The Affective Side of Mathematics Education: Adapting a Mathematics Attitude Measure to the Context of Ethiopia

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Abstract: The purpose of this study is to determine the factorial validity of an adapted "Attitudes towards Mathematics Inventory (ATMI)" measure. The ATMI was originally developed by Tapia and Marsh (2004) in the western culture to measure attitudes towards Mathematics. This paper reports the psychometric prosperities of the adapted Amharic version of the ATMI based on a sample of 385 Ethiopian university students enrolled for Mathematics classes. Confirmatory Factor Analysis (CFA) procedure is employed to test the factorial validity of the ATMI-Amharic. The results reveal that the original four-factor model (Self-confidence, Enjoyment, Motivation, and Value) is retained for the adapted ATMI-Amharic since no statistically significant difference ($\chi^2 =$ 1.827, $p = 0.401$; RMSEA < 0.0001) was found between the base and the observed models. Further, a test of factorial invariance across gender groups and year-levels also yielded that the model has measurement invariance revealing the ATMI-Amharic is independent of gender and number of years in college. Besides, the coefficient alphas for the four subscales ($\alpha = 0.78$-0.89) and for the overall measure ($\alpha = 0.94$) are found to be high. The implications of the findings in relation to the psychometric properties of the ATMI-Amharic and its use in Ethiopian context are discussed.

Keywords: Mathematics Education, Mathematics Attitude, Construct Validation, University, Ethiopia

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Introduction

Needless to argue about the indispensability of mathematics in learning science and engineering, mathematics is a language in which people communicate with the complexities of physical sciences and engineering. Mathematics has also immense its contributions for advancement of scientific research in social and behavioral sciences. Simply put, mathematics is the gateway into the realm of science and technology. It is indeed, a “critical filter” (Sells 1973; 1980) since student performance in mathematics determines their entry into prestigious careers. Despite its apparent significance, the application of mathematical knowledge and skills is limited in countries such as Ethiopia partly because of the lack of attention given to affective factors; such as interest, anxiety, and attitude towards learning mathematics.

Quite recently, however, there are some promising signs suggesting mathematics is gradually getting its legitimate place in school/university curriculum. One of these indications is related to the recent policy favoring science and engineering (MoE, 2008). Evidently, the unfolding situation has increased the currency of mathematics as an aspect of a school curriculum, and also as a subject of scholarly research. Further, there are indications of political will that goes beyond introducing a new policy which demands universities to implement 70% enrollment in science and engineering. These developments include the establishment of the Ethiopian Academy of Sciences (EAS) and the upgrading of the former Science and Technology Agency (STA) to a status of a ministry (i.e. Ministry of Science and Technology). In fact, the macro-level policy measures are not an end in themselves unless they are accompanied by actual improvements in the way young people are educated to be scientists and engineers. The success of accumulating a stock of well-trained scientists and engineers, to a large extent, depends on how well the education systems nurture young people to achieve higher mathematics. Among other things, the low mathematics performance of Ethiopian students (Mulu, 2009) naturally calls for a serious measure to improve mathematics learning from a range of perspectives and academic disciplines.

On the other hand, the changing landscape at macro-level suggests the need for a provision of high quality education for young people. Nevertheless, improved quality of mathematics education depends on sufficient research evidence on affective and cognitive aspects of mathematics education at all levels of the education system. Research evidence on students' attitude towards mathematics is among the key areas of endeavor needed to fill the research gap in the area. Attitude to mathematics is strongly related with achievement in mathematics (e.g., Marsh, 1989), willingness to study, and ability to succeed in the fields of physical sciences and engineering (Sells, 1980; Eccels, 1982). In particular, in a situation where the majority of high school and pre-college students are achieving far lower than 50% (the minimum required score) in mathematics and basic sciences (Mulu, 2009), there is an urgent need to understand the affective aspects in learning mathematics that impinge on the cognitive component..

Notwithstanding the level of importance attached to science and technology in general, and to mathematics education in particular, there exists little empirical evidence that contributes to the improvement of mathematics education. The corpus of research in Ethiopian context is negligible since the majority of studies largely addressed achievement and attitude differences between boys and girls in primary grades (e.g., Seleshi, 1995; 2001; 2004; Tilaye, 2007). Little attention has gone into exclusively adapting a measuring instrument for a wider use (e.g., Seleshi 1995; 2001). In recognition of these gaps, the present study makes a modest attempt at adapting a mathematics attitude measure i.e. the Attitude towards Mathematics Inventory (ATMI), originally developed by Tapia and Marsh (2004).

Research Questions

This study is guided by the following research questions in order to establish the psychometric characteristics of the adapted and translated version of Attitude towards Mathematics Inventory (ATMI-*Amharic*):

1. Does the ATMI-*Amharic* possess factorial validity evidence?
2. Are the factor structures of the ATMI-*Amharic* independent of gender and students' year of stay (Year-Level) at university?
3. Does the ATMI-*Amharic* have acceptable reliability evidence?

Literature Review

This section reviews the existing theoretical and empirical literature on the mathematics attitude construct and its measurements. Accordingly, first we closely examine the most widely cited definitions and conceptualization of mathematics attitude. This is followed by a review of widely known measurements of mathematics attitude. This is followed by a review of widely known measurements of mathematics attitude. The last section of the review identifies the reasons why educational researchers should care about the measuring instruments.

Conceptualizing Mathematics Attitude

The conceptualization of attitude towards mathematics has never been uniform and the definitions forwarded by scholars are as varied as the number and perspectives of the researchers. In a classical work, Neale (1969) defined attitude toward mathematics as an aggregated measure of “a liking or disliking of mathematics, a tendency to engage in or avoid mathematics activities, a belief that one is good or bad at mathematics, and a belief that mathematics is useful or useless” (p.623). Similarly,Haladyna, Shaughnessy, and Shaughnessy

(1983, p. 20) defined attitude toward mathematics as “a general emotional disposition toward the school subject of mathematics”. The authors nevertheless caution that their definition should not be confused with the notion of attitude toward the field of mathematics, toward one's ability to perform in the field of mathematics, or toward some specific area within mathematics (e.g., geometry, word problems). Five years later, Hart (1989) came up with a multi-dimensional notion of mathematics attitude which included emotional response, beliefs regarding the subject, and behavior related to the subject. Most importantly, Hart stresses that attitude toward mathematics is a function of the emotions that students associate with mathematics, and their beliefs towards mathematics. On the other hand, Ma and Kishor, (1997), extended Neale’s definition by including affective responses related to the easy/difficult dimension as well as the importance/unimportance dimension of mathematics attitude.

It is interesting to note that despite the variations in the way how researchers define mathematics attitude, almost all underscore that mathematics attitude is a function of a complex set of factors which include emotions, beliefs, interest, and value (importance/non-importance). A review of existing literature on the measurement of the construct provides additional insight into the reasons why scholars in the field must deal with the complex task of operationalizing the mathematics attitude construct.

Measurement of Mathematics Attitude

The quest for improving student achievement in mathematics apparently brought the mathematics attitude construct to a closer empirical scrutiny. When it comes to what specifically underpins the growing research attention at global level, Haladyna et al.(1983) argue that a positive attitude toward mathematics is valued because of a number of factors which according to the researcher include:

> A positive attitude is an important school outcome in and of itself; attitude is often positively, although slightly, related to achievement; and, a positive attitude toward mathematics may increase one's tendency to elect mathematics courses in high school and college and possibly one's tendency to elect careers in mathematics or mathematics-related fields(p. 20)

In effect, since mid 1950s a number of researchers (e.g. Dutton, 1954; Gladstone, Deal, & Drevdahl 1960; Aiken & Dreger 1961; Dutton & Blum, 1968; Aiken 1974; Fennema & Sherman, 1976; Michaels & Forsyth 1977; Sandman 1980) endeavored to come up with a valid and reliable measure of mathematics attitude. Nonetheless, some of these early measures were uni-dimensional (e.g. Dutton, 1954; Gladstone, Deal, & Drevdahl 1960; Aiken & Dreger 1961) which makes them less effective in terms of tapping the math attitude construct in its entirety. As the research on the issue piled-up, and the construct understood better, multidimensional measures started to emerge (e.g., Aiken 1974; Michaels & Forsyth 1977; Fennema & Sherman, 1976; Sandman 1980). Aiken (1974), for instance, developed scales designed to tap enjoyment of mathematics and the value of mathematics. The ground breaking work, however, goes to the popular Fennema-Sherman Mathematics Attitude Scales (Fennema & Sherman, 1976). According to Tapia and Marsh (2004), this measure has become one of the most popular instruments used in research over the last three decades. And, as a result, several attempts were made to adapt the instrument for use in different cultural contexts (e.g. Melancon, Thompson, & Becnel 1994; Mulhern and Rae, 1998) The Fennema-Sherman Mathematics Attitude Scales consist of a group of nine instruments made up of 108 items: (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.

Notwithstanding the popularity of the Fennema-Sherman measure, the inconsistent findings of subsequent studies (e.g., Liau, Kassim, & Loke, 2007; McLean, & Templeton, 1988; Melancon et al. 1994; Mulhern & Rae 1998; Suinn & Edwards, 1982; O'Neal, Ernest 1988) doubt on its validity and reliability (e.g., O'Neal et al. 1988). Among these, Melancon et al. (1994) reported that their findings failed to find a perfect fit with the model proposed by Fennema and Sherman while Mulhern and Raes (1998) study on Irish sample identified only six factors, which led them to conclude that the scales, might not measure what they were intended to measure. In contrast, in similar validation study on Malysian high school students Liau et al. (2007) confirmed Fennema-Sherman's earlier findings that had nine factors rather than six.

These irregularities in the Fennema-Sherman Mathematics Attitude Scales (Fennema & Sherman, 1976) gave rise to the development of new instruments including the Attitude towards Mathematics Inventory (ATMI) (Tapia & Marsh 2004). The ATMI conceptualizes mathematics attitude in terms of four independent yet related dimensions; namely: self-confidence, enjoyment, motivation, and value. According to the authors, self-confidence sub-scale assesses the level of confidence to do math; enjoyment taps the extent to which a student enjoys doing math; motivation refers to the level of motivation to do Math; and Value component assesses the extent to which the student attaches value to doing math. A part from being a recently developed measure, there is sufficient evidence to suggest the ATMI has a strong construct validity and reliability evidences a reported in subsequent studies (e.g., Tapia & Marsh 2004; 2005).

Why the Measurement of Math Attitude is so Important?

Measuring mathematics attitude through reliable and valid instruments helps educators and practitioners not only to identify individuals who hold negative or positive attitude towards the subject, but also to understand why they behave the way they do. On the other hand, the empirical relationship of mathematics attitude with electing (or enrolling for) mathematics course, mathematics achievement (e.g. Marsh 1989), and other cognitive and affective processes that affect learning mathematics makes attitude measurement worthy of research attention.

In recognition of its significance, there has been an ongoing effort to come up with an effective instrument that reliably measures attitudes towards mathematics (e.g., Fennema and Sherman, 1976; Michaels and Forsyth 1977; Sandman 1980; Tapia & Marsh 2004; 2005). However, little has so far been done in sub-Saharan African countries including Ethiopia. Research efforts to develop culturally relevant math attitude measures is limited in Ethiopia only a few studies made some attempt to adapt the instrument based based on the existing literature on mathematics attitude (e.g., Seleshi 1995; 2001). Developing measuring instruments that enable scholars and researchers generate reliable data on affective aspect of science and mathematics education is critical to improve the quality of learning and boost student achievement. Most importantly, under the circumstances where the problems surrounding education quality particularly in the basic science and mathematics continues to challenge the higher education system the need for sustained engagement of researchers becomes highly significant. Mathematics is a 'critical filter' for those who join science and engineering. Weakness in mathematics is a formidable obstacle which prevents many from successfully completing their studies in science, engineering or technology streams. For instance, Waits and Demana (1988) revealed a strong relationship between mathematics skills and success in college. Similarly, Stage and Kloostermen

(1995) found that students who are under-prepared in mathematics courses may be forced to change their career plans or even dropout of college.

Taken together, an issue of great significance for researchers in the field is to find out whether the problems related to mathematics attitude are associated with lack of mathematical skills or knowledge or whether it is because the attitude of students towards mathematics affects their level of achievement on the subject. Mathematics educators (e.g., Willoughby, 1990; Koch, 1992), however argue that students will achieve better in mathematics if they like it. They argue that there is a need for attention to be directed towards developing, maintaining, and reinforcing positive attitudes towards mathematics. In this connection developing reliable and valid instruments that measures attitude towards mathematics is the logical point of departure.

As discussed earlier, a continued research endeavor over the last five decades has produced several math attitude measures. However, the quest for a shorter, yet reliable and valid instrument later yielded the Attitudes toward Mathematics Inventory (ATMI). The ATMI was initially developed by Tapia (1996) to tap six dimensions of math attitude: *confidence*, *anxiety*, *value*, *enjoyment*, *motivation* and *Parent*/*Teacher expectation* (Tapia & Marsh, 2004). Following an extensive item analyses and explanatory factor analysis, Tapia and Marsh (2004) came up with a 40-item instrument that measures four factors Self-confidence, Value, Enjoyment, and Motivation.

On top of its good psychometric qualities, the relatively short length of the ATMI partly emboldened a wider use in different cultural contexts (e.g., Yee 2010; He 2007). However, it is not known if in fact, the four-factor model can be applicable to Ethiopian context. Moreover, as the ATMI was developed for, and standardized on a sample of students in the Western culture (in American), it raises some concern that the instrument may be inappropriate for use among Ethiopian students. By way of addressing this concern, the present study is set out to determine the factorial validity of the adapted ATMI-*Amharic* based data generated on sample of Ethiopian university students.

Method

Participants

The study participants were randomly selected undergraduate students who were enrolled for mathematics courses at Arbaminch University in the first semester of the 2007 academic year. The sample was made up of 385 students [(Male = 317 and Female = 68 (17.7%)] with mean age of 21.27 (*SD* = 2.23) Years. The composition of the sample with respect to year level was: 104 (27%) freshmen, 206 (54%) sophomore, and 75 (19%) senior students. A stratified random sampling technique was employed to select a representative sample from the three faculties (Business, Engineering, and Science) constituting ten academic fields. The target population was then divided into ten different groups based on the number of academic departments in which mathematics courses were part of the curriculum. The study sample was then determined using systematic random sampling procedure. Accordingly, the distributions of the sample in the three faculties were: 40.7% from Science [i.e. mathematics (n = 80), physics (n = 37), and computer science (n = 40) = 157], 40% engineering [i.e. civil (n = 15), mechanical (n = 26), electrical (n = 25), irrigation (n = 57), & hydraulic (n = 31) = 154], and 19.2% from Business [i.e. Accounting (n = 46) & Management (n = 28) = 78] faculties.

Instrumentation

This study used the adapted ATMI (Attitudes towards Mathematics Inventory) consisting of 40 items originally designed by Tapia and Marsh (2004). The reason why this particular instrument was selected is because of its high content-validity and construct-validity. Another reason for selecting the instrument was that, apart from its multidimensional nature, ATMI was the most recent and the least complicated measure.

The original ATMI was first standardized on a sample of American high school students and resulted in four factors identified as: *Self-confidence*, value, *enjoyment*, and *motivation*. Self-confidence was measured by 15 items. This subscale includes items like: "Mathematics does not scare me at all" and "Studying mathematics makes me feel nervous". The *Value* scale consisted of 10 items: "Mathematics is a very worthwhile and necessary subject" and "Mathematics courses will be very helpful no matter what I decide to study”. *Enjoyment* was assessed using 10 items consisting of items such as: "I really like mathematics" and "I have usually enjoyed studying mathematics in school". The *Motivation* subscale consisted of five items including items like: "I am willing to take more than the required amount of mathematics" and "The challenge of mathematics appeals to me." As illustrated in Table 1, the alpha coefficients for the four subscales were found to swing between 0.88 - 0.95 (Tapia & Marsh, 2004). Tapia and Marsh’s (2005) later study which employed confirmatory factor analysis procedure on a sample of American college students, once again substantiated the validity of the four-factor model.

The ATMI-Amharic

The ATMI-*Amharic* (emphasis is ours) measure was initially adapted and translated into the lecturers studied Amharic Language by the Authors, and later, subjected to a review by two university lecturers. One of the lecturers was professional in mathematics and science education while the other studied Amharic and English Languages. The two lecturers reviewed the draft measure in terms of (a) the accuracy of the translation (including back translation into English), and (b) the extent to which the adaptation to Ethiopian culture was made without altering the essence of the items. The feedback received (including the use of most appropriate Amharic equivalents; conceptual discrepancies between the original and the adapted Amharic items) were then incorporated into the final version of the ATMI-*Amharic* (see: Annex) before it was administered for the final data collection.

The items were constructed using a five-point Likert-type format with the responses ranging from “strongly disagree” = 1 to “strongly agree” = 5. Eleven items of the ATMI-*Amharic* (i.e. Items: 9-12, 25, & 28) were reverse-coded before the data analysis since they were negatively stated (see: Appendix B).

Procedure

The ATMI-*Amharic* was administered to a representative sample of 385 regular undergraduates at Arbaminch University during normal class hours in the first semester of the 2006/07 Academic Year. The instructors who participated in data collection were given verbal and written instructions on how to administer the instrument to make sure that the conditions were uniform for all respondents. Likewise, the study participants were given directions on how to record their answers before they started responding. The completed questionnaires were then returned to the respective instructors. No attrition of participants was reported since all the respondents were willing to take part in the study. Thus, no data was lost due to non-response or incomplete information.

Data Analyses

The psychometric properties of the adapted ATMI-*Amharic* measure were established through the following stages: (1) The internal consistency estimates for the entire measure and the four sub-scales were established employing Cronbach alpha (α); (2) The construct validity evidence of the anticipated four-factor model for the adapted ATMI-*Amharic* measure was established using Confirmatory Factor Analysis (CFA); and (3) Tests of factorial invariance across gender and year level were also conducted using CFA. CFA was preferred since it enables us to establish a construct-validity evidence for the adapted measure which is normally based on pre-established theory (e.g., Kline, 1998) developed by Tapia and Marsh (2004). Further, CFA provides various model fit indices that included: The Chi-square Goodness-of-fit, the Ratio of the Chi-square Goodness-of-fit to the degrees of freedom, the Root Mean Square Error of Approximation (RMSEA), the Goodness of Fit Index (GFI), the Normed Fit Index (NFI), and the Expected Cross-Validation Index (ECVI). The statistical software used for data analyses were AMOS 5 and SPSSWIN 15.

Results

This chapter presents the findings in view of the research questions identified earlier. Accordingly, the first section discusses the internal consistency reliabilities of the adapted ATMI-*Amharic* measure. The Cronbach alphas of the adapted instrument will be compared with the original ATMI developed by Tapia and Marsh (2004). Secondly, the findings related to the construct validity of the ATMI-*Amharic* will be in order. Finally, the Invariance test on ATMI-Amharic will be conducted for its independence as a function of gender and year level.

Internal consistency reliabilities

To determine the internal consistency reliability of ATMI-*Amharic*, Cronbach alpha coefficients were calculated for the whole measure and the four sub-scales. As shown in Table, the internal consistency estimates of the four subscales were found to be between moderate to high with coefficient alphas ranging from 0.79- 0.89 (i.e. 0.89 for Self-confidence, 0.83 for Value, 0.87 for Enjoyment, and 0.79 for Motivation). The internal consistency reliability estimate for the entire ATMI-*Amharic* measure is found to be 0.94. The coefficients generally represent high reliability for the adapted instrument since all α coefficients exceeded Cortina's (1993) criteria of acceptance (i.e. $\alpha = .70$).

Evidently, the internal consistency estimates of the original ATMI and the ATMI-*Amharic* is slightly different. Similar pattern of findings were reported in related studies which adapted math attitude measures in different cultural contexts and samples (Liau et al, 2007; Mulhern & Rae, 1998). Likewise, the comparison of the Means and *SD*s also indicates that the Ethiopian (Mean = 162.68; *SD*= 19.91) sample scored comparatively higher compared to the American (Mean = 137.36; *SD*= 28.93) sample. This may be because Tapia and Marsh's (2004) subjects were high school students while the sample used in the present study were university undergraduates taking higher math courses. Thus, the variations in the mean scores may be attributable to the nature of the sample.

Table 1: Internal consistencies reliabilities *(r_α)* of the four attitude dimensions of the Original and the adapted ATMI-*Amharic*. (N = 385)

	ATMI-Amharic				*ATMI-English**			
Math Attitude Dimensions	*n*	*Mean*	*SD*	α	*N*	*Mean*	*SD*	*α***
Enjoyment	10	40.27	6.04	0.87	10	31.91	8.06	0.89
Motivation	5	19.28	3.54	0.79	5	15.99	4.95	0.88
Self-Confidence	15	60.11	8.62	0.89	15	51.10	13.13	0.95
Value	10	43.02	4.95	0.83	10	38.37	6.74	0.89
Overall Scale	**40**	**162.68**	**19.91**	**0.94**	**40**	**137.36**	**28.93**	**0.97**

*As reported in Tapia and Marsh (2004); ** Cronbach alpha *(α)*

Inter-correlation among the four factors reveals statistically significant linear relationship (see Table 2 below) ranging between 0.49-80 ($p < .001$). Likewise, the correlation between the entire ATMI-*Amharic* measure with the four factors also suggests a strong linear association ranging from 0.65 – 95 ($p < .001$).

Table 2: Inter-correlations of ATMI-*Amharic* Factors

ATMI-*A*-Factors	**1**	**2**	**3**	**4**
1.Enjoyment	-	.80	0.77	0.57
2.Motivation		-	0.70	0.52
3.Self-confidence			-	0.49*
4.Value				-
5. ATMI-*Amharic*[a]	.95	.86	.65	.82

*All correlations are statistically significant at $p < .001$

Inter-Item and Total-Item Correlations

In order to determine the degree of systematic relationship of the ATMI-Amharic with individual items, total-item correlations were computed. The results (see Annex B) once again reveal a statistically significant correlation ranging between 0.30-0.74 ($p <. 01$).

Factorial Validity Evidence

Test of Fit of Measurement Model

The factorial validity of the adapted ATMI-*Amharic* measure was examined using confirmatory factor analysis (CFA) employing a statistical software called AMOS 5 (Field, 2005). Specifically, CFA with maximum likelihood method was employed to evaluate the construct validity of the anticipated four-factor model on a large sample of Ethiopian university students. The CFA procedure is based on several measures to assess the model fit which included: the Chi-square goodness of fit, the ratio of the Chi-square goodness of fit to the degrees of freedom, the Root Mean Square Error of Approximation (RMSEA), the goodness of fit index (GFI), the Normed Fit Index (NFI), and the Expected Cross-Validation Index (ECVI).

Table 3: Confirmatory Factor Analysis Results of ATMI-*Amharic*

Model	NPAR	χ^2	*df*	P	χ^2/df	GFI	NFI	CFI	RMSEA
CFA*	8	1.827	2	0.401	0.913	0.998	0.998	1	000

**CFA = Confirmatory Factor Analysis; ECVI = 0.046; adj GFI = 0.988*

Notes

- NPAR = Number of parameters; *df* = degree of freedom; p = Associated probability; GFI = Goodness of Fit Index; NFI = Normed Fit Index; CFI = Comparative Fit Index; RMSEA = Root Mean Square Error Approximation; ECVI = Expected Cross-Validation Index

As shown in Table 3, the CFA revealed a Chi-square goodness of fit of 1.827 based on 2 degrees of freedom (*df*) with associated probability (p) of 0.401.

According to Shumacker and Lomax (1996), a probability greater than 0.05, indicates a good fit. Further, the goodness of fit index (GFI) and the adjusted GFI were found to be 0.998 and 0.988 respectively. The GFI and GFI were also higher than the required value of 0.90 (Shumacker & Lomax, 1996). The GFI compares the similarity of the sample and the model covariance matrix. Thus, a GFI of 0.998 shows 99.8% of the sample covariance matrix fits the population covariance matrix.

Besides, the root mean square error of approximation (RMSEA) was less than 0.001. According to Hu and Bentler (1999), a value less than .06 implies a good model fit. On the other hand, the normed fit index (NFI) was 0.998 with the comparative fit index (CFI) of 1.000. Further, the expected cross-validation index (ECVI) for both the model and the saturated model was found to be 0.046. According to Shumacker and Lomax (1996), the observed goodness of fit indices represents a good model fit. From the findings, therefore, it can be concluded that the four ATMI-*Amharic* factors (i.e. self-confidence, value, enjoyment and motivation) adapted from Tapia and Marsh (2004) were found to hold for the sample of Ethiopian university students.

Tests of Factorial Invariance of Measurement

In order to answer the question posed earlier as to the independence of the ATMI-*Amharic* with respect to student gender and year level, a test of factorial invariance was run. The procedure is specifically meant to find out whether or not the adapted measure is unbiased with respect to student gender and year of study in university. The findings are discussed in the paragraphs below.

Invariance with respect to gender

To find out whether the four-factor model ATMI-*Amharic* is dependent of student gender, a multi-group comparison was conducted by constraining the measurement weight (the factor pattern coefficients) and letting structural co-variances to be equal across the two gender groups. No significant differences were found between the constrained and unconstrained models [$\chi^2(df)$ = 0.91(1) with associated probability (p) of 0.34 and RMSEA < .0001], indicating that the model is valid for both male and female groups. Table 4 below presents a detailed multi-group comparison fit indices.

Table 4: Factorial invariance test for gender groups

Model Step	NPAR	χ^2	*df*	*p*	χ^2/df	GFI	NFI	CFI	RMSEA
Gender Groups									
Unconstrained Model (UM)	16	2.28	4	0.68	0.57	1.0	.998.	1.0	000
Constrained Model-1(CM1)	13	6.7	7	0.46	0.96	0.99	0.993	1.0	000
Constrained Model-2(CM2)	12	7.61	8	0.473	0.95	0.99	0.992	1.0	000
Model Differences		$\Delta\chi^2$	Δdf	*p*		**ΔGFI**	**ΔNFI**	**ΔCFI**	**ΔRMSEA**
Between UM & CM1		4.42	3	0.22		0.005	0.005	000	000
Between UM & CM2		5.33	4	0.26		0.005	0.006	000	000
Between CM1 & CM2		0.91	1	0.34		0	0.001	000	000

Notes:

- Constrained Model-1 (CM1) = A model constraining the measurement weights to be equal across the groups
- Constrained Model-2 (CM2) = A model constraining both the measurement weights and variance of the variable Attitude to be equal across the groups
- NPAR = Number of parameters; *df* = degree of freedom; p = Associated probability; GFI = goodness of fit index; NFI = Normed Fit Index; CFI = Comparative Fit Index; RMSEA = Root Mean Square Error Approximation.

Invariance across year levels

The test of factorial invariance as a function of year level was carried out. A multi-group comparison was conducted constraining the measurement weight (the factor pattern coefficients) and letting structural co-variances to be equal across the three groups: First year, second year, and third year. No statistically significant differences were observed between the constrained and unconstrained models [$\chi^2(df) = 0.68(2)$; associated probability (p) = 0.71 and RMSEA < .0001], suggesting that the model is valid across the three groups. The detailed multi-group comparison fit indices is presented in Table 5 below.

Table 5: Factorial Invariance across Year-Levels

Model Step	**NPAR**	χ^2	*df*	*p*	χ^2/df	**GFI**	**NFI**	**CFI**	**RMSEA**
Year Level									
Unconstrained Model (UM)	24	2.64	6	0.85	0.44	0.997	0.997	1	000
Constrained Model-1(CM1)	18	9.14	12	0.69	0.762	0.988	0.99	1	000
Constrained Model-2(CM2)	16	9.82	14	0.78	0.701	0.988	0.989	1	000
***Model Difference**s*		$\Delta\chi^2$	Δdf	*p*		**ΔGFI**	**ΔNFI**	**ΔCFI**	**ΔRMSEA**
Between UM & CM1		6.5	6	0.37		0.011	0.007	000	000
Between UM & CM2		7.18	8	0.52		0.011	0.008	000	000
Between CM1 & CM2		0.68	2	0.71		.000	0.001	000	000

Notes:

-Constrained Model-1 (CM1) = A model constraining the measurement weights to be equal across the groups

- Constrained Model-2 (CM2) = A model constraining both the measurement weights and variance of the variable Attitude to be equal across the groups

-NPAR = Number of parameters; *df* = degree of freedom; p = Associated probability; GFI = goodness of fit index; NFI = Normed Fit Index; CFI = Comparative Fit Index; RMSEA = Root Mean Square Error Approximation

In short, from the above findings it can safely be concluded that the ATMI-*Amharic* possesses a good psychometric properties and can be used to measure attitude towards mathematics among Ethiopian university students. Further, the tests of factorial invariance across gender and year level yielded no statistically significant differences between the constrained and unconstrained models suggesting that the ATMI-*Amharic* measure equally treats male and female students as well as students at different year levels of study.

Conclusions

Considering the urgency to improve the quality of science and engineering education in general and mathematics education in particular, the present study made a modest attempt at adapting a measure of mathematics attitude. Apart from the small contribution it makes, the study article is designed to serve as a point of departure for other affective measures to be developed in the future since addressing the cognitive side of mathematics learning depends on the former. As it turned out, the observed psychometric properties of the ATMI-*Amharic* provided sufficient evidence of a good measure. First, the ATMI-*Amharic* is a reliable instrument as it delivered high internal consistency reliability indices. Second, the confirmatory factor analysis evidenced that the ATMI-*Amharic* measure, which is based on pre-determined theory and data structure (Tapia & Marsh 2004), can be considered equivalent to the original instrument. The results further reaffirmed the four-factor structure which was found among high school (Tapia & Marsh 2004) and college students in America (Tapia & Marsh 2005). Thus, the findings of the present study warrant the use of the ATMI-*Amharic* among Ethiopian university students.

The current study also noted out that the four-factor structure has measurement invariance across student gender and year level. This implies that the mathematics attitude scores obtained through the ATMI-*Amharic* equally serves male and female students and students at different levels of study at college/university. Thus, the ATMI-*Amharic* holds promise for providing researchers and educators (with a brief albeit dependable), measure of attitudes toward Mathematics in the Amharic Language – A Language of nation-wide communication. Besides, the ATMI-*Amharic* can further be adapted to different local contexts and languages (such as Afan *Orom* and *Tigregena,)* as well as grade levels (primary and secondary) to improve the current precarious state of mathematics education in Ethiopia.

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Annex A

Item No.	ATMI-Original	ATMI-*Amharic*
1	Mathematics is a very worthwhile and necessary subject	ሒሳብ በጣም ጠቃሚና አስፈላጊ የትምህርት ዓይነት ነው::
2	I want to develop my mathematical skills	የሒሳብ ትምህርት ጠቃሚ በመሆኑ ክህሎቴን ማሳደግ □□ለፉለሁ::
3	I get a great deal of satisfaction out of solving a mathematics problem	የሒሳብ ጥያቄዎቸን (ኘሮብሌሞችን) ሥሰራ ከፍተኛ □የመንፈስ እርካታን አገኛለሁ::
4	Mathematics helps develop the mind and teaches a person to think	ሒሳብ □ሰ□ ል□ አእምሮዉን □እንዲዳብርና የማስብ ችሎታው□□□ እን□ሻሽል ያግዛል::
5	Mathematics is important in everyday life	ሒሳብ ለሰ□ ል□ □ክለት ተክለት ኑሮ አስፈላጊ ትምህርት ነው::
6	Mathematics is one of the most important subjects for people to study	ሒሳብ በጣም አስፈላጊና ሊጠኑ ከሚገባቸው የትምህርት አይነቶች አንዱ ነው::
7	Math courses would be very helpful no matter what I decide to study	የትኛውንም የትምህርት መስክ ለማጥናት ብወስንም በኮሌጅ/ዩኒቨርሲቲ የሚሰጡ የሒሳብ ኮርሶች በጣም ይ□ቅሙኛል::
8	I can think of many ways that I use math outside of school	□ሒሳብን እውቀት ከትምህርት ቤት ውጪ ጥቅም ላዉል የሚያስችሉ ብዙ አማራጮች እንዳሉኝ እረዳለሁ::
9@	Mathematics is one of my most dreaded subjects	ሒሳብ በጣም ከሚያስፈሩኝ የትምህርት ዓይነቶች አንዱ ነው::
10@	My mind goes blank and I am unable to think clearly when working with mathematics	ሒሳብ መሥራት ስጀምር አእምሮ□ ባ□ ስለሚሆብኝ በትክክል ለመስራት አልችልም::
11@	Studying mathematics makes me feel nervous	ሒሳብን በማጠና ግዜ እረበሻለሁ::
12@	Mathematics makes me feel uncomfortable	ሒሳብ ለኔ ምቾትን የሚሰጥ ትምህርት አይደለም::
13@	I am always under a terrible strain in a math class	በሒሳብ □□ለ □□ ሁሌ ከፍተኛ ጭንቀት ዉስጥ እገባለሁ::
14@	When I hear the word mathematics, I have a feeling of dislike	ሒሳብ የሚለውን ቃል ስሰማ የጥላቻ ስሜት ይሰማኛል::
15@	It makes me nervous to even think about having to do a mathematics problem	የሒሳብ ጥያቄን ለመስራት ማሰብም ቢሆን በራሱ □ረብሸኛል::
16	Mathematics does not scare me at all	ሒሳብ በጭራሽ አያስፈራኝም::
17	I have a lot of self-confidence when it comes to mathematics	ሒሳብን በተመለከተ ከፍተኛ በራስ የመተማመን ስሜት አለኝ::
18	I am able to solve mathematics problems without too much difficulty	የሒሳብ ጥያቄዎችን የጎላ ችግር ሳይገጥመኝ መስራት □ችላለሁ::

19	I expect to do fairly well in any math class I take	ማንኛውንም የሒሳብን ኮርስ ብ□ስ□ □ሩ □·□ት □አመጣለሁ ብዬ እገምታለሁ::
20[@]	I am always confused in my mathematics class	በሒሳብ □□ለ □□ ሁሌ □ራእፉባለሁ::
21[@]	I feel a sense of insecurity when attempting mathematics	ሒሳብን ለመስራት ገና ሙከራ ሳደርግ በችሎታዬ ያለመተማመን ስሜት ይሰማኛል::
22	I learn mathematics easily	ሒሳብን በቀላሉ □ረ□ለሁ::
23	I am confident that I could learn advanced mathematics	በደረጃቸው ላቅ ያሉ የሒሳብ ኮርሶችን ብማር □ዉጤታማ እንደምሆን □እተማመናለሁ::
24	I have usually enjoyed studying Mathematics in college	የሒሳብ ትምህርት መማር ለኔ በአብዛኛ□ ያስደስተኛል::
25[@]	Mathematics is dull and boring	የሒሳብ ትምህርት ደስታንሽ የማይሰጥና አሰልቺ ነው::
26	I like to solve new problems in mathematics	አዳዲስ የሒሳብ ጥያቄዎችን (ኘሮብሌሞችን) መስራት □□□ለሁ::
27	I would prefer to do an assignment in math than to write an essay	በ□ሑ□ (essay) ከሚገለጸው ይልቅ በሒሳብ የሚሰራውን የቤት ሥራ □መር□ለሁ::
28[@]	I would like to avoid using mathematics in college	ሒሳብን የሚጠይቁ ትምህርቶች በኮሌጅ ውስጥ ባይሰጡ □መር□ለሁ::
29	I really like mathematics	ሒሳብን በዕረግጥ □□□ለሁ::
30	I am happier in a math class than in any other class	ከሌሎች የትምህርቶች ይልቅ በሒሳብ ክፍለ ጊዜ የበለጠ □ስተኛ ነኝ::
31	Mathematics is a very interesting subject	ሒሳብ በጣም የሚያስደስት የትምህርት ዓይነት ነው::
32	I am willing to take more than the required amount of mathematics	ከሚጠበቅብኝ በላይ ተጨማሪ የሒሳብ ኮርሶችን ብ□ስ□ ፍላጎቴ ነው::
33	I plan to take as much mathematics as I can during my education	በትምህርት ላይ □□ለሁ በተቻለ መጠን ብዙ የሒሳብ ኮርሶችን ለመማር አቅዳለሁ::
34	The challenge of math appeals to me	□ሒሳብ □□□ር (□·□□ር) ለኔ አስደሳችና ማራኪ ነው::
35	I think studying advanced mathematics is useful	ደረጃቸው ላቅ ያሉ የሒሳብ ኮርሶችን ማጥናት ጠቃሚ ነው ብዬ አስባለሁ::
36	I believe studying math helps me with problem solving in other areas	በሌሎች መስኮች ለሚያጋጥሙ ችግሮች መፍትሔ ለመስጠት ሒሳብን መማር ይረዳል ብዬ አምናለሁ::
37	I am comfortable expressing my own ideas on how to look for solutions to a difficult problem in math	ከባድ የሒሳብ ጥያቄ (ኘሮብሌም) በሚ□ፉ□ም □□ ጥያቄውን ለመሥራት በምን አይነት ዘዴ ሙከራ መ□ረ□ □እንዳለበት በተረጋጋ መንፈስ መግለጽ እችላለሁ::
38	I am comfortable answering questions in math class	በሒሳብ □□ለ □□ ለሚነሱ ጥያቄዎች በተረጋጋ ስሜት መልስ □እሰ□ለሁ::
39	A strong math background could help me in my professional life	ጠንካራ የሒሳብ መሠረት ካለኝ በ□□□ቱ □ሥራ (የሙያ) ሕይወቴ ሊረዳኝ ይችላል::
40	I believe I am good at solving math problems	የሒሳብ ጥያቄዎችን በመሥራት ረገድ ጥሩ ችሎታ እንዳለኝ አምናለሁ::

@Items reverse coded before the analysis

Dimensions/Subscales

S.No.	**Dimensions/Subscales**		**Item No**
1	Self confidence	በራስ መተማመን	9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22 & 40
2	Enjoyment	ተደሳችነት □	3, 24, 25, 26, 27, 29, 30, 31, 37 & 38
3	Motivation	ተነሳሽነት	23, 28, 32, 33 & 34
4	Value	□ቃሚነት□	1, 2, 4, 5, 6, 7, 8, 35, 36 & 39

Annex B

Means, *SD*s, and Total-Item-Correlations for ATMI-*Amharic*

Item No.	Items	Mean	SD	r*
1	ሒሳብ በጣም ጠቃሚና አስፈላጊ የትምህርት ዓይነት ነው::	4.58	0.64	0.52
2	የሒሳብ ትምህርት ጠቃሚ በመሆኑ ክህሎቴን ማሳደግ □□ለፉለሁ::	4.63	0.61	0.50
3	የሒሳብ ጥያቄዎቸን (ኘሮብሌሞችን) ሥሰራ ከፍተኛ □የመንፈስ እርካታን አገኛ ለሁ::	4.41	0.81	0.59
4	ሒሳብ □ሰ□ ል□ አእምሮዉን □እንዲዳብርና የማስብ ችሎታው□□□ እን□ሻሽል ያግዛል::	4.41	0.78	0.51
5	ሒሳብ ለሰ□ ል□ □ክለት ተክለት ኑሮ አስፈላጊ ትምህርት ነው::	4.24	0.82	0.35
6	ሒሳብ በጣም አስፈላጊና ሊጠኑ ከሚገባቸው የትምህርት አይነቶች አንዱ ነው::	4.28	0.78	0.47
7	የትኛውንም የትምህርት መስክ ለማጥናት ብወስንም በኮሌጅ/ዩኒቨርሲቲ የሚሰጡ የሒሳብ ኮርሶች በጣም ይ□ቅሙኛል::	4.28	0.82	0.30**
8	□ሒሳብን እውቀት ከትምህርት ቤት ውጪ ጥቅም ላዉል የሚያስችሉ ብዙ አማራጮች እንዳሉኝ እረዳለሁ::	4.14	0.89	0.42
9	ሒሳብ በጣም ከሚያስፈሩኝ የትምህርት ዓይነቶች አንዱ ነው::	3.98	1.19	0.52
10	ሒሳብ መሥራት ስጀምር አእምሮ□ ባ□ ስለሚሆብኝ በትክክል ለመስራት አልችልም::	4.36	0.88	0.45
11	ሒሳብን በማጠና ግዜ እረበሻለሁ::	4.30	0.93	0.47
12	ሒሳብ ለኔ ምቾትን የሚሰጥ ትምህርት አይደለም::	4.28	0.89	0.62
13	በሒሳብ □□ለ □□ ሁሌ ከፍተኛ ጭንቀት ዉስጥ እገባለሁ::	4.41	0.80	0.62
14	ሒሳብ የሚለውን ቃል ስሰማ የጥላቻ ስሜት ይሰማኛል::	4.48	0.84	0.61
15	የሒሳብ ጥያቄን ለመስራት ማሰብም ቢሆን በራሱ ይረብሸኛል::	4.35	0.92	0.54
16	ሒሳብ በጭራሽ አያስፈራኝም::	3.69	1.22	0.54
17	ሒሳብን በተመለከተ ከፍተኛ በራስ የመተማመን ስሜት አለኝ::	3.81	0.91	0.66
18	የሒሳብ ጥያቄዎችን የጎላ ችግር ሳይገጥመኝ መስራት □ችላለሁ::	3.32	0.94	0.59
19	ማንኛውንም የሒሳብን ኮርስ ብ□ስ□ □ሩ □□ት □አመጣለሁ ብዬ እገምታለሁ::	3.84	0.83	0.65
20	በሒሳብ □□ለ □□ ሁሌ □ራእፉባለሁ::	4.10	0.88	0.54
21	ሒሳብን ለመስራት ገና ሙከራ ሳደርግ በችሎታዬ ያለመተማመን ስሜት	3.71	0.98	0.56

	ይሰማኛል::			
22	ሒሳብን በቀላሉ □ረ□ለሁ::	3.65	0.86	0.53
23	በደረጃቸው ላቅ ያሉ የሒሳብ ኮርሶችን ብማር □ዉጤታማ እንደምሆን □እተማመናለሁ::	3.86	0.88	0.66
24	የሒሳብ ትምህርት መማር ለኔ በአብዛኛ□ ያስደስተኛል::	4.24	0.91	0.55
25	የሒሳብ ትምህርት ደስታንሽ የማይሰጥና አሰልቺ ነው::	4.31	0.90	0.60
26	አዳዲስ የሒሳብ ጥያቄዎችን (ኘሮብሌሞችን) መስራት □□□ለሁ::	3.93	0.89	0.66
27	በ□ሑ□ (essay) ከሚገለጸው ይልቅ በሒሳብ የሚሰራውን የቤት ሥራ □መር□ለሁ::	3.95	1.07	0.54
28	ሒሳብን የሚጠይቁ ትምህርቶች በኮሌጅ ውስጥ ባይሰጡ □መር□ለሁ::	4.39	0.90	0.54
29	ሒሳብን በዕረግጥ □□□ለሁ::	4.23	0.78	0.72
30	ከሌሎች የትምህርቶች ይልቅ በሒሳብ ክፍለ ጊዜ የበለጠ ደስተኛ ነኝ::	3.83	1.02	0.67
31	ሒሳብ በጣም የሚያስደስት የትምህርት ዓይነት ነው::	4.13	0.84	0.74
32	ከሚጠበቅብኝ በላይ ተጨማሪ የሒሳብ ኮርሶችን ብወስድ ፍላጎቴ ነው::	3.55	1.12	0.62
33	በትምህርት ላይ □□ለሁ በተቻለ መጠን ብዙ የሒሳብ ኮርሶችን ለመማር አቅዳለሁ::	3.58	0.96	0.66
34	□ሒሳብ □□□ር (□□□ር) ለኔ አስደሳችና ማራኪ ነው::	3.90	0.92	0.68
35	ደረጃቸው ላቅ ያሉ የሒሳብ ኮርሶችን ማጥናት ጠቃሚ ነው ብዬ አስባለሁ::	4.10	0.84	0.54
36	በሌሎች መስኮች ለሚያጋጥሙ ችግሮች መፍትሔ ለመስጠት ሒሳብን መማር ይረዳል ብዬ አምናለሁ::	4.10	0.83	0.48
37	ከባድ የሒሳብ ጥያቄ (ኘሮብሌም) በሚ□ፉ□ም ጊዜ ጥያቄውን ለመሥራት በምን አይነት ዘዴ ሙከራ መ□ረ□ □እንዳለበት በተረጋጋ መንፈስ መግለጽ እችላለሁ::	3.61	0.84	0.61
38	በሒሳብ □□ለ □□ ለሚነሱ ጥያቄዎች በተረጋጋ ስሜት መልስ □እሰ□ለሁ::	3.64	0.84	0.59
39	ጠንካራ የሒሳብ መሠረት ካለኝ በ□□□ቴ □ሥራ (የሙያ) ሕይወቴ ሊረዳኝ ይችላል::	4.25	0.90	0.45
40	የሒሳብ ጥያቄዎችን በመሥራት ረገድ ጥሩ ችሎታ እንዳለኝ አምናለሁ::	3.84	0.77	0.60
	Overall	**162.68**	**19.91**	**1**

* Total-item correlations; ** $p < .01$; All are statistically significant at .01 levels

Annex- C: ATMI-*Amharic* Item Inter-correlation matrix

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**
1	-	0.49	0.34	0.29	0.39	0.44	0.23	0.4	0.18	0.15	0.14	0.27	0.31	0.22	0.25	0.18	0.27	0.27	0.26	0.32	0.26	0.19	0.24	0.18	0.27	0.31
2		-	0.45	0.41	0.32	0.42	0.16	0.37	0.13	0.15	0.2	0.25	0.24	0.29	0.24	0.23	0.22	0.19	0.30	0.2	0.19	0.13	0.24	0.11	0.3	0.27
3			-	0.39	0.19	0.28	0.22	0.28	0.32	0.24	0.28	0.35	0.38	0.44	0.4	0.31	0.35	0.26	0.36	0.28	0.30	0.25	0.30	0.27	0.32	0.38
4				-	0.25	0.42	0.18	0.25	0.12	0.14	0.19	0.26	0.29	0.32	0.31	0.22	0.24	0.31	0.31	0.25	0.25	0.18	0.33	0.19	0.31	0.31
5					-	0.43	0.17	0.48	-.02	0.04	0.06	0.14	0.11	0.17	0.16	0.07	0.16	0.12	0.16	0.18	0.13	0.12	0.18	0.10	0.21	0.23
6						-	0.25	0.4	0.09	0.13	0.1	0.23	0.24	0.21	0.24	0.06	0.19	0.23	0.22	0.26	0.17	0.16	0.23	0.18	0.29	0.29
7							-	0.28	0.11	0.13	0.14	0.19	0.15	0.14	0.13	0.10	0.1	0.17	0.19	0.26	0.08	0.14	0.10	0.14	0.11	**0.08**
8								-	0.06	0.12	0.09	0.21	0.12	0.15	0.2	0.13	0.14	0.17	0.14	0.17	0.17	0.16	0.2	0.13	0.23	0.27
9									-	0.42	0.44	0.43	0.45	0.33	0.34	0.33	0.37	0.25	0.35	0.33	0.2	0.27	0.27	0.29	0.25	0.3
10										-	0.51	0.37	0.35	0.35	0.34	0.26	0.24	0.23	0.28	0.33	0.24	0.24	0.23	0.27	0.19	0.19
11											-	0.43	0.44	0.45	0.43	0.36	0.23	0.18	0.27	0.3	0.24	0.23	0.28	0.2	0.31	0.23
12												-	0.58	0.56	0.4	0.34	0.43	0.28	0.36	0.35	0.31	0.31	0.39	0.34	0.37	0.33
13													-	0.64	0.52	0.38	0.42	0.32	0.36	0.43	0.33	0.2	0.36	0.41	0.40	0.37
14														-	0.52	0.38	0.39	0.33	0.3	0.35	0.32	0.22	0.39	0.36	0.37	0.31
15															-	0.3	0.32	0.3	0.29	0.34	0.28	0.21	0.32	0.21	0.34	0.33
16																-	0.45	0.34	0.33	0.22	0.23	0.29	0.33	0.25	0.30	0.34
17																	-	0.49	0.47	0.28	0.42	0.43	0.52	0.36	0.38	0.45
18																		-	0.49	0.27	0.4	0.42	0.41	0.28	0.28	0.36
19																			-	0.4	0.35	0.44	0.44	0.32	0.32	0.43
20																				-	0.38	0.26	0.32	0.28	0.29	0.28
21																					-	0.34	0.39	0.32	0.28	0.32
22																						-	0.48	0.32	0.22	0.37
23																							-	0.43	0.42	0.46
24																								-	0.41	0.36
25																									-	0.42
26																										-

Annex-C *(Cont'd)*

	27	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
1	0.21	0.29	0.29	0.27	0.36	0.28	0.27	0.31	0.37	0.36	0.29	0.27	0.39	0.25
2	0.24	0.28	0.30	0.32	0.37	0.28	0.31	0.29	0.29	0.28	0.25	0.29	0.33	0.23
3	0.29	0.33	0.42	0.41	0.43	0.30	0.33	0.39	0.28	0.18	0.27	0.33	0.16	0.28
4	0.22	0.25	0.33	0.31	0.32	0.29	0.30	0.33	0.27	0.27	0.22	0.29	0.25	0.31
5	0.11	0.11	0.17	0.13	0.18	0.19	0.19	0.19	0.28	0.29	0.23	0.20	0.33	0.12
6	0.15	0.18	0.26	0.24	0.31	0.28	0.31	0.25	0.38	0.37	0.20	0.28	0.34	0.18
7	**0.02**	0.12	0.15	0.08	0.18	0.10	0.13	0.14	0.15	0.19	0.12	0.15	0.17	0.12
8	0.16	0.18	0.19	0.19	0.28	0.26	0.25	0.19	0.29	0.32	0.27	0.25	0.40	0.15
9	0.25	0.37	0.33	0.29	0.36	0.26	0.31	0.34	0.15	0.15	0.28	0.29	0.04	0.24
10	0.16	0.29	0.27	0.22	0.28	0.10	0.17	0.24	0.10	0.16	0.25	0.24	0.12	0.26
11	0.13	0.29	0.27	0.19	0.28	0.19	0.18	0.22	0.18	0.12	0.19	0.15	0.06	0.14
12	0.25	0.34	0.37	0.39	0.46	0.30	0.35	0.35	0.18	0.18	0.30	0.29	0.20	0.35
13	0.30	0.33	0.41	0.33	0.36	0.25	0.33	0.34	0.23	0.22	0.30	0.27	0.16	0.28
14	0.25	0.34	0.46	0.39	0.4	0.30	0.29	0.34	0.24	0.2	0.27	0.25	0.12	0.29
15	0.17	0.3	0.34	0.28	0.34	0.22	0.28	0.31	0.24	0.15	0.28	0.19	0.18	0.20
16	0.30	0.22	0.41	0.37	0.37	0.26	0.27	0.33	0.21	0.17	0.28	0.31	0.17	0.31
17	0.35	0.29	0.5	0.44	0.44	0.41	0.43	0.44	0.32	0.2	0.44	0.35	0.24	0.40
18	0.28	0.3	0.48	0.4	0.38	0.41	0.37	0.37	0.29	0.19	0.38	0.38	0.18	0.38
19	0.38	0.26	0.48	0.45	0.46	0.46	0.43	0.44	0.28	0.33	0.43	0.40	0.20	0.45
20	0.19	0.32	0.31	0.28	0.35	0.26	0.32	0.28	0.29	0.3	0.25	0.24	0.15	0.24
21	0.24	0.32	0.43	0.41	0.43	0.28	0.32	0.37	0.33	0.19	0.44	0.35	0.18	0.31
22	0.32	0.16	0.39	0.41	0.41	0.34	0.30	0.3	0.18	0.16	0.33	0.3	0.14	0.42
23	0.32	0.34	0.51	0.47	0.51	0.44	0.44	0.44	0.37	0.28	0.41	0.37	0.19	0.42
24	0.36	0.32	0.5	0.4	0.44	0.25	0.34	0.33	0.28	0.18	0.3	0.28	0.19	0.36
25	0.30	0.35	0.43	0.38	0.45	0.34	0.4	0.39	0.33	0.26	0.31	0.36	0.30	0.26
26	0.42	0.37	0.54	0.44	0.46	0.43	0.52	0.51	0.39	0.27	0.39	0.39	0.28	0.37
27	-	0.3	0.43	0.46	0.39	0.36	0.38	0.41	0.16	0.3	0.39	0.31	0.23	0.38
28		-	0.48	0.26	0.38	0.26	0.29	0.32	0.24	0.24	0.28	0.31	0.18	0.25
29			-	0.54	0.65	0.43	0.42	0.5	0.38	0.23	0.37	0.38	0.24	0.46
30				-	0.**67**	0.5	0.53	0.53	0.29	0.19	0.32	0.36	0.22	0.47
31					-	0.52	0.52	0.54	0.4	0.3	0.39	0.38	0.33	0.44
32						-	0.63	0.52	0.36	0.29	0.36	0.35	0.21	0.42
33							-	0.62	0.41	0.28	0.39	0.41	0.29	0.42
34								-	0.41	0.29	0.42	0.48	0.30	0.45
35									-	0.41	0.32	0.28	0.45	0.27
36										-	0.36	0.29	0.48	0.26
37											-	0.52	0.35	0.47
38												-	0.28	0.43
39													-	0.34
40														-

Note: The letters representing the respective factors: E = Enjoyment; M = Motivation, C = Self-confidence, V = Value; and the numbers indicate the item no. in the questionnaire