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# Scale on Attitude Toward Mathematics (SATM)

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**Abstract** This study developed an instrument suited for Filipinos to measure students' attitude towards mathematics. The underlying dimensions of the instrument were determined by examining the responses of 249 students using a factor analysis. The Scale on Attitudes Towards Mathematics among Filipino college students can be recommended for use in the investigation of students' attitudes towards mathematics.

**Keywords:** attitudes, mathematics, Filipino college students

Filipino students commonly see mathematics as a difficult subject in school. Results of national achievement tests for several years support these findings that Filipino students are poor in mathematics. In the 1999 and 2003 results of Trends in International Mathematics and Science Study (TIMSS) Philippines ranked third from the bottom of the participating countries in terms of mathematics achievement. Learners as social beings with personal beliefs, emotions and views, students' attitudes should be considered in the learning process. Their motivation to learn plays an important role for them to achieve. Thus, attitude cannot be easily separated from learning because they are acquired through the process of learning (Akinsola & Olowojaiye, 2008).

Numerous definitions of attitudes towards mathematics had been proposed which can be classified as "simple" definition which is just a positive or negative emotional disposition toward mathematics (McLeod, 1992; Haladyna, Shaughnessy, & Shaughnessy, 1983; Zan & Martino, 2007). Another classification is multidimensional definition of attitudes towards mathematics which refers to individual's attitude toward mathematics (which, however, have a positive or negative value) by the individual's beliefs towards mathematics, and how he or she behaves (Hart, 1989). Another classification is the bi-dimensional definition as the pattern of beliefs and emotions associated with mathematics. In relation to these definitions, students' attitudes towards mathematics can be measured through instruments. Dutton Scale (Dutton, 1954; Dutton & Blum, 1968) was the first instruments which measured

"feelings" toward arithmetic. Unidimensional scales were developed by Gladstone, Deal and Drevdahl (1960) and Aiken and Dreger (1961). Later Aiken (1974) constructed scales designed to measure enjoyment of mathematics and the value of mathematics. Michaels and Forsyth (1977) and by Sandman (1980) developed multidimensional attitude scales. Examples of scales dealing exclusively with math anxiety are the Mathematics Anxiety Rating Scale (Richardson & Suinn, 1972), the Mathematics Anxiety Rating Scale – Revised (Plake & Parker, 1982) and the Mathematics Anxiety Questionnaire (Wigfield & Meece, 1988). One of the most popular used in research for the last three decades is The Fennema – Sherman Mathematics Attitude Scales (1976) developed in 1976 which consist of a group of nine instruments: (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) Effectance Motivation Scale in Mathematics, and (9) Mathematics Usefulness Scale.

On the other hand, Ma and Kishor (1997) proposed a definition of attitude towards mathematics as an aggregated measure of liking or disliking of Mathematics, a tendency to engage in or avoid mathematical activities, a belief that one is good or bad at Mathematics and a belief that Mathematics is useful or useless. This definition became the basis for the researchers to develop an instrument on scale on attitudes toward Mathematics which numerous researchers in the Philippines found to play crucial role in students' achievement in mathematics. To cite an example, for liking and disliking mathematics – I like working on word problems in mathematics; and I get anxious when it's time for me to study mathematics. Another factor included in the new instrument is tendency to engage in or avoid mathematics activities – "I look forward to our next class meetings in mathematics; and I get overjoyed when my mathematics class is off. For the factor a belief that one is good or bad in mathematics – I can easily solve complex problems; and I do not feel confident about my answers in mathematics seatwork. Another factor is a belief that mathematics is useful or useless – My knowledge in mathematics can help me solve real – life problems and Studying advanced topics in mathematics is just a waste of time.

Kulh (1980, Zan & Martino, 2007.) suggested that "it is probably not possible to offer a definition of attitude toward mathematics that would be suitable for all situations, and even if one were agreed on, it would probably be too general to be useful. Thus, an instrument scale on attitudes toward mathematics among Filipinos has been developed based on the definition proposed by Ma and Kishor (1997). Likewise, not even one of the existing instruments on mathematics scale emphasized the four factors such as liking and disliking mathematics, tendency to engage in or avoid mathematics activities, belief that one is good or bad in mathematics and belief that mathematics is useful or useless.

## Method

### Content Domain

The instrument was anchored from the definition of attitudes towards mathematics given by Ma and Kishor (1997). The four main clauses in the definition namely – liking and disliking; tendency to engage in or avoid mathematical activities; a belief that one is good or bad in mathematics; and a belief that mathematics is useful or useless were the latent constructs in the study. They are the proposed factors composing the attitudes of Filipino students toward mathematics. Eight statements were composed for each of the four factors. For each factor, there were four positively-stated and four negatively-stated questions to test the consistency of the respondent's answers. That is, for instance, in the first latent construct, four statements address to the liking of the student toward mathematics and the other four are statements about dislike in mathematics. The scale was presented before a panel of test development specialist for comments and suggestions. Some statements were deleted, some were rephrased. All the suggestions given were noted and incorporated before finalizing the instrument. Table 1 shows sample items from each of the factors. All thirty-two statements were jumbled in the final scale, with the four proposed factors not indicated.

Table 1
*Sample Items by Factors*

| Item Number and Content by Factor |
|---|
| Liking or Disliking Mathematics |
| 7. I like working on word problems in Mathematics. |
| 26. I get anxious when its time for me to study Mathematics. |
| Tendency to Engage in or Avoid in Mathematics Activities |
| 11. I look forward to our next class meetings in Mathematics. |
| 14. I get overjoyed when my Mathematics class is called off. |
| A Belief That One is Good or Bad in Mathematics |
| 5. I do not feel confident about my answers in Mathematics seatworks. |
| 15. I can easily solve complex problems. |
| A Belief that Mathematics is Useful or Useless |
| 12. Studying advanced topics in Mathematics is just a waste of time. |
| 20. My knowledge in Mathematics can help me solve real-life problems. |

The SATM is 32-item scale. It is constructed using a Likert-scale format with the following anchors: 1 strongly disagree, 2 disagree, 3 moderately disagree, 4 moderately agree, 5 agree, and 6 strongly agree.

### Pretesting and Participants

The participants of the study were 249 freshmen engineering department enrolled in College Algebra for the first semester of school year 2012-2013. The test was administered by the participants' respective College Algebra instructor during

their period. They were given 15 minutes to answer the questionnaire. Retrieval of the questionnaires followed a day after for the encoding of data. During the tabulation, the scores for the negatively-stated items were reversed for the analysis of data. Sixteen items were reversed and were given appropriate values. The score was the average of the ratings of the respondents.

## Results

To check the internal consistency of the items, Cronbach's alpha coefficients were calculated for all the 32 items and for each set of eight questions for the four latent constructs. The result is given on the table below.

Table 2
*Reliability: Internal Consistency Measures Results*

| Factors | Cronbach's Alpha | Average Inter-Item Correlation |
|---|---|---|
| Liking or Disliking Mathematics | 0.82 | 0.37 |
| Tendency to Engage in or Avoid Mathematics Activities | 0.72 | 0.25 |
| A Belief That One is Good or Bad in Mathematics | 0.82 | 0.38 |
| A Belief that Mathematics is Useful or Useless | 0.74 | 0.27 |

The table above reveals that the Cronbach's alphas and the average inter-item correlations for the four factors are adequate especially the first and third factors. For the overall internal consistency of the 32 items, a Cronbach's alpha of 0.92 was obtained. This indicates a high degree of internal consistency in the statements of the scale.

Table 3
*Descriptive Statistics for the Factors of Attitudes Toward Mathematics Scale*

| Factors | *M* | Min | Max | *SD* |
|---|---|---|---|---|
| Liking or Disliking Mathematics | 34.02 | 14 | 45 | 6.08 |
| Tendency to Engage in or Avoid Mathematics Activities | 30.82 | 8 | 44 | 5.24 |
| A Belief That One is Good or Bad in Mathematics | 27.80 | 8 | 45 | 6.04 |
| A Belief that Mathematics is Useful or Useless | 35.90 | 23 | 48 | 5.13 |

The highest mean computed is for the fourth factor which also gave the maximum sum of responses out of the four. The minimum sum of responses falling under the second and the third factors are also reported. The standard deviations computed are acceptable, especially with the second and fourth factors, indicating that the responses are not much spread or dispersed.

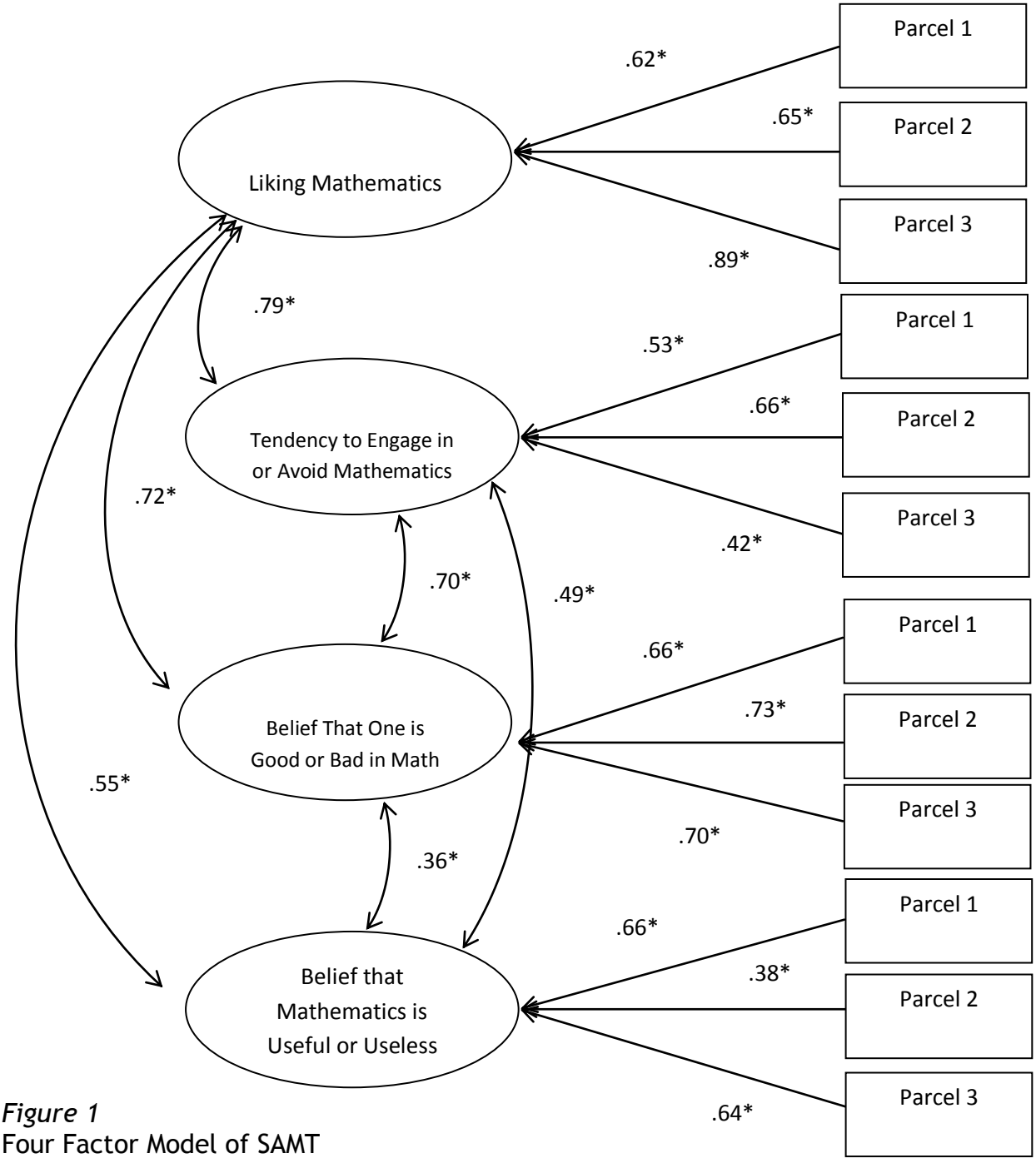


*Figure 1*
Four Factor Model of SAMT

The factors of SAMT were tested using a Confirmatory Factor Analysis (CFA). It is composed of four latent constructs with eight items each. When these eight items were loaded under one latent construct, it resulted to a single covariance matrix. It was then reduced to three parcels for each factor. Items 1 to 3 made up the first parcel, items 4 to 6 for the second parcel, and the remaining two for the third parcel. With these, the parameter estimates resulted to be significant. This reveals that the four are indeed factors affecting the students' attitudes towards mathematics. The fit of the four-factor model was also obtained.

Table 4
*Goodness of fit Indices*

| | |
|---|---|
| RMS Standard Residual | 0.05 |
| Steiger-Lind RMSEA Index | 0.04 |
| McDonald Noncentrality Index | 0.97 |
| Population Gamma Index | 0.92 |
| Adjusted Population Gamma Index | 0.87 |
| GFI | 0.94 |
| AGFI | 0.92 |
| Bentler - Bonett Normal Fit Index | 0.90 |
| Bollen's Rho | 0.90 |
| Bollen's Delta | 0.92 |

It can be seen from the results that different fit indices had acceptable values indicating goodness of fit. This supports the factorial validity of the questionnaire and thus it can be used to assess the attitudes of the students towards mathematics under the mentioned factors.

## Discussion

Four subscales were identified as liking and disliking mathematics, tendency to engage in or avoid mathematics activities, belief that one is good or bad in mathematics, and belief that mathematics is useful or useless. Scores on the 32-item scale developed good internal reliability. The estimated time to complete the instrument ranges from 15 to 25 minutes.

The SATM for Filipino students was analyzed using factor analysis and may be an efficient and effective research tool to assess factors that influence expectations and performance in math because of its content validity, reliable factor scores and brevity.

Research on attitude has a long history in mathematics education (Zan & Di Martino, 2007). Factor analysis had matured as a method to examine interrelationships among a number of variables with minimal loss of information. The scale on attitudes towards mathematics for Filipino students was constructed using these standards. Based on a number of researches conducted in the Philippines, to improve math instruction over the last decade focused on teaching methodologies, kind of instructional materials to use, strategies to improve teacher training, and

appropriate sequencing of math courses in the curriculum. Investigation on student attitude towards mathematics among college students in the Philippines has been given less attention. Although there is a body research about attitudes toward mathematics, most of them are concerned only with anxiety (Ma & Kishor, 1997). Most of this research is also based on results derived from instruments that predated modern statistical standards for factor analysis that currently guide the examination of interrelationships among variables. With the development of this scale, teachers and researchers will realize that success or failure in math performance is greatly determined by personal beliefs. It is also anticipated that Filipino college students will exert effort to improve their performance in mathematics influence by personal beliefs such as liking mathematics, tendency to engage in mathematics activity, belief that mathematics is good and belief that mathematics is useful.

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