vertical line starting from each end of the curve. The data points that are above the break (point of inflexion) are retained factors. The sample size of this study is 300 which is above the recommended of at least 200 sample size in determining the reliability of the Scree Test (Yong and Pearce 2013).

The Scree Plot shows retention of the three factors. Based on Table 2, there are 20 retained factors, but the Scree Plot shows only three retained factors. To resolve this difference and validate the result, the researcher used the third criterion. This criterion is Eigenvalue Monte Carlo Simulation using syntax codes in SPSS. Factors with eigenvalues greater than one were considered significant. However, Cliff (1998) states that the method is affected by the sampling error, and it tends to result in a great (excessive) number of factors when applied to the sample matrix. Hence, this study used Horn's parallel analysis. Table 3 presents the Parallel Analysis Criterion Test for factor extraction using the Monte Carlo Simulation Technique, to determine the number of factors.

Table 3: Parallel Analysis Criterion Test for Factor Extraction

Component Number	Actual Eigenvalue from PCA	Random Order from Parallel Analysis	Decision
1	7.67	2.28	Accept
2	4.05	2.14	Accept
3	2.74	2.05	Accept
4	2.03	1.98	Accept
5	1.90	1.90	Reject
6	1.76	1.84	Reject
7	1.69	1.78	Reject
8	1.58	1.71	Reject
9	1.49	1.68	Reject
10	1.43	1.62	Reject

Note: actual eigenvalues > random ordered eigenvalues = retained factors

Horn's parallel analysis determined the number of factors in exploratory factor analysis. The number of factors thus determined was compared to that of the factors obtained from eigenvalue and scree plot; the two traditional methods for determining the number of factors in terms of consistency. Random data generation, which is parallel to the actual data set, founds this parallel analysis. The Monte Carlo Simulation Technique determined the number of factors and the comparison of eigenvalues of two data (Omay and Duygu, 2016). Table 3 presents the Parallel Analysis Criterion Test for factor extraction, using the Monte Carlo Simulation Technique to determine the number of factors.

Actual eigenvalues were compared with random order eigenvalues in parallel analysis. Factors with actual eigenvalues that surpass randomly ordered eigenvalues are retained (Williams et al. 2010). As reflected, there are four retained factors. Based on the six components with ten items each, the three approaches determined the number of factors. The results show that there are four factors. The items of the questionnaire grouped themselves to represent each factor. After the selection of the final number of factors, the factor loadings of each item were checked. In interpreting the factors, the researcher examined the loadings to determine the strength of the relationships. Factors were identified by the largest loadings, and the zero and low loading were also examined, to confirm the identification of the factors (Gorsuch, 1983). Items with factor loadings below 0.4 were eliminated (Hair et al., 2010). In this manner there were 27 deleted items and 33 remaining items, out of an original 60 items. The 33 remaining items are reflected in Table 5. The final run of the Exploratory Factor Analysis was performed. The main result is presented in Tables 5, 6, 7, and 8. The data shows four factors with 33 items. Table 4 presents the descriptive statistics, including the means, standard deviations, minimums, and maximums of the four proposed factors of the Mathematics Attitude Scale.

Table 4: Descriptive Statistics of Each Element of Mathematics Attitude Scale

	M	SD	Skewness	Kurtosis	Min	Max	N
1. Students' Perceived Motivation and Support in Learning Mathematics	2.41	0.49	0.22	0.60	1.25	4.17	236
2. Students' Perceived Anxiety in Learning Mathematics	2.83	0.44	0.07	0.17	1.7	4.2	236
3. Students' Perceived Self-Efficacy in Learning Mathematics	2.90	0.55	-0.04	-0.04	1.33	4.33	236
4. Teacher and Parents' Influences to Students in Learning Mathematics	3.07	0.56	-0.58	0.64	1	4.2	236

Note: skewedness and kurtosis < I 1 I = normally distributed

As demonstrated, participating students have a low perception of motivation and support in learning mathematics (M = 2.41, SD=0.49), perception of math anxiety in learning mathematics (M = 2.83, SD=0.44), perception of math self-efficacy in learning mathematics (M = 2.90, SD=0.55), and teacher and parents' influences in Learning Mathematics (M = 3.07, SD=0.56).

The results support the variables as normally distributed based on the degrees of skewedness and kurtosis, because both are less than the absolute value of one. The sample size of this study was larger than 200; thus, the rule of thumb was also applied to test the normal distribution of the data (Field, 2009). In a large sampling, it is significant to visually assess the distribution shape, rather than testing the statistical significance of skewedness and kurtosis (Field, 2009). Table 5 presents the Items and final four-factor structure of the Mathematics Attitude Scale (MAS) after factor reduction procedures.

Table 5: The Items and Final Four-Factor Structure of the Mathematics Attitude Scale (MAS) after Factor Reduction Procedures

		Factor			
		1	2	3	4
Factor 1: *Students' Perceived Motivation and* Support in Learning Mathematics					
1	It is important and valuable for me to get high grades in mathematics.	0.498			
2	I seek the help of others if I find difficulty in learning mathematics.	0.493			
3	Learning mathematics can assist me to find an excellent career in the future.	0.495			
4	Learning mathematics will develop me as critical thinker.	0.523			
5	My parents think learning mathematics is important.	0.632			
6	My parents are happy to see my good grades in mathematics.	0.626			
7	I am interested to learn mathematics when my teacher praises me.	0.463			
8	My teacher encourages me to learn mathematics.	0.623			
9	I like to learn math with my approachable teacher.	0.551			
10	I learn mathematics more with the help of my supportive teacher.	0.560			
11	My teacher gives positive feedbacks that boost my confidence to perform better in my math class.	0.513			
12	I really like to engage in math discussion if the topic interests me.	0.520			
Factor 2: Students' Perceived Anxiety in Learning Mathematics					
13	I am usually uneasy in math classes.		0.529		
14	I am not good in mathematics.		0.599		
15	I study math but it really seems difficult for me.		0.512		
16	My mind becomes blank and unable to think clearly when working in mathematics.		0.540		
17	I hate mathematics subject.		0.491		
18	I cannot solve difficult math problems.		0.539		

19	I feel worried that I will not be able to answer the test in mathematics subject.		0.561		
20	I get tense when there is an announcement of schedule of math test.		0.538		
21	I get nervous when taking a mathematics test.		0.449		
22	I like to solve new mathematical problems.		0.445		
Factor 3: Students' Perceived Self-Efficacy in Learning Mathematics					
23	I believe I can do good in mathematics.			0.632	
24	I think I am the type of student who actively participates in math activity.			0.620	
25	I believe I can get a good grade in a mathematics subject.			0.468	
26	I work hard in my mathematics classes.			0.500	
27	I believe I can understand the mathematical concepts.			0.570	
28	I love solving mathematics problems.			0.550	
Factor 4: Teachers and Parents' Influences to Students in Learning Mathematics					
29	I perform well in math class when my parents support me.				0.438
30	My parents pressure me to do my math assignment.				0.588
31	My parents stress the importance of mathematics.				0.435
32	I don't want to attend math classes with a strict teacher.				0.573
30	Mathematics class is dull and boring.				0.579
Extraction Method: Principal Component Analysis.					
Rotation Method: Varimax with Kaiser Normalization.					
Rotation converged in 6 iterations.					

There are four factors with 33 items. Factor 1 represents the *Students' Perceived Motivation and Support in Learning Mathematics*, with 12 items. Factor 2 represents *Students' Perceived Anxiety in Learning Mathematics* with 10 items. Factor 3 is the *Students' Perceived Self-Efficacy in Learning Mathematics*; six items. And lastly, Factor 4 represents the *Teachers and Parents' Influences to Students in Learning Mathematics*, with 5 items.

To name factors is more of an art as there are no rules, except to give names that best represent the variables within the factors (Yong and Pearce, 2013). Anything that directs one's behaviour to do something whether these are internal or external forces, is called motivation (Ryan R. & Deci E., 2000). The item number 1 "*It is important and valuable for me to get high grades in mathematics*" indicates the significance of high grades. To get good grades in mathematics, students should motivate themselves to study it hard. In addition, the item number 3 "*Learning mathematics can assist me to find an excellent career in the future*" is also a motivation that drives students to learn mathematics. There are also other motivators that encourage students to learn mathematics. Item number 8 "*My teacher encourages me to learn mathematics*", number 10 "*I learn mathematics more with the help of my supportive teacher*", number 11 "*My teacher gives positive feedbacks that boost my confidence to perform better in my math class*" reflect showing support to the students to learn mathematics well. The other items are also in the form of support to students learning mathematics. The mentioned statements relate to the perceived motivations and supports for students learning mathematics.

Anxiety is a feeling of uneasiness and worry, usually generalised and unfocused (Bouras N. & Holt G., 2007). The statements number 13 *"I am usually uneasy in math classes",* and number 19 *"I worry that I will not be able to answer the test in mathematics subject"* show student anxieties towards mathematics, as do the other items. These items reflect the perceived anxiety of the students in learning mathematics because being uneasy in math class bothers them emotionally when learn math, and being worried also hinders and disturbs them students when learning the subject.

Self-efficacy is an individual's belief in their innate ability to achieve something (Bandura A., 1982). The items "*I believe I can do good in mathematics*", "*I believe I can understand the mathematical concepts*" and the other items show self-efficacy, because believing that one is good in mathematics, and that one can understand mathematical concepts, are evidence of self-efficacy in learning the subject. Thus, these items show students' perceived self-efficacy in learning mathematics.

Lastly, the items "*My parents stress the importance of mathematics*" and "*I don't want to attend math classes when my teacher is strict*" show that parents and teachers influence students. The ability of the students to perform well in math class may be hindered or honed, but it depends on how their teachers and parents influence them. Having parents value the subject, and a teacher who is strict, can really influence students' ability to perform well in math class. Therefore, these items show the teachers and parents' influences upon students in learning mathematics.

Table 6 presents the correlation matrix of each extracted factors. Table 6 shows that the correlation of "*Students' Perceived Motivation and Support in Learning Mathematics"* and "*Perceived Anxiety in Learning Mathematics"* is 0.116. This means that "*Students' Perceived Motivation and Support in Learning Mathematics"* and *"Students' Perceived Anxiety in Learning Mathematics"* have a weak positive correlation, and is not statistically significant.

This means that a motivated and supported student is not affected by his or her perceived anxiety in learning mathematics.

Table 6: Correlation Matrix of the Extracted Factors

Factor	**1**	**2**	**3**	**4**
1. Students' Perceived Motivation and Support in Learning Mathematics	1			
2. Students' Perceived Anxiety in Learning Mathematics	0.116	1		
3. Students' Perceived Self-Efficacy in Learning Mathematics	.242**	-.141*	1	
4. Teacher and Parents' Influences to Students in Learning Mathematics	.142*	.172**	.157*	1

Note: Cell contains ***r*** (correlation coefficient); ** Correlation is significant at the 0.01 level (2-tailed), ***r*** is interpreted using Cohen's Scale: -0.3 to +0.3 = weak, -0.5 to -0.3 or +0.3 to +0.5 = moderate relationship, -0.9 to -0.5 or +0.5 to +0.9 = strong relationship, -1.0 to -0.9 or +0.9 to +1.0 = very strong relationship.

While "*Students' Perceived Motivation and Support in Learning Mathematics*" and "*Students' Perceived Self-Efficacy in Learning Mathematics*" have a weak positive correlation, it is at a 0.01 level of significance. This implies that the motivated and supported students are capable and self-efficient in learning math. The "*Students' Perceived Motivation and Support in Learning Mathematics*" and "*Teachers and Parents' Influences to Students in Learning Mathematics*" still have weak positive correlation, but it has significance statistically, at a 0.05 level of significance. Thus, students are motivated to learn math when they are influenced by their teachers and parents. The *"Students' Perceived Anxiety in Learning Mathematics"* and "*Students' Perceived Self-Efficacy in Learning Mathematics*" have a weak negative correlation, but it is statistically significant at a 0.05 level of significance. Therefore, students who perceive anxiety in learning mathematics are less efficient in math. The *"Students' Perceived Anxiety in Learning Mathematics"* and "*Teachers and Parents' Influences to Students in Learning Mathematics*" have a weak positive correlation, but these factors are correlated at 0.01 level of significance. This means that the worried and uneasy students are affected and influenced by their teachers and parents. Lastly, the "*Students' Perceived Self-Efficacy in Learning Mathematics*" and *Teachers and Parents' Influences to Students in Learning Mathematics*" have a weak positive correlation, but these factors are statistically significant at a 0.05 level of significance. This means that the good and efficient students are also influenced by their teachers and parents.

Table 7 presents the reliability coefficients for each element of the Mathematics Attitude Scale (MAS). This includes the Number of Items, Cronbach's Alpha, Average Variance (AVE) and Composite Reliability of each factor. The convergent validity assesses the items related to the proposed construct. The Average Variance Extracted (AVE) was utilised to summarise the measure of convergence among items (Taylor and Francis Group, 2010). A factor with an Average Variance Extracted (AVE) that is greater than 0.5 is acceptable. Average Variance Extracted (AVE) equals 4 is considered because it is close to adequate convergent. Moreover, if AVE is less than 0.5, but composite reliability is higher than 0.6, the convergent validity of the construct is still adequate. The acceptable value of composite reliability is 0.6 or higher (Fornell & Larcker, 1981).

Table 7: Reliability Coefficients for Each Element of the Mathematics Attitude Scale (MAS)

Factor	Number of Items	Cronbach's Alpha	Average Variance Extracted (AVE)	Composite Reliability
1. Students' Perceived Motivation and Support in Learning Mathematics	12	0.729	0.296	0.833
2. Students' Perceived Anxiety in Learning Mathematics	10	0.766	0.273	0.788
3. Students' Perceived Self-Efficacy in Learning Mathematics	6	0.776	0.313	0.730
4. Teacher and Parents' Influences to Students in Learning Mathematics	5	0.561	0.278	0.654

Note: Average Variance Extracted is less than 0.5, but composite reliability is higher than 0.6, the convergent validity of the construct is still adequate. Composite reliability ≥ 0.6 = acceptable

The Table 7 shows that the composite reliabilities of factors *"Students' Perceived Motivation and Support in Learning Mathematics", "Students' Perceived Anxiety in Learning Mathematics", "Students' Perceived Self-Efficacy in Learning Mathematics",* and "*Students' Perceived Self-Efficacy in Learning Mathematics"* are 0.833, 0.788, 0.730, and 0.654 respectively. Hence, the convergent validity of these four factors is adequate (Fornell & Larcker, 1981). This means that the four factors represent the attitude of the Filipino high school students towards mathematics.

The internal reliability of a measurement was used in multi-item scales, and it turned to its consistency (Hair et al., 2006). Internal reliability determines the internal consistency of the items. It also determines whether items that constitute the scale are measuring a single concept (Hair et al., 2006; Lee, 2001). In this study Cronbach's Coefficient Alpha, the most popular indicator of internal consistency, was used to evaluate the reliabilities of a measurement (Hair et al, 2006; Lee, 2001). Nunnally (1978) recommended that an acceptable level of coefficient alpha for a reliable scale is at least 0.70. The instrument underwent test-retest reliability analysis. Test-retest reliability is a form of reliability achieved through administering the same instrument to the same group of respondents on two different occasions, and then correlating the two sets of scores (Pallant J., 2007). The higher the correlation the greater the reliability of the instrument. The reliability was determined through the value of Cronbach Alpha.

After the conduct of the test-retest reliability, Table 7 shows that the three factors *"Students' Perceived Motivation and Support in Learning Mathematics", "Students' Perceived Anxiety in Learning Mathematics",* and "*Students' Perceived Self-Efficacy in Learning Mathematics"* have Cronbach Alpha values of 0.729, 0.766, and 0.776 respectively. Hence, these three factors are reliable. The fourth factor "*Teacher and Parents' Influences to Students in Learning Mathematics"* has the reliability value of 56.1. This means that the fourth factor is not reliable. Hence, the researcher will recommend revalidating this fourth factor in the Confirmatory Factor Analysis (CFA).

There are three limitations in this study. The first limitation relates to the statistical method. Exploratory Factor Analysis (EFA) is an advantageous statistical technique for examining the psychometric properties and construct validity of an instrument. However, EFA is not sufficient for testing the theoretical foundations of the instrument. Thus, a CFA should be conducted to further the knowledge in this area. The second limitation of this study is the sampling bias. The sample was from grade 9 and grade 10 students in one high school only. In this study, the sampling might threaten the generalisation of the results. The third limitation is not performing the contemporary counterpart analysis. The contemporary counterpart analysis which is the Rash Modelling analyses the attitude scale, by allowing the researcher to calibrate items and measure persons independently.

The Mathematics Attitude Scale (MAS) can provide feedback to the researchers and mathematics teachers about the attitude of Filipino high school students towards mathematics. Moreover, this questionnaire can be used as a research instrument in studying Filipino high school students' attitudes to mathematics.

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