BEST: International Journal of Humanities, Arts, Medicine and Sciences (BEST: IJHAMS)
ISSN (P): 2348–0521, ISSN (E): 2454–4728
Vol. 8, Issue 1, Jan 2020, 15-22

DEVELOPMENT AND VALIDATION OF CATANDUNGANONS' ATTITUDE TOWARDS MATHEMATICS SCALE (CATOMS)

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ABSTRACT

The purpose of this study is to develop a scale attitude towards mathematics that is suitable to secondary Catandunganon students. Existing attitude towards mathematics scales are already established for its validity and reliability, however these were not tested if it is suited to Catandunganon students. Existing scale on attitude towards mathematics scale also for Filipino students were also established valid and reliable to college students. There was not study that developed scale on attitude towards mathematics that is suitable to secondary Catandunganon students. The researcher collected items to compose a 30-item scale on attitude towards mathematics from existing scales used in previous researches in the Philippines that are established valid and reliable. These items might be suitable to secondary Catandunganon students. Face and Content Validity was performed by the mathematics professors and teachers teaching in Catanduanes. Cronbach's α was computed to establish the internal validity of the scale. Factor analysis was performed to identify factors of the scale being developed. The researcher named the scale as Catandunganon's Attitude towards Mathematics Scale (CATOMS).

KEYWORDS: Exploratory factor analysis, Content validity & Attitude towards Mathematics

INTRODUCTION

Attitude towards mathematics play the key role of students' success in mathematics. Attitude also influences the participation rate of learners (Ali, 2016). It affects students' achievement in mathematics. The teaching method, the support of the structure of the school, the family and students' attitude towards school affect the attitudes towards mathematics. Usually, the way that mathematics is represented in the classroom and perceived by students, even when teachers believe they are presenting it in an authentic and context dependent way stands to alienate many students from mathematics (Barton, 2000; Furinghetti and Pekhonen, 2002).

Attitudes towards mathematics refer to the valuation, the appraisal, and the enjoyment of this discipline, underlining the affective facet more than the cognitive one (Palacios, Arias and Arias, 2014). The definition of attitude towards mathematics as proposed by Ma and Kishor (1997) 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.

Over the past decades, the study of attitude towards mathematics has been the eye of many researchers, to name a few: Aiken and Dreger (1961); Dutton and Blum (1968); Aiken (1972, 1974, 1979); Fennema and Sherman (1976); Michaels and Forsyth (1977); Sandman (1980); McLeod (1992); Tapia and Marsh (2004); Kadijevich (2008); and Adelson, & McCoach (2011). Dutton (1954), Aiken and Dreger (1961) and Dutton and Blum (1968) have been the pioneer of the

study on the attitude towards mathematics. Many researchers followed after them.

One of the first instruments developed was the Dutton Scale (Dutton, 1954; Dutton & Blum, 1968), which measured "feelings" toward arithmetic (Tapia and Marsh, 2004). In one of the first measurement instruments of these attitudes, Aiken and Dreger (1961) prepared a questionnaire made up of 20 items with two subscales: Pleasure and Fear of Mathematics (Palacios, Arias and Arias, 2014)

The Fennema-Sherman Mathematics Attitude Scales (1976) were developed in 1976, and it has become one of the most popular instruments used in research over the last three decades. The Fennema-Sherman Mathematics Attitude Scales 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 (Tapia and Marsh, 2004).

Attitudes cannot be directly observed, so to measure attitudes one can simply ask the person or use indirect methods of inferring cues to measure implicit attitudes. Usually, direct methods are used in both academic and applied research (Bohner & Wänke, 2002).

Existing scales have been developed to determine the attitude towards mathematics. However, most of these scales were validated to Western students. Farooq and Shah (2008), in order to determine the Pakistani students' attitude towards mathematics has adapted the Fennema-Sherman Attitude towards Mathematics Scale (Fennema and Sherman, 1976) but they devised an Urdu translated scale of it. They validated the Urdu translated Fennema-Sherman Attitude towards Mathematics Scale to selected Pakistani students.

Guce and Talens (2013) developed a scale on attitude towards mathematics for Filipino students. This scale however was validated to the freshmen engineering students. This present study will develop a scale specifically suitable for Secondary students of Catanduanes. It will be called Catandunganons' Attitude towards Mathematics Scale (CATOMS). Catanduanes is a small island province in the Bicol region, Philippines where the researcher originated.

Results of the National Achievement Test show that Catandunganon students have poor performance in mathematics. Only a few students from Catanduanes were also admitted in the Big 4 Universities in Manila – University of the Philippines, De La Salle University, Ateneo de Manila University and University of Santo Tomas.

In the study conducted by Tapia and Marsh (2004), they revealed that attitude towards mathematics influence their performance in mathematics. According to Barton (2000), attitude towards mathematics plays a crucial role in the teaching and learning processes of mathematics. It effects students' achievement in mathematics. Researchers concluded that positive attitude towards mathematics leads students towards success in mathematics. Attempt to improve attitude towards mathematics at lower level provides base for higher studies in mathematics. It also causes effect in achievement of mathematics at secondary school level (Ma and Xu, 2004).

In assessing mathematics performance and potential of students, attitudes toward mathematics and mathematics learning are frequently cited factors contributing to success. Several studies have shown that positive attitudes are conducive to good performance (Hungerman, 1967).

In the Philippine setting, there are no studies yet found on the attitude towards mathematics of Catandunganon

students. Guce and Talens (2013) developed a scale on attitude towards mathematics and their respondents in pilot testing were Filipino college freshmen engineering students. Although this study has been validated and found reliable, this might not be suitable for Catandunganon students since the characteristics of Catandunganon students are different from the participants of this study. This is the reason why this study has been conducted. To develop and validate an attitudinal scale that is suitable for Catandunganon students.

METHOD

Participants

The participants of the study were 391 Catandunganon students enrolled in 7 randomly selected secondary schools in the Division of Catanduanes during the school year 2018-2019. These participants were conveniently selected by the researcher. Those who are present during the administration were included in the study, thus they answer the survey questionnaire.

The participants of the study are Junior High Schools students (Grades 7 – 10), all of whom are taking mandatory mathematics subject in the basic education curriculum. All the participants indicated their gender and grade level. There are a total of 100% retrieval rate of the survey questionnaire. Table 1 shows the total distribution of participants for each grade level and gender.

***Table 1*: Distribution of Participants by Level and Gender**

	Male	Female	Total
Grade 7	30	27	57
Grade 8	45	70	115
Grade 9	49	75	124
Grade 10	33	62	95
Total	**157**	**234**	**391**

The Instrument

In developing the CATOMS, the researcher took from different studies items that might be suitable to secondary Catandunganon students. The scale developed by the researcher is a 30-item scale in four factors/domains.

These items were taken from the studies of Doepken, et.al (2003), Grundmeier (2002), Kanai and Norman (1997), Lazim, et.al (2004), Fadali (2004) and Tapia and Marsh (2004). All thirty statements were jumbled in the final scale.

After constructing the final questionnaire with 30 items, it was presented to the selected mathematics faculty members of Catanduanes State University and Catanduanes National High School. The faculty members who validated the instrument for face and content validity have been teaching in Catanduanes for more than 15 years. These faculty members have already known the nature of the secondary students in Catanduanes for more than a decade. They can identify the items that are not suitable for secondary Catandunganon students. Suggestions given by these faculty members were noted and included in before finalizing the instrument.

Following the recommendations of Lyn (1986), a content validity with 8 experts was conducted. These 8 experts are composed of 3 faculty members teaching at a state university and 5 teaching from public schools. Results of the content validity indicated a Content Validity Index of Scale (S-CVI) equivalent to .88 which is of high content validity.

CATOMS was constructed using a Likert-scale format with the following anchors: 1 strongly disagree, 2 disagree,

3 agree, and 4 strongly agree. There were 16 positive statements and 14 negative statements.

PROCEDURE

After securing the approval to administer the questionnaire from the schools division superintendent as well as from the respective school principals, the questionnaire was distributed to mathematics teachers in those respective schools to administer to their respective students. Only students who are willing to participate in the pilot testing were given copies to answer with.

The test was administered as a part of the subject of the participants. This is to give the students ample time to answer the questionnaire. It was noted that the longest time interval to complete the survey was 15 minutes. The teachers immediately retrieved the questionnaires right after the students completed answering them.

RESULTS AND DISCUSSIONS

Guce and Talens (2013) explained that prior to factor analysis there is a need to determine first the internal consistency of the scale and for each factor. For this reason, the researcher conducted first the test of reliability by determining the Cronbach's α of the scale and of each factor. The Cronbach's α for the overall 30-item scale was .87 with item-total correlations of .19. The items with less than .40 item-total correlations were discarded in the final questionnaire leaving only 27 items.

The final 27-item were analysed using the principal axis factoring to identify the factorability of the correlation matrix and to determine the appropriate number of factors. The Kaiser-Myer-Olkin measure of sampling adequacy was .91. This suggests that the data set was appropriate for factor analysis.

The resulting number of factors after performing the principal axis factoring was three. This is the same result given by the scree plot. From the total variance explained, the first factor is accounted for 17.79% of the total variance, the second factor is accounted for explaining the 14.09% of the total variance while the third factor is accounted for the remaining 8.40% of the total variance. There were only three factors from the total variance explained that is accounted for the total variance. The rotated factor matrix suggests three factors also.

The 27 remaining items were computed for its internal consistency. The computed Cronbach's of the entire questionnaire was .88 with item-total correlations of .22. Table 2 presents the Cronbach's α of every item in each factor.

Table 2: Reliability: Internal Consistency Measures Results

Factors	Cronbach's α	Item-total correlations
Factor 1	.88	.40
Factor 2	.84	.33
Factor 3	.65	.32

Table 3: Factor Loadings of Items in each Factor

Statements	Factor		
	1	2	3
21. I like mathematics.	.747		
20. Mathematics is very interesting for me.	.718		
23. I feel definite positive reaction to mathematics. It's enjoyable.	.652		
12. Studying mathematics in school is enjoyable and interesting.	.620		
19. I am able to solve mathematical problems without too much difficulty.	.592		
7. I plan to take as much mathematics during my College studies.	.587		
26. If I am confronted with a new mathematical situation, I can cope with it because I have a good background in mathematics.	.581		
24. I am interested and willing to acquire further knowledge in mathematics.	.539		
13. I am happier to use much mathematics when I get out of school.	.521		
14. I can get good grades in mathematics.	.489		
5. I want to concentrate more in math than in any other class.	.366		
30. Topics in mathematics are interesting and they are important in our daily lives.	.365		
2. Mathematics makes me feel uncomfortable, restless, irritable and impatient.		.688	
3. Mathematics has been my worst subject.		.677	
4. Mathematics will not be important in my life's work.		.573	
18. Mathematical problems make me feel uneasy and confused.		.572	
16. Mathematics is hard for me.		.565	
29. Topics in mathematics are less interesting and difficult.		.559	
15. I don't expect to use mathematics when I get out of school.		.554	
10. Mathematics is a boring subject.		.538	
27. I am always in a terrible strain in a mathematics class. I get worried if I am confronted with a new math problem different from the problems worked in class.		.521	
9. Mathematics is a difficult subject.		.511	
6. I see mathematics something I won't use very often when I get out of school.		.388	
25. I want to gain more knowledge in mathematics.			.556
1. I believe that if I work long enough on a mathematics problem, I will be able to solve it.			.541
17. Mathematics helps a person to think logically.			.461
11. Mathematics classes provide opportunities to learn values that are useful in other parts of daily living.			.433

Extraction Method: Principal Axis Factoring.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 5 iterations.

Factor 1 and 2 has high reliability coefficient while Factor 3 has relatively low reliability coefficient. Factor 3 has only 4 items. This suggests that the lesser the number of items in each factor reduces the reliability of the scale. Worthington and Whittaker (2006) suggested that factors with low reliability coefficient but with item-total correlations of greater than .30 and the number of items retained are more than 3 can be retained. Thus, the researcher decided to consider factor 3 and included in the three-factor loading for the questionnaire being developed.

The 12 items of factor 1 all refers to the enjoyment while students are learning and doing mathematics, thus, the researcher labelled it as *Enjoyment in Learning and Doing Mathematics.* The 11 items of factor 2 all refers to their confidence while learning and doing mathematics, thus the researcher labelled it as *Confidence in Learning and Doing Mathematics.* The four items of factor 3 all refers to their motivation in learning and doing mathematics, thus, the

researcher labelled it as *Motivation in Learning and Doing Mathematics.* The factor loadings of each item for each factor are summarized in Table 3.

CONCLUSIONS

The questionnaire being developed underwent face and content validity from the experts in the field of mathematics education. The reported S-CVI is .88 which suggests of high content validity based on the guidelines of Lynn (1986). Using principal axis factoring with varimax rotation, three factors or subscales were produced and were named as *Enjoyment in Learning and Doing Mathematics, Confidence in Learning and Doing Mathematics and Motivation in Learning and Doing Mathematics.* The questionnaire being develop is of high reliability as reflected in the reported Cronbach's $\alpha = .88$ and with .22 item-total correlations. According to George and Mallery (2003), an instrument with Cronbach's $\alpha > .80$ is of excellent reliability coefficient. This justifies that the questionnaire being developed is of excellent reliability. Hence, the above discussion suggests that the questionnaire being developed is valid and reliable as an attitudinal scale that would determine the attitude towards mathematics of junior high school students.

Since CATOMS was validated and tested for its reliability to Catandunganon students, the instrument is suited for this kind of students. There is no need to retest for its validity and reliability if CATOMS will be used for future studies with Catandunganon students as research participants. However, should the research participants be students not residing from Catanduanes, there is a need to retest for its validity and reliability.

RECOMMENDATIONS

The Catanduanganon's Attitude towards Mathematics Scale has been validated among the Catandunganon students. It has been found to be valid and reliable after the conduct of content validity, testing for internal consistency and conduct of exploratory factor analysis. It is therefore recommended that for future researches, CATOMS may be used provided the research participants are Catandunganon students without the need to test its validity and reliability. However, should the research participants be a mixed of students other than Catandunganon students, there is a need to retest its validity and reliability.

It is also recommended to conduct a study that will confirm the factor loadings of the present questionnaire using confirmatory factor analysis.

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