DOCUMENT RESUME

ED 471 301 TM 034 669

AUTHOR	Tapia, Martha; Marsh, George E., II
TITLE	Confirmatory Factor Analysis of the Attitudes toward Mathematics Inventory.
PUB DATE	2002-11-00
NOTE	12p.; Paper presented at the Annual Meeting of the Mid-South Educational Research Association (Chattanooga, TN, November 6-8, 2002).
PUB TYPE	Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE	EDRS Price MF01/PC01 Plus Postage.
DESCRIPTORS	*College Students; *Factor Structure; High School Students; High Schools; Higher Education; *Mathematics; *Student Attitudes; Test Use
IDENTIFIERS	Confirmatory Factor Analysis

ABSTRACT

The Attitudes toward Mathematics Inventory (ATMI) was developed to measure students' attitudes toward mathematics. The ATMI was initially produced using samples of high school students at a private high school, and the initial pool of items was submitted to exploratory factor analysis. Four factors were identified: self-confidence, value, enjoyment, and motivation. Because the ATMI was developed with high school students, this study was undertaken to see if the four factors would hold with a college population. The ATMI was also derived used a predominantly Hispanic population, raising the question of whether there might be a different factor structure for a different sample. Responses of 134 college students to the ATMI were analyzed. Confirmatory factor analysis was used to determine whether the four-factor model would hold, and results indicate that the four-factor model does hold for U.S. college student. (Contains 2 tables and 18 references.) (Author/SLD)

Running head: Attitudes Toward Mathematics

CONFIRMATORY FACTOR ANALYSIS OF THE ATTITUDES TOWARD MATHEMATICS INVENTORY

Martha Tapia

Berry College

and

George E. Marsh II

The University of Alabama

Paper presented at the Annual Meeting of the
Mid-South Educational Research Association,
Chattanooga, Tennessee
November 6-8, 2002

Abstract

The Attitudes Toward Mathematics Inventory (ATMI) was developed to measure students' attitudes toward mathematics. The ATMI was initially produced using samples of high school students in a private American school. The initial pool of items was submitted to exploratory factor analysis and four factors were identified: self-confidence, value, enjoyment, and motivation.

Due to the fact that the ATMI was developed using high school students, it was unknown if the four factors would hold for a college population. Moreover, the ATMI was derived using a predominantly Hispanic sample, so there was a question about the possibility of a different factor structure for an American sample.

The present study used responses of 134 college-aged American students. Confirmatory factor analysis was used to determine if the four-factor model previously identified would hold for college-aged American students. The results of the confirmatory factor analysis indicated that the four-factor model holds for American college students.

Introduction

Clearly, research has shown that attitudes toward mathematics are important in achievement (Dwyer, 1993). Differences have been found for differential influence of parents (Kenschaft, 1991) and teachers (Dossey, 1992). Attitudes influence success and persistence in the study of mathematics (Chang, 1990; Thorndike-Christ, 1991). Differences in attitudes have been reported for gender, ethnicity, cultural background, and instructional approaches that affect the attitudes of students toward mathematics (Leder & Forgasz, 1994; Murphy & Ross, 1990; Huang & Waxman, 1993; and Hollowell & Duch, 1991). Self-confidence is a good predictor of success in mathematics (Goolsby, 1988; Randhawa, Beamer, & Lundberg, 1993; Linn & Hyde, 1989). Anxiety is directly related to previous school mathematics performance (Hauge, 1991). Terwilliger and Titus (1995) found that positive attitudes toward mathematics are inversely related to math anxiety. Most of this research has been concerned primarily with student in K-12 schools.

Many U.S. campuses struggle to attract students into mathematics beyond the required courses at the undergraduate level. About 1 percent of students major in mathematics at the undergraduate level. Of course, some students with an interest in math are attracted to alternatives, such as computer programming, and some take degrees that lead to immediate employment upon graduation, but there is no question that students avoid mathematics. A study released by the Conference Board of the Mathematical Sciences (Lutzer, Maxwell, & Rodi, 2002).) reported that bachelor's degrees granted in mathematics fell 19 percent between 1990 and 2000, at a time when overall undergraduate enrollment rose 9 percent. The long-term problems for the nation may be affected by the

fact that the pool of potential students who will seek advanced degrees in math is small, and currently over half the students who take graduate degrees in mathematics are foreign. While it seems highly likely that attitudes of college students are important in making decisions about mathematics courses, there is a paucity of research in this area and lack of a valid, reliable instrument for assessing the attitudes of college students. Tapia (1996) developed an instrument (ATMI) for use with secondary students, but there is no evidence to demonstrate that the ATMI is suitable for college students. The purpose of this study was to determine if t he ATMI would be similar in statistical properties with an older population.

The ATMI was developed in several stages. The original instrument was designed to measure six dimensions of attitudes toward mathematics. Extensive item analysis and exploratory factor analysis using high school students resulted in a 40-item questionnaire measuring four factors identified as self-confidence, value, enjoyment, and motivation.

Due to the fact that the ATMI was developed using high school students, it was unknown if the four factors would hold for a college population. Moreover, the ATMI was derived using a predominantly Hispanic sample, so there was a question about the possibility of a different factor structure for an American sample. Therefore, the present study addressed the question as to whether the four-factor model previously identified would hold for college-aged American students. To answer this question, a confirmatory factor analysis was carried out.

Method

Subjects

The subjects were 134 undergraduate students enrolled in mathematics classes at a state university in the Southeast. Seventy-one subjects were male and 58 were female. Five participants did not provide their gender. Approximately 80% of the sample was Caucasian and about 20% African-American. The ages of the sample ranged from 17 to 34. Ten participants did not report their ages. All subjects were volunteers and all students in the classes agreed to participate.

Materials

The Attitudes Toward Mathematics Inventory (ATMI) consists of 40 items designed to measure students' attitudes toward mathematics (Tapia 1996). The items were constructed using a Likert-format scale of five alternatives for the responses with anchors of 1: strongly disagree, 2: disagree, 3: neutral, 4: agree, and 5: strongly agree. Eleven items of this instrument were reversed items. These items were given appropriate value for the data analyses. The score was the sum of the ratings.

Exploratory factor analysis of the ATMI using a sample of high school students resulted in four factors identified as self-confidence, value, enjoyment, and motivation. Self-confidence consisted of 15 items. The value scale consisted of 10 items. The enjoyment scale consisted of 10 items. The motivation scale consisted of five items. Table 1 shows anchor items by factors. Alpha coefficients for the scores of these scales were found to be .95, .89, .89, and .88 respectively (Tapia 1996).

Table 1

Anchor items by factors

Item by Factor
Self-confidence
Mathematics does not scare me at all.
Studying mathematics makes me feel nervous.
My mind goes blank and I am unable to think clearly when working mathematics.
Value
Mathematics is a very worthwhile and necessary subject.
Mathematics courses will be very helpful no matter what I decide to study.
Mathematics is important in everyday life.
Enjoyment
I really like mathematics.
I have usually enjoyed studying mathematics in school.
I am happier in a math class than in any other class.
Motivation
I am willing to take more than the required amount of mathematics.
I plan to take as much mathematics as I can during my education.
The challenge of mathematics appeals to me.

Procedure

The ATMI was administered to participants during their mathematics classes. Directions were provided in written form and students recorded their responses on computer scannable answer sheets.

Results

Confirmatory factor analysis was used to evaluate the viability of the anticipated four-factor model. Several measures were used to assess the model fit: the χ^2 goodness of

fit, the ratio of the χ^2 goodness of fit to the degrees of freedom, the root mean square error of approximation (RMSEA), the normed fit index (NFI), and the expected cross-validation index (ECVI).

The first step in the confirmatory factor analysis was to create a four-factor model with self-confidence, value, enjoyment, and motivation as defined by Tapia (1996). Cronbach alpha coefficients were calculated for the scores of the scales and were found to be .96 for self-confidence, .93 for value, .88 for enjoyment, and .87 for motivation. Correlations for the factors in this model were calculated for 134 subjects and the correlations can be found in Table 2.

Table 2

Correlation Matrix of Variables in the Model

	Self-confidence	Value	Enjoyment	Motivation
Self-Confidence	1.000			
Value	0.524	1.000		
Enjoyment	0.752	0.632	1.000	
Motivation	0.759	0.645	0.813	1.000

The adequacy of the four-factor model was examined using confirmatory factor analysis using LISREL8. The χ^2 goodness of fit was 2.834 which based on 2 degrees of freedom has an associated probability of 0.242. A probability greater than 0.05 indicates a good fit (Shumacker & Lomax, 1996). LISREL run yielded a goodness of fit index (GFI) of 0.99. The adjusted GFI was found to be 0.94. The GFI and AGFI were to be higher than the desired value of 0.90 (Shumacker & Lomax, 1996). The GFI compares the similarity of the sample and the model covariance matrix. A GFI of 0.99 indicates that 99.3% of the sample covariance matrix fits the population covariance matrix.

The root mean square error of approximation (RMSEA) was 0.056. Hu and Bentler (1999) indicate that a value less than .06 shows good model fit. Furthermore, the normed fit index (NFI) was 0.99, the expected cross-validation index (ECVI) for the model was 0.14 and 0.15 for the saturated model. These goodness of fit statistics indicate a good model fit.

Conclusions

The four ATMI factors of self-confidence, value, enjoyment, and motivation reported by Tapia (1996) using a sample of high school students were found to hold for the college-age respondents in the present study. Furthermore, reliability estimates for the scores on the four factors were found to be good as were the corresponding ones of the scores of the high school students.

References

Chang, A. S. (1990, July) *Streaming and Learning Behavior.* Paper presented at the Annual Convention of the International Council of Psychologists, Tokyo, Japan (ERIC Reproduction Service No. ED 324092).

Dossey, J. (1992) *How school mathematics functions: Perspectives from the NAEP 1990 and 1992 assessments.* Princeton, NJ: National Assessment of Educational Progress. (ERIC Document Reproduction Service No. ED 377057)

Dwyer, E. E. (1993) *Attitude scale construction: A review of the literature.* Morristown, TN: Walters State Community College (ERIC Document Reproduction Service No. ED 359201).

Goolsby, C. B. (1988). Factors affecting mathematics achievement in high-risk college students. *Research and Teaching in Developmental Education,* 4(2), 18-27.

Hauge, S. K. (1991) *Mathematics anxiety: A study of minority students in an open admissions setting.* Washington, DC: University of the District of Columbia (ERIC Reproduction Service No. ED 335229).

Hollowell, K. A. & Duch, B. J. (1991, April) *Functions and statistics with computers at the college level.* Paper presented at the annual conference of the American Educational Research Association, Chicago, IL (ERIC Reproduction Service No. ED 336090).

Hu, L. & Bentler, P. M. (1999) *Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives.* Structural Equation Modeling 6(1), 1-5.

Huang, S. L. & Waxman, H. C. (1993) *Comparing Asian- and Anglo-American students' motivation and perception in the learning environment in mathematics.* Paper presented at the annual conference of the National Association for Asian and Pacific American Education, New York, NY (ERIC Reproduction Service No. ED 359284).

Kenschaft, P. (Ed.) (1991) *Winning women into mathematics.* Washington, DC: Mathematical Association of America.

Leder, G. & Forgasz, H. (1994, April) *Single-sex mathematics classes in a co-educational setting: A case study.* Paper presented at the annual meeting of the American Educational Research Association, New Orleans, LA (ERIC Reproduction Service No. ED 372946).

Linn, M & Hyde, J. (1989) Gender, mathematics, and science. *Educational Researcher*, 18(8), 17-19, 22-27.

Lutzer, D.J., Maxwell, J.W., & Rodi, S.B. (2002) *Statistical Abstract of Undergraduate Programs in the Mathematical Sciences in the United States.* Providence, RI: American Mathematical Society.

Murphy, L. O. & Ross, S. (1990) Protagonist gender as a design variable in adapting mathematics story problems to learner interest. *Educational Technology, Research and Development*, 38(3), 27-37.

Randhawa, B. S., Beamer, J. E., & Lundberg, I. (1993) Role of the mathematics self efficacy in the structural model of mathematics achievement. *Journal of Educational Psychology*, 85, 41-48.

Schumacker, R. E. & Lomax, R. G. (1996) *A beginner's guide to structural equation modeling*. Mahwah, NJ: Lawrence Erlbaum Associates.

Tapia, M. (1996) *The Attitudes Toward Mathematics Instrument*. Paper presented at the annual meeting of the Mid-south Educational Research Association, Tuscaloosa, AL (ERIC Reproduction Service No. ED 404165).

Terwilliger, J. & Titus, J. (1995) Gender differences in attitudes and attitude changes among mathematically talented youth. *Gifted Child Quarterly*, 39(1), 29-35.

Thorndike-Christ, T. (1991) *Attitudes toward mathematics: Relationships to mathematics achievement, gender, mathematics course-taking plans, and career interests*. WA: Western Washington University (ERIC Document Reproduction Service No. ED 347066).

U.S. Department of Education
Office of Educational Research and Improvement (OERI)
National Library of Education (NLE)
Educational Resources Information Center (ERIC)

REPRODUCTION RELEASE

(Specific Document)

TM034669

I. DOCUMENT IDENTIFICATION:

Title: Confirmatory Factor Analysis of the Attitudes Towards Mathematics Inventory	
Author(s): Martha Tapia and George E. Marsh II	
Corporate Source:	Publication Date:

II. REPRODUCTION RELEASE:

In order to disseminate as widely as possible timely and significant materials of interest to the educational community, documents announced in the monthly abstract journal of the ERIC system, *Resources in Education* (RIE), are usually made available to users in microfiche, reproduced paper copy, and electronic media, and sold through the ERIC Document Reproduction Service (EDRS). Credit is given to the source of each document, and, if reproduction release is granted, one of the following notices is affixed to the document.

If permission is granted to reproduce and disseminate the identified document, please CHECK ONE of the following three options and sign at the bottom of the page.

The sample sticker shown below will be affixed to all Level 1 documents

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL HAS BEEN GRANTED BY

Sample

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

1

Level 1

Check here for Level 1 release, permitting reproduction and dissemination in microfiche or other ERIC archival media (e.g., electronic) *and* paper copy.

The sample sticker shown below will be affixed to all Level 2A documents

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN MICROFICHE, AND IN ELECTRONIC MEDIA FOR ERIC COLLECTION SUBSCRIBERS ONLY, HAS BEEN GRANTED BY

Sample

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

2A

Level 2A

Check here for Level 2A release, permitting reproduction and dissemination in microfiche and in electronic media for ERIC archival collection subscribers only

The sample sticker shown below will be affixed to all Level 2B documents

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY

Sample

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

2B

Level 2B

Check here for Level 2B release, permitting reproduction and dissemination in microfiche only

Documents will be processed as indicated provided reproduction quality permits.
If permission to reproduce is granted, but no box is checked, documents will be processed at Level 1.

I hereby grant to the Educational Resources Information Center (ERIC) nonexclusive permission to reproduce and disseminate this document as indicated above. Reproduction from the ERIC microfiche or electronic media by persons other than ERIC employees and its system contractors requires permission from the copyright holder. Exception is made for non-profit reproduction by libraries and other service agencies to satisfy information needs of educators in response to discrete inquiries.

Sign here, please

Signature: Martha Tapia	Printed Name/Position/Title: MARTHA TAPIA / PROF / DR.
Organization/Address: Berry College / P.O Box 495014 Mt. Berry, GA 495014	Telephone: 706-290-2662 / FAX: 706-238-7849
	E-Mail Address: mtapia@berry.edu / Date: 11-9-02

(Over)

III. DOCUMENT AVAILABILITY INFORMATION (FROM NON-ERIC SOURCE):

If permission to reproduce is not granted to ERIC, or, if you wish ERIC to cite the availability of the document from another source, please provide the following information regarding the availability of the document. (ERIC will not announce a document unless it is publicly available, and a dependable source can be specified. Contributors should also be aware that ERIC selection criteria are significantly more stringent for documents that cannot be made available through EDRS.)

Publisher/Distributor:
Address:
Price:

IV. REFERRAL OF ERIC TO COPYRIGHT/REPRODUCTION RIGHTS HOLDER:

If the right to grant this reproduction release is held by someone other than the addressee, please provide the appropriate name and address:

Name:
Address:

V. WHERE TO SEND THIS FORM:

Send this form to the following ERIC Clearinghouse:

ERIC CLEARINGHOUSE ON ASSESSMENT AND EVALUATION
UNIVERSITY OF MARYLAND
1129 SHRIVER LAB
COLLEGE PARK, MD 20742-5701
ATTN: ACQUISITIONS

However, if solicited by the ERIC Facility, or if making an unsolicited contribution to ERIC, return this form (and the document being contributed) to:

ERIC Processing and Reference Facility
4483-A Forbes Boulevard
Lanham, Maryland 20706

Telephone: 301-552-4200
Toll Free: 800-799-3742
FAX: 301-552-4700
e-mail: ericfac@inet.ed.gov
WWW: http://ericfacility.org