An Analysis of the Short Form of the Attitude Toward Mathematics Inventory Using Elementary Student Data

Matthew Bonhamgregory
University of North Texas, USA
Matthew.Bonhamgregory@unt.edu

The influence of feelings and learning has been historically studied, researched, and debated. While there have traditionally been those who have sought to draw a line between "hard" and "soft" sciences, recent research efforts have sought to explore and explain how the way we feel and think influences the degree to we can functionally interact "hard" science environments.

Working under the parameter that younger students are the most formidable, both cognitively and emotionally, it is imperative that teachers be equipped with the necessary pedagogical and instructional skill-sets to influence this population. It is not IQ that drives a student's ability to persist but intrinsic motivation (Battle, 1965). If students feel good about themselves, they are more likely to challenge themselves with more complex problems. Conversely, the opposite may occur, and if the student believes they might fail, they may seek to protect their ego by providing excuses for their poor effort (Starnes & Zinser, 1983). Children who believe in their abilities tend to experience more successes, have greater coping and problem-solving skills (Lufi & Cohen, 1987).

Furthermore, Leeson, Ciarrochi, & Heaven (2008) concluded that positive thinking affects academics while the character trait "hope" is a predictor of academic success. Students need to have positive feelings associated with learning across all content areas to reach their full academic capabilities. These associations develop intrinsic motivations and a sense of belonging at school (Dweck, Walton, & Cohen, 2011). Furthering exemplifying the need for research on personality traits and how it influences learning, a report from the US Department of Education (2013) identified non-cognitive personality traits needed to "thrive" in the 21st century and gave examples of how to quantify the measurement of these traits. The report gave suggestions on the adjustments schools can make to meet these needs. Regardless of their demographic, all students can be successful in a school setting if they are provided with meaningful lessons with positive experiences (Lewis et al., 2014). As such, there seems to be the ability to intervene and change mindsets centering on "student attitudes, beliefs, and dispositions [that] affect the quality, duration, and intensity with which students engage in critical academic behaviors" (Snipes et al., 2012).

In 2014, a capstone project examined if a 12-week treatment that focused on instruction and character traits would positively affect students' feelings toward school and mathematics and their academic performance in mathematics. In addition, an attempt was made to understand if an increase in perseverance led to a change in attitude toward mathematics, perceptions about themselves as students, and standardized test scores.

Ability to appropriately statistically analyze data kept that analysis on a surface level; it lacked depth. For the 2014 capstone project, a decrease in "disagree" responses was desired. Results of each factor of the Attitudes Toward Mathematics Inventory (ATMI) are displayed in Figure 1.

However, these ATMI interpretations conflicted with the growth measured by the self-reported perseverance survey and academic achievement.

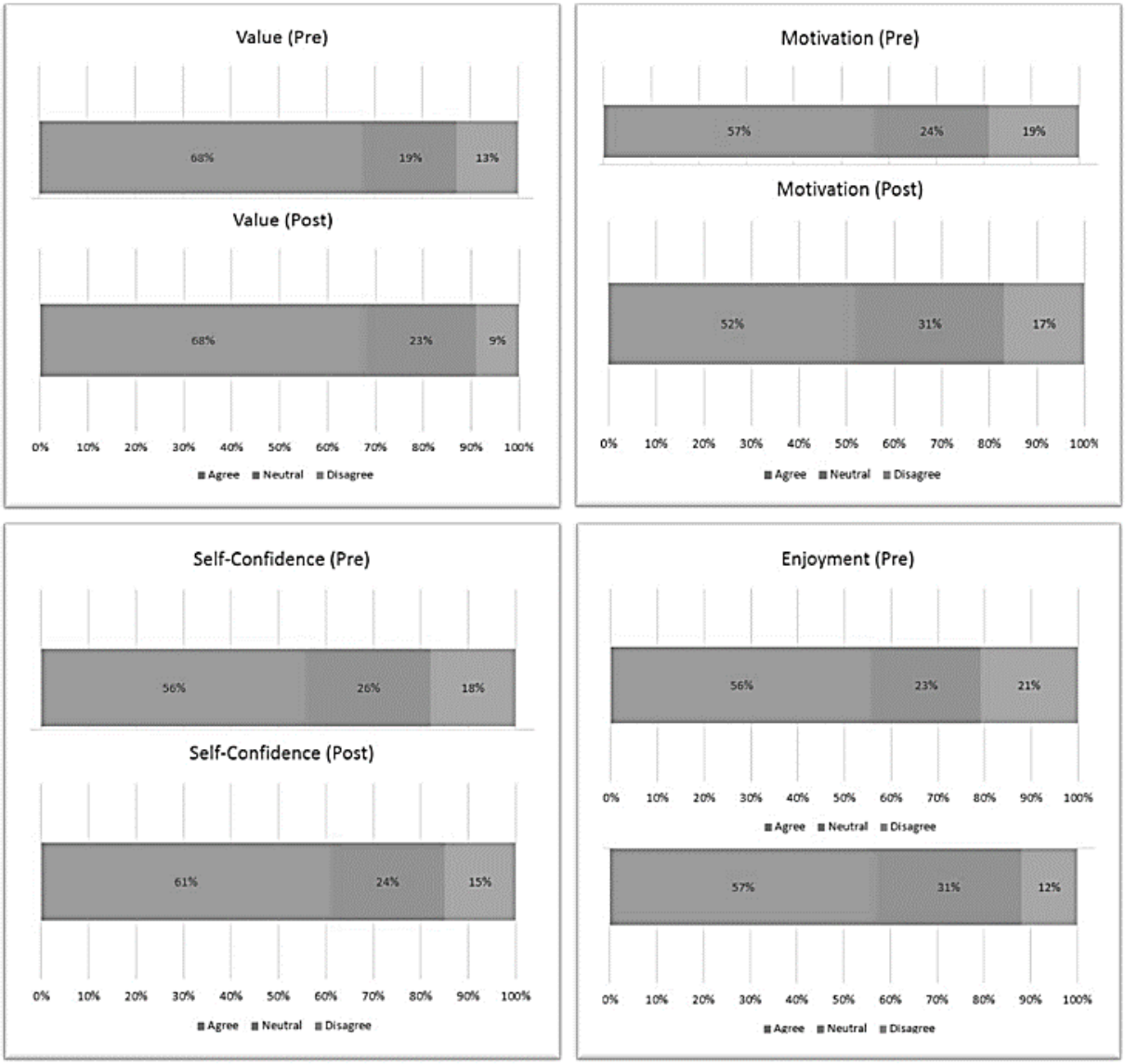

Figure 1. Four-factor analysis from the 2014 ATMI survey.

A re-examination of the data was needed as the data in the capstone study was performed at a minimal statistic level for two reasons. The first Attitudes Toward Mathematics Inventory (ATMI; Tapia, 1996) was designed and tested for older students, specifically middle and high school students. The participants of the capstone project were grade 5 students located on an elementary campus. Therefore, validation of the initial data analysis needs to be substantiated. Second, a determination is needed as to if the ATMI is a proper instrument to measure attitudes for this age group.

Moenikia and Zahed-Babelan (2010) defined mathematics attitudes as "a predisposition to respond unfavorably or favorably to mathematics. By accepting this view, mathematics attitude includes relevant beliefs, behavior, and attitudinal or emotional reactions".
If a positive attitude can influence self-efficacy and academic achievement (Mohsenpour, Hejazi, & Kiamanesh, 2008), then pre-service teachers and veteran teachers need professional development to nurture these desired outcomes in the classroom.

Original ATMI. The original ATMI survey (Tapia, 1996) was designed for middle and high school students. It tested 544 private bilingual preparatory students in one school located in Mexico City. The original six factors were value, anxiety, motivation, confidence, enjoyment, and adults' perspectives. Although the survey yielded a 0.96 Cronbach's Alpha reliability score, the decision was made to remove nine items as the data showed a lack of internal consistency reliability with the other items. Therefore, the adults' perspectives factor was deleted, and some of the anxiety factor questions were. The remaining questions from the anxiety factor were merged into other factors. The final instrument had four instruments, 40 questions, and an overall Cronbach's Alpha reliability of 0.97.

Short Form ATMI. The Fennema-Sherman Mathematics Attitude Scale (FSMAS; 1976) and Attitude Toward Mathematics Inventory Survey are two of the more widely used instruments on the topic. The ATMI sought to develop an instrument shorter than the F-S MAS; an instrument has nine instruments, 108 items, and takes 45 minutes to complete. Furthermore, Tapia and Marsh (2004) noted subsequent research that questioned the reliability of some of its factors. As Tapia did before them, Lim and Chapman (2012) sought to shorten the ATMI for somewhat similar reasons. They felt that 40 questions were too long and that some were redundant. While Tapia felt that 10-20 minutes for a survey was reasonable, Lim and Chapman felt that a survey accomplished under 10 minutes would provide a more authentic reflection of the students' attitudes. The short form of the ATMI (SF-ATMI) was developed and tested on 1,601 participants from a Singapore pre-tertiary school. The research yielded 19 questions that kept the original four factors intact. The full scale produced a Cronbach's Alpha score of 0.93 and the mean for individual subscales, 0.87. A one-month test-retest period produced a Cronbach's Alpha score of 0.75 across all subscales

Method

Data Analysis

The data was collected using the ATMI survey (Appendix A). The ATMI is a 40 question Likert Scale survey. Responses range from A (strongly disagree) to E (strongly agree). Students were read aloud the questions to remove reading as a barrier. The surveys did not have any student identifiers and were collected anonymously to encourage complete honesty. Responses were entered and analyzed using Eduphoria software. An output data sheet was exported into an Excel spreadsheet and verified for accuracy for a third and final time. IBM's Statistical Package for Social Sciences (SPSS) was used to run the analysis on the data, which included the following: descriptive analysis, reliability, factor analysis, and one-way ANOVA. Furthermore, after the 12-week treatment, a follow-up ATMI survey was conducted. An initial analysis of the pre-survey and post-survey data is included. Only the 19 items as valid in the Short Form ATMI (Lim & Chapman, 2012) were analyzed for this study.

Descriptive Statistics

The study was conducted in a Title-I elementary school located in a suburban setting in Texas. The campus hosts pre-kindergarten through fifth grades. During the 2014-2015 school year, the campus reported 481 students, of which 53% were Hispanic, 39% were White, 4% two or more races, and 2% Black. Grade 5 was departmentalized among three teachers; all grade 5 students shared the same mathematics teacher. However, for reasons such as incomplete data, lack of full participation (such as pull-out programs, prolonged illness), and refusal to fill out the survey, it was determined that 56 students fully participated and completed the data. Ethnicity and gender frequencies are listed in Table 1.

Table 1

Frequencies: Ethnicity and Gender.

Ethnicity

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Hispanic	26	46.4	46.4	46.4
	Asian	1	1.8	1.8	48.2
	Black/African American	1	1.8	1.8	50.0
	White	27	48.2	48.2	98.2
	Two or More	1	1.8	1.8	100.0
	Total	56	100.0	100.0	

Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	27	48.2	48.2	48.2
	Male	29	51.8	51.8	100.0
	Total	56	100.0	100.0	

An analysis of the descriptive statistics shows nearly two balanced groups among gender and ethnicity.

Reliability

Running a reliability test on the 19-item short-form survey yielded a Cronbach's Alpha of .694, which is minimally acceptable (DeVellis, 1991). Reliabilities for the 19-item SF-ATMI are listed in Table 2 and the accompanying Scree Plot in Figure 2.

A closer look at the data as displayed in Figure 1 shows that one subscale stood out statistically: self-confidence of mathematics. In addition, all five questions showed a negative corrected item-total correlation and a positive effect on Cronbach's Alpha if they were to be deleted. No other question in the survey had these characteristics; for this reason, a decision was made to run reliability tests against each of the four subscales.

Removal of the self-confidence factor significantly increases the survey's Cronbach's Alpha from .694 to .891, a jump from minimally acceptable to very good according to DeVellis (1991) guidelines for acceptable internal consistency reliabilities. Therefore, a decision was made to remove the self-confidence factor. Reliabilities for updated reliabilities and

Table 2

Reliabilities for the 19-item SF-ATMI

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
VAL1	41.67	75.743	.573	.655
VAL4	41.60	74.800	.496	.658
VAL5	42.07	75.809	.592	.655
VAL6	41.65	74.934	.570	.654
SC3	43.27	89.165	-.135	.722
SC5	43.16	98.843	-.520	.754
SC7	43.09	94.899	-.335	.748
SC10	43.15	96.571	-.440	.746
SC13	43.02	89.500	-.150	.720
MOT1	42.40	71.948	.585	.645
ENJ2	42.29	78.284	.323	.677
ENJ4	42.16	76.769	.346	.674
ENJ6	41.93	72.439	.587	.646
ENJ7	42.25	74.304	.423	.664
ENJ8	41.93	71.995	.737	.637
MOT3	42.15	72.904	.607	.646
MOT4	41.87	76.484	.504	.661
MOT5	41.55	75.401	.597	.653
VAL10	41.58	77.396	.376	.671

Rotated Component Matrix[a]

	Component 1	Component 2
VAL1	.678	.276
VAL4	.582	.138
VAL5	.732	.126
VAL6	.712	.047
SC3	.068	-.509
SC5	-.297	-.806
SC7	-.342	-.326
SC10	-.254	-.714
SC13	.055	-.553
MOT1	.604	.431
ENJ2	.435	.265
ENJ4	.303	.598
ENJ6	.726	.100
ENJ7	.439	.464
ENJ8	.855	.013
MOT3	.577	.445
MOT4	.380	.592
MOT5	.606	.235
VAL10	.324	.701

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.

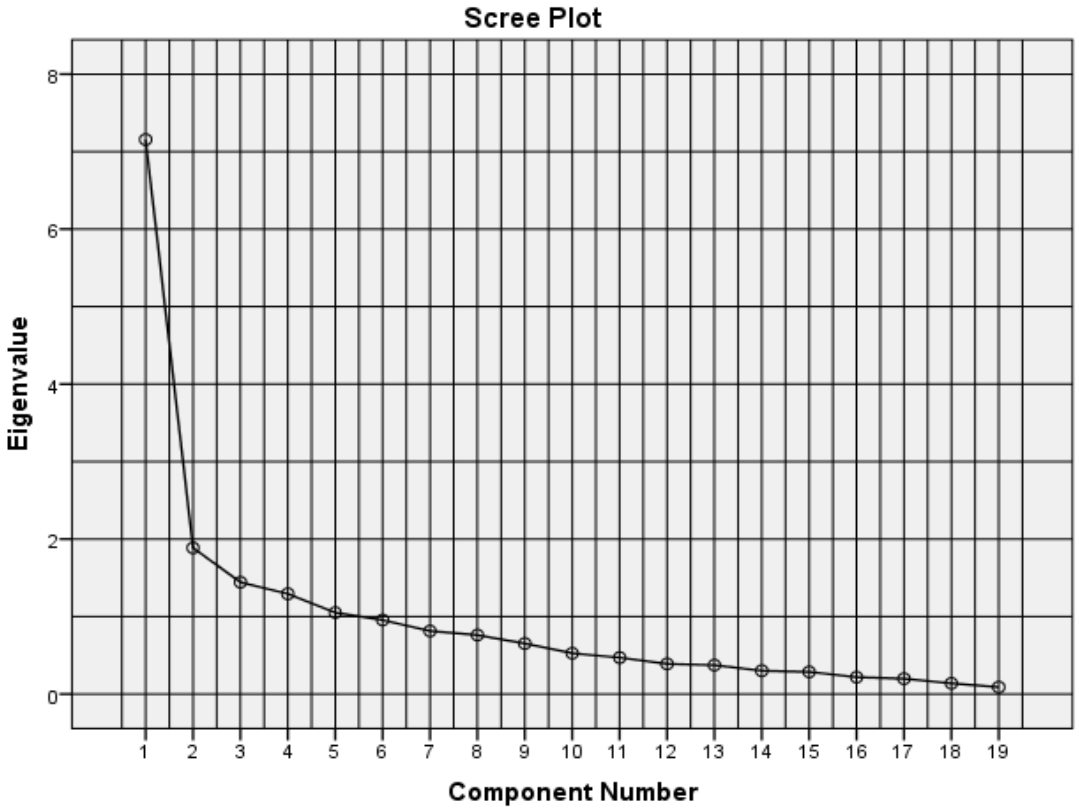

Figure 2. Scree Plot for the 19-item SF-ATMI

rotated component matrix with the Self-Confidence Factor removed are listed in Table 3 and the accompanying Scree Plot, in Figure 3.

Factor Analysis of Each Subscale	
Perceived Value of Mathematics: .764	Removal of any particular question does not increase Cronbach's Alpha.
Self-Confidence of Mathematics: .662	Removal of SC3 increases Cronbach's Alpha to .682
Motivation to Do Mathematics: .789	Removal of any particular question does not increase Cronbach's Alpha
Enjoyment of Mathematics: .770	Removal of any particular question does not increase Cronbach's Alpha.

Table 3

Reliabilities for 14-item SF-ATMI, Self-Confidence Factor Removed

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
VAL1	34.43	110.468	.643	.881
VAL4	34.39	111.188	.487	.887
VAL5	34.82	111.531	.610	.882
VAL6	34.43	111.377	.559	.884
MOT1	35.14	105.070	.670	.878
ENJ2	35.04	112.399	.424	.890
ENJ4	34.93	109.086	.501	.887
ENJ6	34.68	107.422	.610	.881
ENJ7	35.05	107.215	.533	.886
ENJ8	34.71	108.717	.680	.879
MOT3	34.93	107.268	.666	.879
MOT4	34.68	111.531	.557	.884
MOT5	34.30	111.743	.589	.883
VAL10	34.34	109.465	.559	.884

Rotated Component Matrix[a]

	Component 1	Component 2
VAL1	.455	.569
VAL4	.564	.210
VAL5	.549	.420
VAL6	.535	.363
MOT1	.688	.326
ENJ2	.106	.635
ENJ4	.558	.207
ENJ6	.146	.886
ENJ7	.285	.598
ENJ8	.277	.834
MOT3	.662	.352
MOT4	.800	.010
MOT5	.641	.271
VAL10	.733	.107

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.

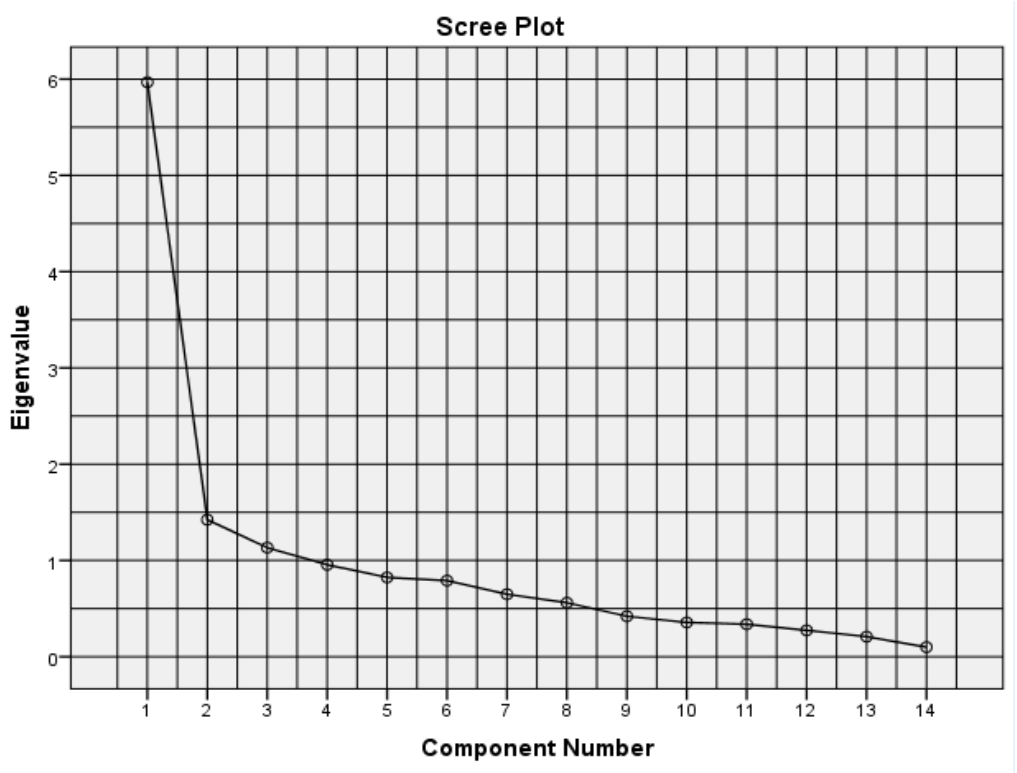

Figure 3. Scree Plot for a 14-item SF-ATMI, Self-Confidence Factor Removed

Construct Validity

Analysis of each factor. A Cronbach's Alpha reliability test of each factor revelated that the Self-Confidence factor has a reliability of 0.662; minimally acceptable according to DeVellis (1991). Table 4 and Table 5 show the low Self-Confidence reliability compared to the other three factors.

Table 4

Reliabilities for Perceived Value and Motivation of the SF-ATMI

Perceived Value

Cronbach's Alpha	N of Items
.764	5

Item Statistics

	Mean	Std. Deviation	N
VAL1	2.95	1.069	56
VAL4	2.98	1.286	56
VAL5	2.55	1.043	56
VAL6	2.95	1.135	56
VAL10	3.04	1.279	56

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
VAL1	11.52	12.072	.580	.708
VAL4	11.48	11.709	.473	.746
VAL5	11.91	11.610	.579	.676
VAL6	11.52	12.218	.507	.731
VAL10	11.43	11.777	.469	.748

Motivation

Cronbach's Alpha	N of Items
.789	4

Item Statistics

	Mean	Std. Deviation	N
MOT1	2.23	1.388	56
MOT3	2.45	1.249	56
MOT4	2.70	1.127	56
MOT5	3.07	1.059	56

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
MOT1	8.21	7.953	.577	.755
MOT3	8.00	8.073	.671	.698
MOT4	7.75	8.882	.632	.721
MOT5	7.38	9.766	.530	.769

Table 5

Reliabilities for Enjoyment and Self-Confidence of the SF-ATMI

Enjoyment

Cronbach's Alpha	N of Items
.770	5

Item Statistics

	Mean	Std. Deviation	N
ENJ2	2.34	1.325	56
ENJ4	2.45	1.426	56
ENJ6	2.70	1.334	56
ENJ7	2.32	1.503	56
ENJ8	2.66	1.133	56

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
ENJ2	10.13	16.766	.478	.749
ENJ4	10.02	17.472	.352	.793
ENJ6	9.77	14.727	.704	.670
ENJ7	10.14	14.888	.566	.720
ENJ8	9.80	16.379	.660	.696

Self-Confidence

Cronbach's Alpha	N of Items
.662	5

Item Statistics

	Mean	Std. Deviation	N
SC3	1.33	1.292	55
SC5	1.44	1.244	55
SC7	1.51	1.451	55
SC10	1.45	1.214	55
SC13	1.58	1.166	55

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
SC3	5.98	13.277	.253	.682
SC5	5.87	10.632	.635	.505
SC7	5.80	11.644	.361	.641
SC10	5.85	11.201	.572	.538
SC13	5.73	13.387	.303	.656

Factor groups. To determine if there were significant differences between the means of the two groups, a one-way analysis of variance (ANOVA) was run with the remaining three factors. The Rotated Component Matrix did not reveal three constructs. As retest using forcing two components gave results wherein motivation and perceived value formed one construct and enjoyment formed the other. Of note is that items ENJ4 and VAL1 fell into different components. The rotated components matrix for the remaining three factors is shown in Table 6.

Component one was labeled "Motivation / Perceived Value," and component two was labeled "enjoyment." The Motivation / Perceived Value factor consists of nine items; Q5, Q7, Q6, Q23, Q26, Q32, Q33, Q36, Q39. The Enjoyment factor consists of five items; Q1, Q24, Q29, Q30, Q31.

One-way ANOVA. Ethnicity was selected to compare against the two constructs. Cohen's D analysis (1988) was used to determine effect size for ethnicity against each factor. According to Cohen (1988), the benchmarks for effect with sizes identified as 0.2 small, 0.5 moderate, and 0.8 large to determine the effect size. Descriptive statistics for Hispanic and White groups using the modified, 14-item SF-ATMI data are listed in Table 7. Thescree plot with rotated components matrix to test constructs against ethnicity is shown in Figure 4.

Table 6

Rotated Components Matrix for the Remaining Three Factors

Rotated Component Matrix[a]

	Component 1	Component 2
MOT4	.800	
VAL10	.733	.107
MOT1	.688	.326
MOT3	.662	.352
MOT5	.641	.271
VAL4	.564	.210
ENJ4	.558	.207
VAL5	.549	.420
VAL6	.535	.363
ENJ6	.146	.886
ENJ8	.277	.834
ENJ2	.106	.635
ENJ7	.285	.598
VAL1	.455	.569

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.

COMPONENT ONE
MOT4
VAL10
MOT1
MOT3
MOT5
VAL4
ENJ4
VAL5
VAL6

COMPONENT TWO
ENJ6
ENJ8
ENJ2
ENJ7
VAL1

Table 7

Descriptive Statistics for Two Ethnic Groups Completing the modified, 14-item SF-ATMI

Factor_Motivation_PerceivedValue

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Hispanic	26	2.5684	.82272	.16135	2.2361	2.9007	.33	3.67
White	27	2.7654	.86140	.16578	2.4247	3.1062	1.22	4.00

Factor_Enjoyment

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Hispanic	26	2.6846	.81814	.16045	2.3542	3.0151	.40	4.00
White	27	2.4667	1.11769	.21510	2.0245	2.9088	.40	4.00

All14Items

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Hispanic	26	2.6099	.78590	.15413	2.2925	2.9273	.36	3.64
White	27	2.6587	.84639	.16289	2.3239	2.9936	1.00	4.00
Total	53	2.6348	.80978	.11123	2.4116	2.8580	.36	4.00

The results of a One-way ANOVA testing the two constructs against ethnicity are provided in Table 8, while Table 9 gives the reliabilities of each construct if the other were to be deleted. The analysis reaffirms that the 14-item, modified ATMI shows a null hypothesis against ethnicity.

Pre and post-survey analysis. An analysis of the post-survey data further confirmed the previous determination that the 14-question version of the SF-ATMI, with the Self-Confidence factor removed, is a reliable scale measure in determining attitude towards mathematics. In addition, the constructs of "Enjoyment" and "Motivation/Perceived Value" remained consistent across the pre-survey and pre-post survey data when measured against ethnicity (Table 10).

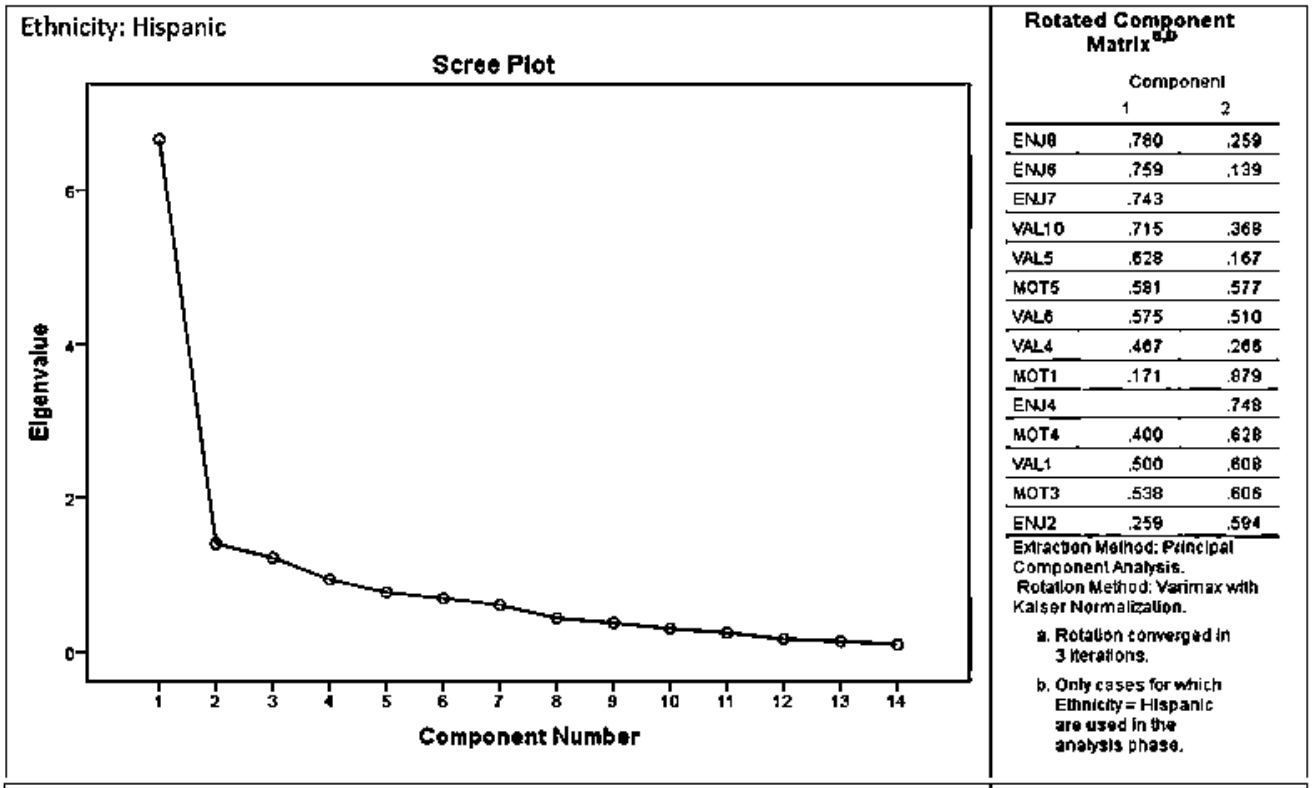

Figure 4. Scree Plot with Rotated Components Matrix to test constructs against ethnicity.

Table 8

One-way ANOVA testing constructs against ethnicity

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Factor_Motivation_PerceivedValue	Between Groups	.514	1	.514	.724	.399
	Within Groups	36.214	51	.710		
	Total	36.728	52			
Factor_Enjoyment	Between Groups	.629	1	.629	.652	.423
	Within Groups	49.214	51	.965		
	Total	49.843	52			

Table 9

Reliabilities of Constructs if Deleted for the Proposed 14-item survey: Both Ethnicities

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Factor_Motivation_PerceivedValue	**39.9679**	**145.450**	**.926**	**.**	**.904**
Factor_Enjoyment	**40.0873**	**144.522**	**.837**	**.**	**.905**

Construct	Cohen's D	Effect Size	p-value	Significance
Motivation/Value	0.233	Small	0.399	Not significant
Enjoyment	0.222	Small	0.423	Not significant

A Cronbach's Alpha reliability test shows that a 14-item, modified SF-ATMI, has a very good reliability of 0.854, both ethnicities included. However, if the five-question, Self-Confidence factor is included, Cronbach's Alpha drops to an unacceptable 0.591. The post-survey reliability is consistent with the pre-survey reliability, which revealed that removing the self-confidence factor significantly increases the survey's Cronbach's Alpha from .694 to .891. Additional item and factor reliability analyses of the pre-survey and post-survey are in Appendix C.

Table 10

Reliabilities for Pre and Post Survey: Constructs, SF-ATMI, Proposed 14-item survey

CRONBACH'S ALPHA PRE-SURVEY		CRONBACH'S ALPHA POST-SURVEY		
Hispanic	White	Hispanic	White	
0.748	0.852	0.625	0.751	Construct - Enjoyment
0.870	0.841	0.822	0.753	Construct - Motivation / Perceived Value
0.459	0.740	0.724	0.635	Factor - Self-Confidence (removed from modified SF-ATMI)
0.734	**0.668**	**0.641**	**0.519**	**19 Questions - Short Form ATMI**
0.907	**0.884**	**0.860**	**0.847**	**14 Questions - Shortened, Short Form ATMI**

Conclusion

The purpose of this study was to examine if the Short Form ATMI was a valid instrument to use with upper elementary students. One factor, self-confidence, showed poor internal reliability and therefore was removed. Two constructs were tested against ethnicity, revealing the internal reliability as "very good," which indicates that these selected items are measuring accurately with this group of participants. The analysis is consistent across the pre-survey and post-survey data.

As such, it has been determined that the 14-item scale, a shortened version of the SF-ATMI, may be reliable when used in similar settings. However, given the small sample size, it is recommended that this survey is used with a larger sample size and more diverse population and reexamine its validity.

Resources

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Appendix A

ATTITUDES TOWARD MATHEMATICS INVENTORY

Name _____ *School* _____

Teacher _____

Directions: This inventory consists of statements about your attitude toward mathematics. There are no correct or incorrect responses. Read each item carefully. Please think about how you feel about each item. Enter the letter that most closely corresponds to how each statement best describes your feelings. Please answer every question.

PLEASE USE THESE RESPONSE CODES:

A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

1.	Mathematics is a very worthwhile and necessary subject.	
2.	I want to develop my mathematical skills.	
3.	I get a great deal of satisfaction out of solving a mathematics problem.	
4.	Mathematics helps develop the mind and teaches a person to think.	
5.	Mathematics is important in everyday life.	
6.	Mathematics is one of the most important subjects for people to study.	
7.	High school math courses would be very helpful no matter what I decide to study.	
8.	I can think of many ways that I use math outside of school.	
9.	Mathematics is one of my most dreaded subjects.	
10.	My mind goes blank and I am unable to think clearly when working with mathematics.	
11.	Studying mathematics makes me feel nervous.	
12.	Mathematics makes me feel uncomfortable.	
13.	I am always under a terrible strain in a math class.	
14.	When I hear the word mathematics, I have a feeling of dislike.	
15.	It makes me nervous to even think about having to do a mathematics problem.	
16.	Mathematics does not scare me at all.	
17.	I have a lot of self-confidence when it comes to mathematics.	
18.	I am able to solve mathematics problems without too much difficulty.	
19.	I expect to do fairly well in any math class I take.	
20.	I am always confused in my mathematics class.	
21.	I feel a sense of insecurity when attempting mathematics.	
22.	I learn mathematics easily.	
23.	I am confident that I could learn advanced mathematics.	
24.	I have usually enjoyed studying mathematics in school.	
25.	Mathematics is dull and boring.	
26.	I like to solve new problems in mathematics.	
27.	I would prefer to do an assignment in math than to write an essay.	
28.	I would like to avoid using mathematics in college.	
29.	I really like mathematics.	
30.	I am happier in a math class than in any other class.	
31.	Mathematics is a very interesting subject.	
32.	I am willing to take more than the required amount of mathematics.	
33.	I plan to take as much mathematics as I can during my education.	
34.	The challenge of math appeals to me.	
35.	I think studying advanced mathematics is useful.	
36.	I believe studying math helps me with problem solving in other areas.	
37.	I am comfortable expressing my own ideas on how to look for solutions to a difficult problem in math.	
38.	I am comfortable answering questions in math class.	
39.	A strong math background could help me in my professional life.	
40.	I believe I am good at solving math problems.	

Appendix B

Short Form ATMI - Item Descriptions with Aligned Codes

Q	Item	Code	Code Expanded
1	Mathematics is a very worthwhile and necessary subject	VAL1	Perceived Value of Mathematics
5	Mathematics is important in everyday life	VAL4	
6	Mathematics is one of the most important subjects to study	VAL5	
7	H.S. mathematics courses would be very helpful no matter what I decide to study	VAL6	
11	Studying mathematics makes me feel nervous	SC3	Self-Confidence of Mathematics
13	I am always under a terrible strain in a math class	SC5	
15	It makes me nervous to even think about having to do a mathematics problem	SC7	
20	I am always confused in my mathematics class	SC10	
21	I feel a sense of insecurity when attempting mathematics	SC13	
23	I am confident that I could learn advanced mathematics	MOT1	
24	I have usually enjoyed studying mathematics in school	ENJ2	Enjoyment of Mathematics
26	I like to solve new problems in mathematics	ENJ4	
29	I really like mathematics	ENJ6	
30	I am happier in a mathematics class than in any other class	ENJ7	
31	Mathematics is a very interesting subject	ENJ8	
32	I am willing to take more than the required amount of mathematics	MOT3	Motivation to do Mathematics
33	I plan to take as much mathematics as I can during my education	MOT4	
36	I believe studying math helps me with problem solving in other areas	MOT5	
39	A strong math background could help me in my professional life	VAL10	

Appendix C

Reliabilities for Pre and Post Survey: Factors, SF-ATMI

	CRONBACH'S ALPHA IF DELETED	CRONBACH'S ALPHA		CRONBACH'S ALPHA IF DELETED		
Code		PRE	POST		Code	Code Expanded
VAL1	0.708	0.764	0.659	0.573	VAL1	Perceived Value of Mathematics
VAL4	0.746			**0.701**	VAL4	
VAL5	0.676			0.633	VAL5	
VAL6	0.731			0.589	VAL6	
SC3	**0.682**	0.662	0.720	0.632	SC3	Self-Confidence of Mathematics
SC5	0.505			0.657	SC5	
SC7	0.641			0.664	SC7	
SC10	0.538			**0.728**	SC10	
SC13	0.656			0.673	SC13	
MOT1	0.755	0.789	0.690	0.594	MOT1	Motivation to do Mathematics
ENJ2	0.749	0.770	0.761	0.714	ENJ2	Enjoyment of Mathematics
ENJ4	**0.793**			0.719	ENJ4	
ENJ6	0.670			0.719	ENJ6	
ENJ7	0.720			0.713	ENJ7	
ENJ8	0.696			0.724	ENJ8	
MOT3	0.698	0.789	0.690	0.665	MOT3	Motivation to do Mathematics
MOT4	0.721			0.627	MOT4	
MOT5	0.769			0.612	MOT5	
VAL10	0.748	0.764	0.659	0.524	VAL10	Perceived Value of Mathematics