THE RELIABILITY AND CONSTRUCT VALIDITY OF SCORES ON THE ATTITUDES TOWARD PROBLEM SOLVING SCALE

[1]Sabri Ahmad, [2]Effandi Zakaria, [3]Zolkepeli Haron

[1]Jabatan Matematik, Fakulti Sains dan Teknologi Kolej Universiti Sains dan Teknologi (KUSTEM)
[2,3] Jabatan Perkaedahan dan Amalan Pendidikan Fakulti Pendidikan Universiti Kebangsaan Malaysia 43600 Bangi, Selangor
[1]sba@kustem.edu.my ,[2]effandi@ukm.my, [3]zol@ukm.my

Abstract

The Attitudes Toward Problem Solving Scale (ATPSS) has received limited attention concerning its reliability and validity with a Malaysian secondary education population. Developed by Charles, Lester & O'Daffer (1987), the instruments assessed attitudes toward problem solving in areas of Willingness to Engage in Problem Solving Activities, Perseverance During the Problem Solving Process and Self Confidence With Respect to Problem Solving. This study addressed the lack of information about this measure by examining the scale's reliability and its factorial structure. Subjects were 233 secondary school students. Reliability coefficients of the three subscales and the total score were high, indicating that the scale is stable and reliable in measuring Attitudes Toward Problem Solving. Results from factor analyses imply that the ATPSS measures more various traits in Malaysian culture.

Key words: Attitudes toward problem solving, reliability, validity

1. Introduction

Current reform efforts in education have demanded that more attention be given to the development of problem solving, critical thinking and decision making skills in student. Problem solving means " engaging in a task for which the solution method is not known in advance" (NCTM 2000). The importance of problem solving as a goal in mathematics education cannot be disputed. Problem solving is an important and integral part of all mathematics learning. It involves the recall of fact, the use of skills and procedures and the ability to evaluate one's own thinking and progress (Charles et al. 1997). Developing students' problem solving abilities is a challenging and complex task. Furthermore, students' work in problem solving is influence by beliefs and other affective factors that include students' feelings toward mathematics and problem solving (Kroll & Miller 1993; Lester 1994). The way individuals feel about their ability and their level of confidence are also factors in successful problem solving (Conway 1996).
According to Beaver (1994), problem solver should incorporate certain attitudes into his or her problem solving efforts.

Beaver listed the following attitudes:
a) The problem solver must have some interest to the problem
b) The problem solver must desire a solution to the problem
c) The problem solver must feel capable of solving the problem
d) The problem solver must be willing to begin the problem solving process.

These are in line with the instruments used by Charles et. al (1997), which assesses: willingness to engage in problem solving, perseverance during problem solving and self confidence with respect to problem solving. Therefore, it is crucial to find and develop effective instruments to measure attitudes toward problem solving.

2. Attitudes Toward Problem Solving Scale (ATPSS)

Developed by Charles et. al (1987), this scale was used to measure the students' attitudes toward problem solving. This Likert-scaled instrument contains 20 items with five choices each. This instruments assesses three scales: Willingness to Engage in Problem Solving, Perseverance During Problem Solving Process and Self Confidence With Respect to Problem Solving.

According to Moses (1976), two forms of validity have been explored for the ATPSS; content validity established by 10 judges, while factor analysis confirmed the three scales. This instrument was examined by Moses for internal consistency for a population of elementary school students. The results of the analysis using Cronbach's coefficient alpha are: Willingness to Engage in Problem Solving, 0.64, Perseverance During Problem Solving Process, 0.55; and Self Confidence With Respect to Problem Solving, 0.73. Overall coefficient alpha is 0.79.

Moses (1976) also evaluated the test-retest reliability of this instrument. The Pearson product-moment correlations were: Willingness to Engage in Problem Solving, 0.57; Perseverance During the Problem Solving Process, 0.36 and Self Confidence With Respect to Problem Solving, 0.71. Overall correlation is 0.71. These correlations were all significantly different from zero at the 0.001 level. In a study involving pre service teachers, Conway (1996) found that the ATPSS have good internal consistency, with Cronbach's α ranging from 0.85 to 0.94. In a study involving Malaysian matriculation students, Effandi (2003) reported reliability coefficient alpha of 0.88 on the total scale. In another study, Faridah (2004) found that the coefficient alpha of the overall ATPSS scale is 0.86. Cronbach's α for the three subscales ranged from 0.73 to 0.74. This shows that the scale have good internal consistency.

Whilst these studies provide valuable psychometric information about the ATPSS, to my knowledge none have looked at the factorial structure of the ATPSS with regards to Malaysian secondary students samples. Thus the present study builds on previous research into the reliability and validity of the ATPSS by using data collected from Malaysian secondary school students. The present study, utilizes the three subscale of the ATPSS. Anexploratory principal component analysis with varimax rotation was conducted to assess the scale.

3. Methodology

Sample

Data for the study was collected from 233 Form 4 secondary schools students in Melaka, Negeri Sembilan and Pahang. The ATPSS were voluntary completed during class time. The sample included 160 (68.7%)females and 73 (31.3%) males. Intact classes were used in the sample. Mathematics was a compulsory subjects for all of the students involved. The ratio of total participants (233) to variables (20) exceed Nunnally and Bernstein's (1994) minimum recommendation of 6:1.

Instrumentation

The ATPSS consists of 20 items, divided into three subscales: Willingness to Engage in Problem Solving (6 items; numbers 1, 3, 5, 15, 16, 18), Perseverance During Problem Solving Process (6 items; numbers 2, 4, 6, 10, 11, 17) and Self Confidence With Respect to Problem Solving (8 items; numbers 7, 8, 9, 12, 13, 14, 19, 20). The items include positively and negatively worded statements. The instrument employs a 5 point likert style questionnaire: 1= Strongly Disagree; 2 Disagree; 3= Not Sure; 4= Agree and 5=Strongly Agree, in which the students indicate their feelings by selecting one of five choices. Scores for the ATPSS were computed by adding the total number of item response scores. The first author of this paper translated the ATPSS scale into Malay language. A bilingual expert translated it back to English. Both researchers in the present study judged the translation appropriately reflected conceptual equivalence of the original scale in English. The Malay language translation contains the same 20 items representing the same three factor subscales.

Procedures

The sample were administered the ATPSS at the beginning of semesters. The questionnaire administered to the students consisted of two section. Contained in the first section is a set of questions concerning demographics. The second section of the questionnaire consisted of the ATPSS subscale. It was an anonymous study, therefore, the students were told not to put their name on it. Item responses were coded so that a higher score indicated a more positive attitude towards problem solving. Teachers were asked to inform students that the questionaire was not meant to be a test and hence, there was no right or wrong answer for each item. Students took approximately 20 minutes to complete the questionnaire.

Data Analysis

Data was analyzed by using SPSS 11.0. The scales was subjected to principal component analysis. In order to achieve simple structure, the ATPSS factorial structure was subjected to a varimax rotation; the exploratory factor analysis was conducted with eigenvalues of one or higher. Scree plots were also examined to determine the criterion for the numbers of factor. A factor loading cut-off point of 0.40 or higher was selected as the inclusion criterion for factor interpretation. A reliability analysis, in the form of Cronbach's alpha, was conducted to determine the internal consistency of the ATPSS. Means, standard deviations, and intercorrelations of the ATPSS subscales were also computed.

4. Result

The means scores for the subjects of this study on the ATPSS was 67.28, with a standard deviation of 10.05. Table 1 presents the means and standard deviations for each of the three subscales. In general, the results suggest that the sample as a whole held positive attitudes toward problem solving (a total score of 50 would have indicated a neutral attitude toward problem solving).

Table 1 *Mean and Standard Deviations of the Subscale*

Subscales	Mean	Sd
Willingness	22.22	3.83
Perseverance	21.04	3.86
Confident	24.02	4.04
Total	67.28	10.05

The internal consistency (coefficient alpha) was calculated as 0.81, 0.75, and 0.77 for the subscales of Willingness to Engage in Problem Solving, Perseverance During the Problem Solving Process and Self Confidence With Respect to Problem Solving. Cronbach's alpha for the entire scale was 0.89. The Cronbach's alpha coefficient exceed the recommended standard of 0.70 for establishing internal reliability (Nunnally 1978).The results indicate that the scales are reliable. Intercorrelations between the subscales revealed correlations between subscales.

Factors analysis was conducted with two, three, four and five factors. Scree plots and the eigenvalues were examined to determine the criterion for the numbers of factors. The four factor structures resulted in good factor loadings matrices and provided the best simple structure fit. The four factors had eigenvalues greater than 1, 6.78, 1.74, 1.34, and 1.16 respectively. The principal components analysis with varimax rotation explained 55% of the variance for the four factor structure. Individually, the amount of variance (after rotation) accounted for by factors 1 to 4 were, 33.9%, 8.7%, 6.7% and 5.8%.

Factor pattern/structure coefficients for each of these four factor are presented in Table 2. Factor I consisted of 7 items with pattern/structure coefficients of 0.40 or higher (one of these items also had coefficients of 0.40 or higher on other factors). Five of these items were from the perseverance during problem solving process subscale and two from the willingness subscale. All item on Factor II had pattern/structure of 0.40 or higher. Five of these items were from the willingness subscale and one from the confidence subscale. The third factor consisted of six items with pattern/structure coefficients of 0.40 or higher, one of these items were from the willingness subscale (two of these items also had coefficients of 0.40 or higher on other factors). Factor IV, consisted of four items, appeared to be a composite of items from confidence subscale and perseverance subscale (one of these items had coefficients of 0.40 or higher on other factors). From Table 2, we can see that Factor I is related to perseverance. Factor II is related to willingness. Factor III is related to confidence. Factor IV is more concern with confidence with respect to someone else. These students tend to depend on others in whatever they do.

Table 2: Varimax-rotated Four-factor Solution of the Problem Solving Attitude Scale

Subscale	Item No.	Factor I	Factor II	Factor III	Factor IV
Willingness	1		**0.49**		
	3		**0.64**		
	5	**0.60**			
	15		**0.72**		
	16		**0.69**		
	18	**0.44**	**0.44**	**0.50**	
Perseverance	2				**0.46**
	4	**0.67**			
	6	**0.42**			
	10	**0.77**			
	11	**0.52**			
	17	**0.67**			
Confidence	7			**0.46**	**0.55**
	8			**0.53**	
	9				**0.60**
	12			**0.65**	
	13				**0.72**
	14			**0.78**	
	19			**0.71**	
	20		**0.65**		

Items with loadings less than 0.40 omitted

5. Conclusion

The main purpose of this study was to examined the factor structure of the ATPSS with respect to Malaysian secondary schools students; additional analyses addressed the reliability of the ATPSS. The reliability coefficients of the three subscale and total score from the original instrument were quite high indicating that each subscale was stable enough to be used and reliable to measure attitudes toward problem solving. Results obtained from factor analyses shows that the ATPSS measures more various traits in Malaysian culture.

This instrument was tested only at the secondary school level. All subjects were from secondary schools in Melaka, Negeri Sembilan and Pahang. This is a limitation of the study. Hence, the results can only be generalized to secondary school students of this particular schools. This instrument might be useful for mathematics teachers to know their students attitude toward problem solving, so that they could provide better instruction and guidance. The results of this study indicated that the scale might be a useful tools for measuring attitude toward problem solving, but the constructs function differently between cultures. Further research is needed in order to investigate the causes of differentiated

feelings toward problem solving. Also by using various population and sample sizes the research will give further insight as to the appropriateness of the factors and the items necessary to assess attitudes toward problem solving. In sum, this study contributes to the knowledge base on problem solving attitude by providing detailed information regarding factor pattern structure coefficients of ATPSS items.

Appendix 1
Attitude Questionaire

No.	Statement
1	I like to try hard problem
2	I will put down any answer just to finish a problem
3	It is no fun to try to solve problems
4	I will work a long time on a problem
5	I will try almost any problem
6	When I do not get the right answer right away I give up
7	My ideas about how to solve problems are not as good as other students' ideas
8	I am sure I can solve most problems
9	I can only do problems everyone else can do
10	I will keep on working on a problem until I get the right answer
11	I give up on problems right away
12	I can solve most hard problem
13	I need someone to help me work on problem
14	I am better than many students at solving problems
15	There are some problems I will just not try
16	I do not like to try problems that are hard to understand
17	I will keep working on a problem until I get it right
18	I like to try to solve problems
19	I am a good problem solver
20	Most problems are too hard for me to solve

References

1. Beaver, J.R (1994). Problem solving across the curriculum. Eugene, OR: International Society for Technology in Education.
2. Charles, L., Lester, F.,& O'Daffer, P. (1987). How to evaluate progress in problem solving NCTM , Reston: Virginia.
3. Conway (1996). The effects of the open approach to teaching mathematics on elementary pre service teachers' problem solving performance, attitudes toward mathematics and beliefs about mathematics.
4. Effandi Zakaria. (2003). Kesan pembelajaran koperatif ke atas pencapaian matematik dan sikap pelajar terhadap matematik dan penyelesaian masalah. Prosiding Simposium Kebangsaan Sains Matematik ke XI, Universiti Malaysia Sabah. 22-24 Disember.
5. Faridah Salleh. (2004). Keupayaan menyelesaikan masalah matematik bukan rutin dikalangan pelajar cemerlang akademik. Projek Penyelidikan Sarjana Pemdidikan UKM.
6. Kroll, D.L., & Miller, T (1993). Insights from research on mathematical problem solving in the middle grades. In D.T. Owens, (Ed), Research ideas for the classroom: Middle grades mathematics (pp. 58-77). New York: Macmillan Publishing Company.
7. Lester, Jr.,F.K (1994). Musing about mathematical problem solving research: 1970-1994. Journal for Research in Mathematics Education 25, 660-675.
8. Moses, B. E (1976). SAQ validation report. In N.L Webb (Ed.), Technical Report IV: Summative evaluation [Mathematical Problem Solving Project], Bloomington, IN: Mathematics Education Development Center.
9. NCTM (2000). Principles and standards for school mathematics. Reston, VA.
10. Nunnally, J.C. & Bernstein, I.H. (1994). *Psychometric theory* (3rd ed.) New York: Mc Graw- Hill.