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THE DEVELOPMENT OF A STUDENT SURVEY ON ATTITUDES TOWARDS MATHEMATICS TEACHING-LEARNING PROCESSES

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Abstract

This study aimed to develop a survey instrument to measure student attitudes towards mathematics teaching-learning processes that is appropriate for the Indonesian context. This study consisted of two phases: Phase 1 (n=320) was a pilot study to assess the suitability of the instrument items for Indonesian students. Phase 2 (n=1001) was conducted to examine the construct validity of the instrument. The data collected from Phase 1 were analysed using descriptive statistics (i.e., frequency counts, simple correlation, and one-way ANOVA for item analysis). Factor analysis was utilised to select items and for scale construction. The result of the screening process (44 items) was piloted to assess its reliability and validity. The instrument, consisting of 22 items, is a reliable and valid rating scale that measures three distinct factors: Teacher Presentation, Mathematics Interest, and Mathematics Value. The data from Phase 2 were analysed by employing confirmatory factor analysis (CFA) and the results confirmed that the three factors identified in the previous factor analysis underlie the student attitudes instrument.

Keywords: Attitude, Student survey, Mathematics teaching and learning, Exploratory factor analysis, and Confirmatory factor analysis.

Abstrak

Studi ini bertujuan untuk mengembangkan instrumen survei untuk mengukur sikap siswa terhadap proses pembelajaran dan pengajaran matematika yang sesuai dengan konteks Indonesia. Studi ini mencakup dua fase. Fase 1 (n=320) merupakan sebuah pilot untuk menilai kecocokan butir-butir instrument bagi siswa Indonesia. Fase 2 (n=1001) untuk menetapkan validitas konstruk dari instrument. Data dari Fase 1 dianalisis menggunakan statistik deskriptif (mencakup hitungan frekuensi, korelasi sederhana, dan ANOVA satu jalur untuk analisis butir). Analisis faktor digunakan untuk memilih butir-butir dan konstruksi skala. Proses skreening menghasilkan 44 butir yg selanjutnya diuji reliabilitas dan validitasnya. Instrumen survei ini mencakup 22 butir yang reliabel dan valid untuk mengukur tiga faktor yg berbeda, yaitu Presentasi Guru, Ketertarikan pada matematika, dan Nilai matematika. Data dari Fase 2 dianalisis menggunakan analisis faktor konfirmatory dan hasilnya mengkonfirmasi bahwa tiga faktor yang telah diidentifikasi sebelumnya mendasari instrumen survei sikap siswa terhadap proses pembelajaran dan pengajaran matematika.

Kata kunci: Sikap, Survei siswa, Pengajaran dan pembelajaran matematika, Analisis factor ekploratori, dan Analisis faktor konfirmatori.

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Student affect has been a sustained topic of mathematics education research for decades (Hannula, 2014; Schoenfeld, 1989). Although students may perceive mathematics as boring, difficult, and impractical (Ignacio, Nieto, & Barona, 2006), students tend to regard the subject as a very important discipline (Ernest, 2004). Consistently, research suggests that mathematical achievement is attributable not only to cognitive factors but also to affective variables, such as attitudes, beliefs, and motivation. Ma and Kishor (1997) defined attitudes towards mathematics as “an aggregated measure of a 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” (p.

27). In general, it is believed that the more positive one's attitude towards the behaviour, the stronger one's intention to perform it (Lipnevich, MacCann, Krumm, Burrus, & Roberts, 2011). Similarly in mathematics education, a positive relationship has been observed between students' attitudes and their mathematics achievement (Aiken, 1970; Ma & Kishor, 1997; Mohd, Mahmood, & Ismail, 2011). In other words, students who have positive attitudes towards mathematics are more successful than those who have negative attitudes (Ma & Kishor, 1997; Reyes, 1984).

Affect in Mathematics Education

Since Schoenfeld's ground-breaking work in the 1980s (e.g., Schoenfeld, 1983), there has been a burgeoning interest in affect within mathematics education. For example, McLeod (1989) maintained that problem-solving performance was influenced by the respective beliefs, attitudes, and emotions students bring to the task. Moreover, by helping students to control and monitor affective factors, significant increases in their academic achievement can be expected (Chamberlin, 2010). Given the importance of student attitudes, it has been argued that the assessment of students should focus both on measuring the explicit curriculum and also on "any and all factors that impact its transmittance to students" (Chamberlin, 2010, p. 169). Bhowmik and Banerjee (2012) categorised the factors that affect students' attitudes into three distinctive groups: factors related to students themselves, such as their mathematical achievement score (Köğce, Yıldız, Aydın, & Altındağ, 2009); factors related to the school, teacher, and teaching, such as teaching materials and teachers' content knowledge; and factors from the home environment and society, such as educational background and occupation of parents (Köğce et al., 2009).

Studies on the affective domain in mathematics continue to be afforded such prominence since improvements in attitudes tend to support student performance (Grootenboer, 2003; Lim & Chapman, 2013). For instance, variables such as enjoyment of mathematics, self-confidence in mathematics, and motivation to do mathematics tend to be highly correlated with student achievement (Bouchey & Harter, 2005; Samuelsson & Grantström, 2007). Even teachers' views regarding individual students' mathematics capacity can impact positively or negatively on students' mathematics attainment (Sorhagen, 2013). Other studies have considered affect within cohorts. For example, Arslan, Çanli, and Sabo (2012) examined the effect of attitudes, achievement, and gender on mathematics education and found that female students had more positive attitudes towards mathematics than male students, and they also had higher grades than male students. Zan, Brown, Evans, and Hannula (2006) identified two main foci of research on mathematics education: mathematics anxiety and attitude towards mathematics. They argued that most research on anxiety assumed a negative relationship between test anxiety and performance as text anxiety prevents cognitive processes. For instance, students' fears and anxiety towards mathematics and their constant failure can make them believe they can never succeed and therefore accept defeat (Köğce et al., 2009). Zan et al. (2006) also argued that research on attitude is based on two beliefs: "attitude towards mathematics is related to achievement, and affective outcomes (such as liking mathematics) are significant per se" (p. 113).

Measures of Affect

A considered number of instruments still used to measure affect were produced more than 40 years ago. These instruments were constructed and validated in western cultures using a variety of scales (e.g., *Mathematics Anxiety Rating Scale* [MARS] by Richardson and Suinn (1972); *Attitude towards Mathematics Inventory* [ATMI] by Tapia and Marsh (2004); *Mathematics Attitude Scales* by Fennema and Sherman (1976)). Notably, most of these well-respected scales included the word "attitude" in the title (Chamberlin, 2010). One of the most widely used scales is *Mathematics Attitude Scales* developed by Fennema and Sherman (1976), which comprised scales for measuring values, beliefs, and disposition towards active problem solving. More recent instruments have gone beyond these well-established constructs to include measures associated with enjoyment, motivation, and parent/teacher expectations (Tapia & Marsh, 2004).

Context and Aims of the Research Project

Although there are a number of instruments used to measure students' attitudes towards mathematics, there is growing concern that the instruments are not relevant to communities outside western cultures or indeed today's students (Khine & Afari, 2014; Zan et al., 2006). Khine and Afari (2014) pointed out that affective instruments should be created in other countries in their native languages to collect data for empirical research. The present study helps address this gap by developing an instrument for measuring students' attitudes towards mathematics specific to an Indonesian context.

This research was carried out as part of a four-year Australian Department of Foreign Affairs and Trade (DFAT) project titled *Promoting Mathematics Engagement and Learning Opportunities for Disadvantaged Communities in West Nusa Tenggara, Indonesia*. A central goal of the project was to produce learning modules in mathematics that would promote mathematics engagement and learning opportunities for students in disadvantaged communities, while simultaneously enhancing teachers' pedagogical content knowledge (PCK) through a pedagogical learning framework (for more details about the program, see Lowrie & Patahuddin, 2015a; 2015b). In order to measure students' attitudes towards mathematics within the new pedagogical framework, it was imperative to develop an instrument that was for the Indonesian context—given our hypothesis that western instruments may not be suitable for students from these disadvantaged communities. Consequently, we sought to determine whether: (1) the items in existing instruments were appropriate and relevant; and (2) whether the items derived from other local contexts could be included in a new instrument. With an appropriate instrument, we could then derive factors or dimensions to measure students' attitudes towards the new mathematics pedagogical practices (i.e., the ELPSA framework, Lowrie & Patahuddin, 2015a, 2015b).

In summary, the present study was carried out to achieve the following objectives:

1. To generate items that are appropriate and relevant for measuring students' attitudes towards mathematics teaching-learning processes; and
2. To construct a scale for measuring the dimensionality of students' attitudes towards mathematics student-learning processes by the use of factor analysis.

METHOD

The present researchers incorporated both rational and empirical approaches into the development of the survey instrument to increase the likelihood of practical relevance and theoretical significance. This method represents the procedure that allows the instrument to be conceptually meaningful and politically viable for all stakeholders involved in the instrument development process, including teachers, school administrators, and students.

This study was conducted in two phases. Phase 1 (n=320) was a pilot study to assess the suitability of the instrument items for Indonesian students. Phase 2 (n=1001) was the main study that administered the revised instrument to verify the validity of the student survey instrument.

Participants

In Phase 1, two junior high schools (one general (government) school and one religious (private) school) were selected for the pilot study. The participants were 320 students (57.5% female; 42.5% male) aged 12–15 in grades 7, 8, and 9, from SMP 15 (located in central Mataram city) and Pondok Pesantren (located in a suburb of Mataram city). Prior to completing the survey, students were told about the purpose of the pilot study. They were then asked to fill out the survey objectively and were assured that their data would remain anonymous. In Phase 2, 1001 participants aged 12–15 in grades 7, 8, and 9 (57% female; 43% male) were drawn from eight districts in Lombok (Mataram city, Lombok Barat, Lombok Tengah, Lombok Timur, Lombok Utara) and Sumbawa (Sumbawa, Sumbawa Barat, Bima). The distribution of female and male students in each district was:

1. Mataram city (60%, 40% of 99 students)
2. Lombok Barat (62%, 38% of 180 students)
3. Lombok Tengah (57%, 53% of 178 students)
4. Lombok Timur (46%, 54% of 84 students)
5. Lombok Utara (48%, 52% of 33 students)
6. Sumbawa (55%, 45% of 239 students)
7. Sumbawa Barat (51%, 49% of 82 students)
8. Bima (67 %, 33% of 106 students)

Procedure

The pilot study involved several stages including the generation and screening of an item pool, and the construction of the scale. The item pool was generated by conducting a critical review of previous studies or existing instruments, and group discussions, and using the nominal group process technique. This item bank was reviewed and discussed at IKIP Mataram among teachers, administrators, and academic staff (10 people). English version items were translated and adjusted to the local context. Other items that were considered relevant but were not yet included in the existing instrument were added. All items were screened and checked for content and language appropriateness. The result of the screening process was 44 items. These 44 items comprised the initial student survey that was piloted to assess its reliability and validity for measuring students' attitudes towards mathematics teaching-learning processes.

Data Analysis

The data collected were coded and analysed statistically using SPSS (Version 21), particularly factor analysis procedures. Exploratory factor analysis was used to construct the scale and examine the construct validity of the student survey (22 items with 320 students). Additional correlation techniques were used to examine the specificity of items and the reliability of the scales and the survey instrument. The criteria for the selection of items and scale construction included:

1. ANOVA for sex effects: A series of one-way analysis of variance (ANOVA) were performed for each of the rating items to estimate sex effects; items that had a statistically significant difference among males and females were excluded from the instrument.
2. ANOVA for class level effects: ANOVA was also performed for each of the rating items to determine the class level effect towards individual student rating items. This step was intended to ensure that items to be included in the instrument could be applied across classes (i.e., grades 7, 8, and 9).
3. Omission of inappropriate items: A series of frequency counts were carried out for each of the rating items to identify the number or percentage of all students who considered each item to be inappropriate or irrelevant to measuring student attitudes towards mathematics teaching-learning processes. An item was omitted if at least 10% of students believed that the item was considered inappropriate. This criterion helped to further refine the instrument to only consist of items that are appropriate for measuring students' attitudes in the Indonesian context.
4. Factor analysis: Factor analysis was utilised to identify the cluster of items (variables) that correlate with one another and correlate less with members of other clusters (Mutohir, 1986). It is an attempt to identify the factors or dimensions that underlie the instrument (construct validity). This provides evidence of whether students are able to differentiate dimensions of the instrument and whether the empirical factors confirm the components that the instrument is designed to measure.
5. Specificity of items (validity): Simple correlation techniques were adopted to identify the correlations between each item and other items in the same scale (A), and the correlation between

each item and other items in the whole instrument (B). An item was considered as a distinctive measure if the coefficient A was higher than coefficient B.

6. Analysis of reliability: In order to cross check the estimate of reliability of each of the scales and the whole instrument, Cronbach's alpha measure of internal consistency was employed by the use of SPSS's reliability procedure.
7. Confirmatory factor analysis (CFA): CFA was used to further examine the factors that underlie the survey instrument.

RESULTS

Item Analysis

At the outset, items were screened with three criteria. Items that: (1) were considered inappropriate by at least 10% of students; (2) had sex effects; and (3) had class level effects were omitted from the instrument.

Inappropriate Items

Based upon the frequency counts, all 44 items were checked for appropriateness. Items that were considered to be inappropriate (≥10%) by students were excluded from the instrument. All items fulfilled this criterion except item A36 (Mathematics class is not my interest). Although item A36 was perceived by students to be inappropriate (11.9%), the difference was quite small (1.9%) and was thus considered insignificant or trivial. Because item A36 is so specific to the content area and also passes the other criteria employed (sex and class level effects, discussed below), this item was still included for further analysis.

Sex Effects. The results of the ANOVA test on each rating item indicated that there were several items that had significant probability levels at $p<0.05$. Ten items revealed a sex effect ($p<0.05$) and were omitted from the instrument

Class Level Effects. ANOVA tests were also conducted for each of the 44 rating items by class level. Seven items showed the class level effect ($p<0.05$) and therefore were omitted from the instrument

Preliminary Factor Analysis

Factor analysis was carried out for the purpose of both selecting items and constructing scales. From the selection process, 15 items were eliminated prior to further analyses. The remaining 29 items were retained to be subsequently included in the student survey instrument, and were further analysed using factor analysis. The factor analysis identified 7 items that have factor loadings less than 0.30. These items were not considered valuable and therefore were omitted. The 22 remaining items were run through a similar approach, principle component analysis with a varimax rotation. At the outset, the 22 items were tested for appropriateness based on the Kaiser-Meyer-Olkin (KMO) and

Bartlett's Test. The KMO and Bartlett's test indicated that all variables (items) were appropriate to be further analysed by factor analysis. The value of the KMO Measure of Sampling Adequacy was within an appropriate range (KMO=0.768, $p<0.001$). This provided evidence that the use of factor analysis was justified.

A principal component analysis with a varimax rotation with Kaiser Normalization was conducted. Rotation merged in 5 iterations. Three factors with eigenvalues of 3.89, 2.8, and 1.76 accounted for 38% of the total variance. The factor loadings for items loaded on the respective factors are presented in Table 1. It was apparent that the three dimensions of students' attitudes towards mathematics teaching-learning processes related to *Teacher Presentation of Content* (17.7%); *Value of Mathematics* (12.7%); and *Interest Towards Mathematics* (7.9%).

Table 1. Factor Analysis of 22 Selected Items (n=320)

FACTORS	Factor Loading		
	Factor 1	Factor 2	Factor 3
Teacher Presentation of Content			
My teacher respects my ideas and suggestions (A23)	0.621		
My teacher gives us opportunities to explain our ideas (A22)	0.607		
My teacher provides real examples to help us solve mathematics problems (A19)	0.592		
Students should learn mathematics even though it is no longer compulsory (A4)	0.530		
My teacher spends time to summarise what we have learned every day (A24)	0.528		
My teacher asks students to explain more about the answers they give (A18)	0.508		
I enjoy working in groups better than alone in math class (A14)	0.468		
If I don't understand something, my teacher explains it another way (A16)	0.479		
My teacher asks questions to be sure we are following along when s/he is teaching (A17)	0.359		
Interest Towards Mathematics			
When I see a math problem, I am nervous (A10)		0.721	
I don't like working on the homework given by my mathematics teacher (A15)		0.695	
I do not like to speak in public (A9)		0.598	
I am not eager to participate in discussions that involve mathematics (A11)		0.598	
This class does not keep my attention—I get bored (A20)		0.589	
Mathematics is boring (A3)		0.562	
I sometimes feel nervous talking out loud in front of my classmates (A8)		0.535	
Value of Mathematics			
I feel confident in my abilities to solve mathematics problems			0.668

(A12)	
I am good at mathematics (A2)	0.661
I can understand my teacher's explanation easily (A13)	0.664
Mathematics is interesting (A1)	0.639
I would like to use math in my real job after I leave school (A6)	0.573
I spend lots of time to practice mathematics or work on assignments (A7)	0.462

Importantly, the three factors have very small inter-correlation coefficients (range 0.002–0.076), as shown in Table 2. Factor 1 and Factor 2 have a very small correlation (r=0.002), while Factor 1 and Factor 3 have a very small correlation coefficient; Factor 2 and Factor 3 also have a very small correlation coefficient (r =-0.076 and r=0.071, respectively).

Table 2 Inter-Correlation Among the Three Factors

	Factor 1	Factor 2	Factor 3
Factor 1	1.000		
Factor 2	0.002	1.000	
Factor 3	-0.076	0.071	1.000

Specificity

The instrument should contain items that have specificity to reflect its validity. The data relating to the comparison of correlation between each item and other items in the same factor (A) and the correlation between each item and other items in the whole instrument (B) indicate that the majority of items under A (range 0.06–0.50) are higher than those in B (range 0.03–0.12). Table 3 provides data relating to the specificity measures. Since the coefficient values of all the items in the factors (A) are higher than those in the instrument (B), it can be inferred that all items have the specify.

Table 3. Specificity of Student Survey Items (22 Items)

FACTORS	Specificity (Distinctiveness)	
	A	B
Teacher Presentation of Content		
My teacher respects my ideas and suggestions (A23)	0.22	0.11
My teacher gives us opportunities to explain our ideas (A22)	0.29	0.12
My teacher provides real examples to help us solve mathematics problems (A19)	0.31	0.12
Students should learn mathematics even though it is no longer compulsory (A4)	0.25	0.11
My teacher spends time to summarise what we have learned every day (A24)	0.26	0.07
My teacher asks students to explain more about the answers they give (A18)	0.26	0.11
I enjoy working in groups better than alone in math class (A14)	0.26	0.10
If I don't understand something, my teacher explains it another way (A16)	0.19	0.12
My teacher asks questions to be sure we are following along when s/he is teaching (A17)	0.28	0.11

Interest Towards Mathematics		
When I see a math problem, I am nervous (A10)	0.24	0.06
I don't like working on the homework given by my mathematics teacher (A15)	0.36	0.05
I do not like to speak in public (A9)	0.35	0.08
I am not eager to participate in discussions that involve mathematics (A11)	0.31	0.03
This class does not keep my attention—I get bored (A20)	0.35	0.04
Mathematics is boring (A3)	0.34	0.04
I sometimes feel nervous talking out loud in front of my classmates (A8)	0.29	0.09
Value of Mathematics		
I feel confident in my abilities to solve mathematics problems (A12)	0.29	0.09
I am good at mathematics (A2)	0.48	0.06
I can understand my teacher's explanation easily (A13)	0.46	0.09
Mathematics is interesting (A1)	0.50	0.03
I would like to use math in my real job after I leave school (A6)	0.39	0.11
I spend lots of time to practice mathematics or work on assignments (A7)	0.06	0.07

Note. A: Correlation between each item and other items in the same factor; and B: Correlation between each item and other items in the whole instrument.

Reliability

Internal consistency was assessed to examine the estimated reliability (homogeneity) of the derived student survey. Homogeneity (internal consistency reliability) refers to freedom from measurement error across tests or items. The data revealed the extent of internal consistency within each of the three factors, and across the instrument as a whole (see Table 4).

Table 4. Reliability Test of Items within the Scales and the Whole Instrument

FACTORS	Cronbach's Alpha if Item Deleted (Factor)	Cronbach's Alpha if Item Deleted (Instrument)
Teacher Presentation of Content		
My teacher respects my ideas and suggestions (A23)	0.577	0.420
My teacher gives us opportunities to explain our ideas (A22)	0.588	0.420
My teacher provides real examples to help us solve mathematics problems (A19)	0.582	0.417
Students should learn mathematics even though it is no longer compulsory (A4)	0.606	0.420
My teacher spends time to summarise what we have learned every day (A24)	0.598	0.422
My teacher asks students to explain more about the answers they give (A18)	0.606	0.423
I enjoy working in groups better than alone in math class (A14)	0.645	0.431
If I don't understand something, my teacher explains it another way (A16)	0.606	0.409

My teacher asks questions to be sure we are following along when s/he is teaching (A17)	0.592	0.422
Interest Towards Mathematics		
When I see a math problem, I am nervous (A10)	0.595	0.454
I don't like working on the homework given by my mathematics teacher (A15)	0.599	0.464
I do not like to speak in public (A9)	0.599	0.440
I am not eager to participate in discussions that involve mathematics (A11)	0.635	0.487
This class does not keep my attention—I get bored (A20)	0.613	0.470
Mathematics is boring (A3)	0.613	0.473
I sometimes feel nervous talking out loud in front of my classmates (A8)	0.629	0.439
Value of Mathematics		
I feel confident in my abilities to solve mathematics problems (A12)	0.522	0.438
I am good at mathematics (A2)	0.515	0.449
I can understand my teacher's explanation easily (A13)	0.519	0.432
Mathematics is interesting (A1)	0.516	0.449
I would like to use math in my real job after I leave school (A6)	0.584	0.420
I spend lots of time to practice mathematics or work on assignments (A7)	0.652	0.449

These data provide evidence that all the items in the scales or instrument (22 items) are reliable, with reliability for each scale being r=0.628, 0.599, and 0.648, respectively.

Confirmatory Factor Analysis

Confirmatory factor analysis (CFA) was used to examine whether the three factors (dimensions) resulting from the exploratory factor analysis underlie the survey instrument. The CFA was administered to a large sample (n=1001) with the 22 items derived from the factor analysis. The results indicate that items A7 and A14 have low loadings (0.13 and 0.08, respectively) and they are not clustered in the designated factors purported to be measured. These two items, therefore were omitted from the scales. A final CFA was administered across the 20 items of the instrument, and the result is presented in Figure 1.

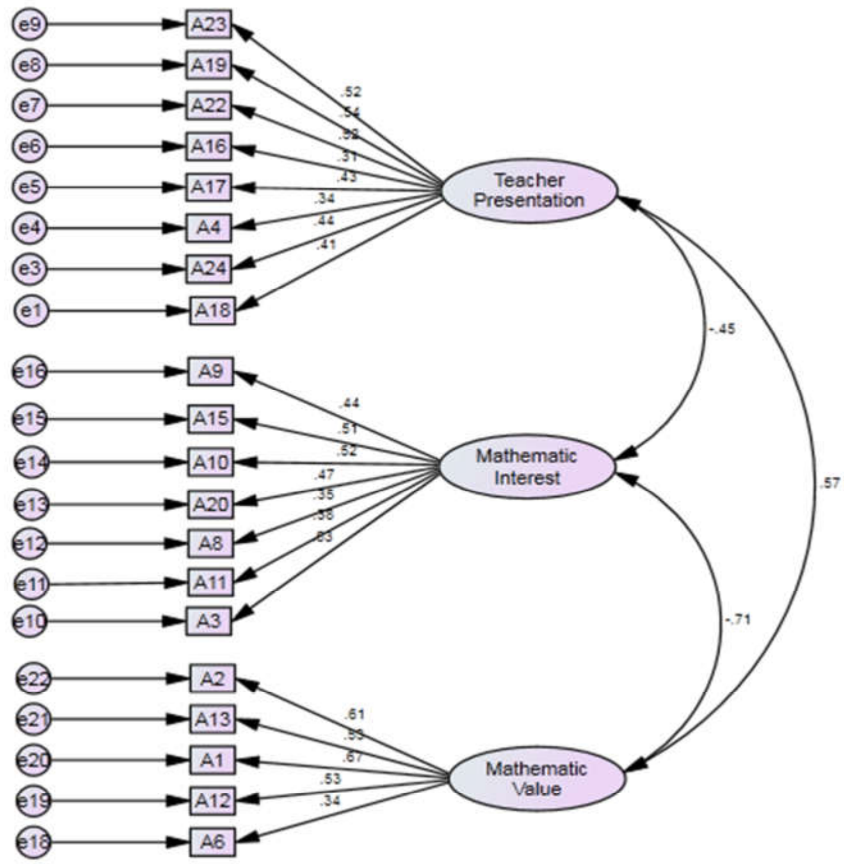

Figure 1. Confirmatory Factor Analysis of 20 Items of the survey Instrument (n=1001) – Standardised Estimates

Factor loadings for each item in the three scales are significant. It is evident that the three dimensions identified in the student survey from the previous analysis (Teacher Presentation, Mathematics Interest, and Mathematics Value) underlie the SSAM items. To determine the instrument's goodness of fit, the following measures were used because they are the most widely respected and reported fit indices: goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI), parsimony goodness-of-fit index (PGFI), and root mean square error of approximation (RMSEA). Because the Chi-square approach represents the traditional measure for evaluating overall model fit, it is not used in this analysis (Hu & Bentler, 1999). The GFI statistic was created by Jöreskog and Sörbom as an alternative to the Chi-square test (Tabachnick & Fidell, 2007). PGFI is based on the GFI by adjusting for loss of degrees of freedom. This approach is strongly recommended by Mulaik et al. (1989) to produce better fit indices. The three-factor model had an acceptable fit to the data based on the obtained values parameter estimates (RMR=0.052; GFI=0.939; AGFI=0.924; PGFI=0.760; RMSEA=0.051). The GFI and AGFI measures are 0.939 and 0.924, respectively. Since both values are greater than 0.90, the model fit of the data is appropriate. Additionally, given that the RMSEA estimate (0.051) is within an acceptable range (close to 0–0.08), it suggests that the model fits the data (Hu & Bentler, 1999; Steiger, 2007). The total variance explained by the three factors extracted from the factor analysis was 37.22%.

Based on the above factor analysis, it is possible to interpret the meaning of the factors. The conceptual interpretations of the three identified factors are as follows.

1. *Factor 1: Teacher Presentation.* Teacher clarity in explaining ideas with variations and providing examples, respecting students' ideas and suggestions, allowing time for students to ask for further clarification, encouraging students to learn mathematics especially in a group, and summarising what students learn.
2. *Factor 2: Mathematics Interest.* Students' self confidence and ability to do mathematics, including comprehending the teacher's explanation, showing interest towards mathematics, spending more time on homework, and wanting to use mathematics at their job after completing school.
3. *Factor 3: Mathematics Values.* Students' feelings of anxiety in facing mathematics problems, feelings of insecurity to talk in front of the class, feelings of unhappiness to do homework and to talk about or discuss mathematics, feelings of boredom, and believing that mathematics is a dull subject.

CONCLUSION

The purpose of the study was to develop a reliable instrument for Indonesian contexts to measure student affect in mathematics. The instrument was developed through a structured logical-empirical approach. The development process of the instrument consisted of three stages: generating an item pool, screening the item pool, and constructing scales. A 22-item instrument satisfied all reliability and validity criteria. A modified form of the instrument, which consisted of 20 items, fufilled the criteria of construct validity as resulted from confirmatory factor analysis. Based upon the results of the factor analyses (exploratory and confirmatory), there were three distinctive factors that were identified that underlie the instrument: Teacher Presentation of Content, Value of Mathematics, and Interest Towards Mathematics. We recommend that the survey instrument be used for junior secondary grades (especially grades 7–9) in Indonesian schools.

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