International Journal of Engineering & Technology, 7 (2.29) (2018) 535-539

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research paper

Application of Confirmatory Factor Analysis for Correlate of Students Attitude, Self-Belief, Students Engagement in Mathematics Lessons and Mathematics Achievement

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Abstract

The study aimed to propose the Confirmatory Factor Analysis via four latent variables : 1) Students Attitude toward mathematics, 2) Self-belief in mathematics, 3) Students engagement in mathematics lessons and 4) Mathematics Achievement and 19 observed variables and then we conduct to the correlations between latent variables and observed variables. The subjects were 5795 eight grades students from the result of the Trends in International Mathematics and Science Study (TIMSS) 2011 assessment conducted in Indonesia. Data Analysis were undertaken using the Lisrel software to examine the effect of students attitude toward mathematics, students self belief and students engagement in mathematics lesson for mathematics achievement. The proposed Confirmatory Factor Analysis model of the latent variables and observed variables fit well with the empirical data set (RMSEA = 0,071). The results of multivariate analyses has shown a strong negative relationship between student attitude toward mathematics, self-belief in mathematics and their mathematics achievement (t value = -6.32 and t = -6.10, respectively) and a strong positive relationship between students engagement in mathematics lesson with mathematics achievement (t value = 8,28).

Keywords: *Student attitude toward mathematics; Students self-belief; students engagement in Mathematics; mathematics achievement; Confirmatory Factor Analysis*

1. Introduction

Mathematics is also called as the servant and queen of science, mathematics is also a body of knowledge essential for the achievement of a scientific/technological nation 1. Students' mathematics achievement is assosiated with the success of the government, schools, parents and teachers. Various efforts made to can improve mathematics achievement in the countries. Based on Trends in International Mathematics and Science Study (TIMSS) 2011 report, mathematics achievement for Indonesia student's lowest than other ASEAN countries such as Thailand, Malaysia and Singapore and other countries in the world. Based on the problem, we used TIMSS data for Indonesia student's to found whether there are correlation between students attitude, self-belief, students engagement in mathematics lessons with mathematics achievement.

Confirmatory Factor Analysis (CFA) is a multivariate statistical procedure that is used to study the relationships between a set of latent variables and a set observed variables. The use of CFA could be impacted by the research hypothesis being testing and the requirement of sufficient sample size. In the study will be analyzed the correlations among latent variables (students attitude, self-belief, students engagement in mathematics lessons and mathematics achievement) and observed variables. Michelli 2 found that there was a positive relationship between mathematics attitude and achievement, the data analyzed using the Statistical Package for the Social Science (SPSS) software and was conducted statistical analysis, a Pearson correlation to examine relationship significantly between attitude and mathematics achievement. Rahmatina 3 has also conducted through a regression linear was used to determine whether there are effect between student attitude toward mathematics and their mathematics achievement, the data analyzed using SPSS and Lisrel software and had summarized that a strong positive relationship between student attitude toward mathematics and their mathematics achievement.

Several researcher was used Structural Equation Modeling to provide information for assessing the effect, correlation of learning and teaching strategies4 by evaluated relations among attitudes, initial skill, and performance in a Quantitative Methods course that involved students in active learning using a structural modeling approach. Similar with other studies5 has been observed that established model has acceptable fit indices and an increasing number of teachers and expert teachers have positive effects on students' science and mathematics achievements. And also used by 6, they are included the Confirmatory Factor Analysis to compared of self belief for predicting student motivation and achievement. In this study, we tried to address using CFA in students attitude, self-belief, students engagement in mathematics lessons

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and mathematics achievement and examined the correlation between its variables.

2 Literature Review

Attitudes toward mathematics can be defined as a concept of how an individual to think, act, and behave. Student's success in mathematics depends upon attitude towards mathematics, factors that affect student success in learning comes from internal and external factors. Students' attitudes toward mathematics is one of the internal factors that affect mathematics achievement. Kulm 7 suggests that it is probably not possible to offer a definition of attitude toward mathematics that would be suitable for all situations, and even if one were agreed on, it would probably be too general to be useful.

Self belief in mathematics can be defined as the individual's personal judgement in relation to his/her abilities in mathematical process. According to Richardson 8, beliefs are "psychologically held understandings, premises, or propositions about the world that are felt to be true" and Raymond 9 defined mathematics beliefs as personal judgments about mathematics formulated from experiences in mathematics, including beliefs about the nature of mathematics, learning mathematics, and teaching mathematics. During the last twenty years the research area about self beliefs and mathematics achievement, and many different countries have been included in the research, for example Rao et al., 10, in Daniel11 noted that self concept of mathematics ability was a significant predictor of subsequent achievement. The meta analysis can be used to finding of the relation of self belief to academic achievement, and found that there are relations between measures of self belief and later achievement, controlling for prior achievement12.

Engagement is a construct used to describe an inner quality of concentration and effort to learn, student engagement in academic work as the student's psychological investment in and effort directed toward learning, understanding, or mastering the knowledge, skills, or crafts that academic work is intended to promote 13. Linnenbrink and Pintrich 14 divided student engagement into three types, the first is "behavioral engagement", which involves observable behavior, the second type of engagement is "cognitive Engagement " which associated with better learning and levels of achievemenet and the third type of engagement is "motivational engagement" , there are three aspects of motivational engagement are personal interest, utility value and affect or emotional experiences. Warwick,15 found that ways to reduce anxiety and enhance self-efficacy and engagement can significantly improve student performance in mathematics and, as such, can be a powerful complementary approach to mathematics support.

3 Methodology/Materials

Data were obtained from the Trends in International Mathematics and Science Study (TIMSS) international database 2011. Man16y studies have used TIMSS data of the research such as 16-22. TIMSS contains international results in mathematics presents extensive information on student performance in mathematics. TIMSS was originally conducted in 1995 and continue every four years, in 1999,2003,2007,2011 and most recently in 2015. For Indonesia participant in TIMSS 2015 at fourth grade only. The TIMSS 2011 database contains achievement data and student, home, teacher and school background data collection in the 63 countries and 14 benchmarking participants including three Canadian provinces, nine us state and two emirates from the united Arab emirates. For this study, the following database from TIMSS 2011 for eighth grade were used students attitude toward mathematics, students self belief, students engagement in mathematics, mathematics achievement. In this case study, the targeted population at the eighth grade in Indonesia country, total the participants was 5795 students (female : 2972; male : 2823) and number of schools was 153. The analysis data used by SPSS and Lisrel software.

The following items were selected from the TIMSS 2011 about four latent variables :

1. Students Attitude toward mathematics,
2. Self-belief in mathematics,
3. Students engagement in mathematics lessons and
4. Mathematics Achievement

Students attitude toward mathematics contains three observed variables : 1) Students like learning mathematics,2) Students value mathematics, and 3) Student confidence with mathematics. Students like learning mathematics scale addressed to measure students' interest and liking of learning mathematics. Students value mathematics scale addresses students' attitudes about the importance of the subject and usefulness of the subject, sometimes called attainment value and utility value 23 and the student confidence with mathematics scale assesses students' self-confidence or self-concept in their ability to learn mathematics. To assess mathematics assessment is based on a comprehensive framework developed collaboratively with the participant countries, the way to measure student's mathematics achievement on that scale in the TIMSS 2011 had five plausible variables which explained mathematics achievement, there are labelled BSMMAT01 through BSMMAT05.There are four content domains, numbers, algebra, geometry, data and chance, whereas knowing, applying and reasoning were assessed in the cognitive domain can be seen in Table 1 by TIMSS 2011

Table 1. Achievement scale of the mathematics

Content Domains	Number
	Algebra
	Geometry
	Data and Chance
Cognitive Domains	Knowing
	Applying
	Reasoning

The data contains 5795 observations of 19 indicators of four latent variables. More specifically, the first 3 indicators (BSDGSLM, BSDGSVM, BSDGSCM) are indicators of the latent variable students attitude toward mathematics, BSBM14A to BSBM14F are indicators of the latent variable self-belief about mathematics, BSBM15A to BSBM15E are indicators of the latent variable Students Engagement in Mathematics Lessons and BSMMAT01 to BSMMAT05 are indicators of the latent variable mathematics achievement is shown in table 2. Three likert scale item measure students attitude toward mathematics, six Likert - scale item measure student's self belief in learning mathematics and five likert scale item measure students Engagement in Mathematics Lessons.

Table 2 shows indicator of the variables by TIMSS 2011

Laten Variables	Labels	Statements	Point scale
Students attitude toward mathematics (ATTITUDE)	BSDGSLM	Students like learning mathematics	1= like learning mathematics, 2 = somewhat like learning mathematics, 3 = do not like learning mathematics
	BSDGSVM	Students value mathematics	1= value, 2 = somewhat value, 3 = do not value
	BSDGSCM	Student confidence with mathematics	1 = confident, 2 = somewhat confident, 3 = not confident
Self-belief about mathematics (BELIEF)	BSBM14A	Enjoy learning mathematics	1 = agree a lot, 2 = agree a little, 3 = disagree a little 4 = disagree a lot
	BSBM14B	Wish have not to study mathematics	
	BSBM14C	Math is boring	
	BSBM14D	Learn Interesting Thing	
	BSBM14E	Like mathematics	
	BSBM14F	Important to do well in math	
Students Engagement in Mathematics Lessons (ENGAGEMENT)	BSBM15A	Teacher expects to do	1 = Agree a lot 2 = Agree a little 3 = Disagree a little 4 = Disagree a lot
	BSBM15B	Things not related to the lesson	
	BSBM15C	Teacher is easy to understand	
	BSBM15D	Interested in what teacher says	
	BSBM15E	My teacher gives me interesting things to do	
Mathematics achievement. (ACHIEVEMENT)	BSMMAT01	1st plausible value mathematics	
	BSMMAT02	2nd plausible value mathematics	
	BSMMAT03	3rd plausible value mathematics	
	BSMMAT04	4th plausible value mathematics	
	BSMMAT05	5th plausible value mathematics	

The theoretical measurement model is a Confirmatory Factor Analysis (CFA) model that specifies that the 19 indicators are indeed indicators of the latent variables students attitude, self-belief , Students Engagement and mathematics achievement. A path diagram of this model is shown in figure 1.

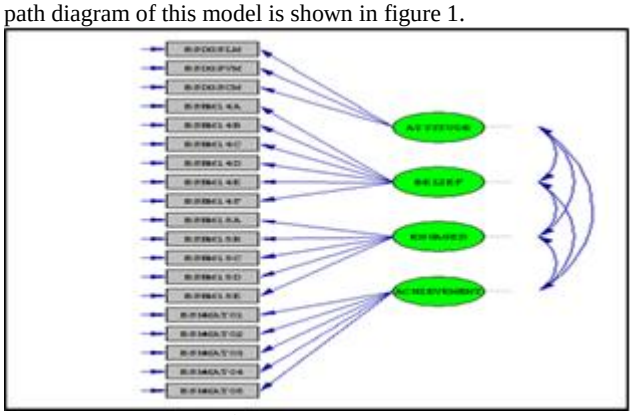


Fig 1: Confirmatory Factor Analysis Model

4 Results and Finding

The analysis is conducted through a correlation used determine whether there are correlated among latent variables students attitude, self-belief , students engagement,mathematics achievement and observed variables. The student questionnaire seeks information about students attitude toward mathematics can be seen that 2,3% only student confident with mathematics, this percentage was lower for like learning mathematics and value mathematics,18,3% and 30,2 % respectively (see Table 3). In table 4 shown that the percentage of students self belief about mathematics for important to do well in math has highest percentage (40%) of the point scale agree a lot, and only small percentages of students (1%) disagree a lot, the majority of students (82,4%) of the point scale agree to like mathematics, and the majority of students (79,1%) disagree math is boring

Table 3:.Students attitude toward mathematics : Percentage frequency response

Statements	Point scale	Percent
Students like learning mathematics	Like learning mathematics,	18,3
	somewhat like learning mathematics,	70,2
	do not like learning mathematics	11,4
Students value mathematics	value	30,2
	somewhat value	61,9
	do not value	7,9
Student confidence with mathematics	confident	2,3
	somewhat confident	48,8
	not confident	48,9

Table 4: Self-belief about Mathematics: Percentage frequency response

Statements	Point scale			
	agree a lot	agree a little	disagree a little	disagree a lot
Enjoy learning mathematics	20	66,7	11,8	1,6
Wish have not to study mathematics	1,6	6,3	53,7	38,4
Math is boring	2,7	18,1	56,6	22,5
Learn Interesting Thing	21,3	67,7	9,5	1,5
Like mathematics	20,6	61,8	15,5	2,1
Important to do well in math	40,0	53,5	5,5	1,0

Table 5: Students Engagement in Mathematics Lessons: Percentage frequency response

Statements	Point scale			
	agree a lot	agree a little	disagree a little	disagree a lot
Teacher expects to do	24,5	68,1	6,5	0,9
Things not related to the lesson	2,5	21,2	60,2	16,2
Teacher is easy to understand	22,6	65,5	10,7	1,2
Interested in what teacher says	19.0	68,4	11,5	1,1
My teacher gives me interesting things to do	23,8	66,4	8,7	1,1

Table 6. Mean and standard deviation in mathematics achievements

Mathematics achievement.	Mean	Std. Deviation
1st plausible value mathematics	400.9769	82.94193
2nd plausible value mathematics	400.3401	83.98521
3rd plausible value mathematics	400.6655	83.94974
4th plausible value mathematics	400.1713	83.33684
5th plausible value mathematics	400.3396	83.79095

In table 5 shown that the percentage of students engagements in mathematics lessons, most students agree teacher expects to do (92,6%) and disagree (7,4 %), smaller percentages of students agree (23,7%) for interested in what teacher says,the majority of students (88,1%) of the point scale agree that teacher is easy to understand. In table 6 shown that descriptive statistics for mathematics achievement variable, the mean for mathematics achievement about 400 and standard deviation is 83.

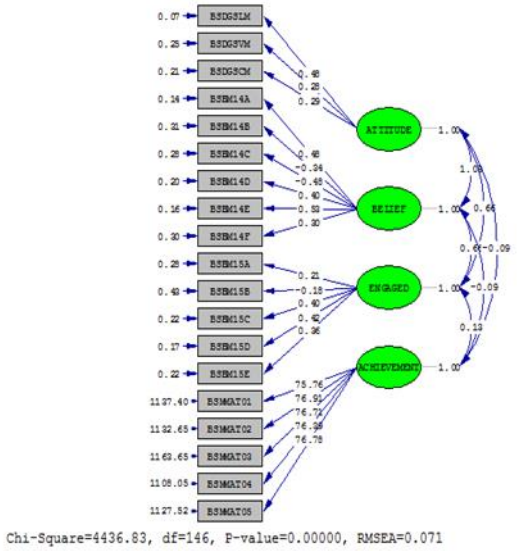


Fig 2: Estimates Basic Model

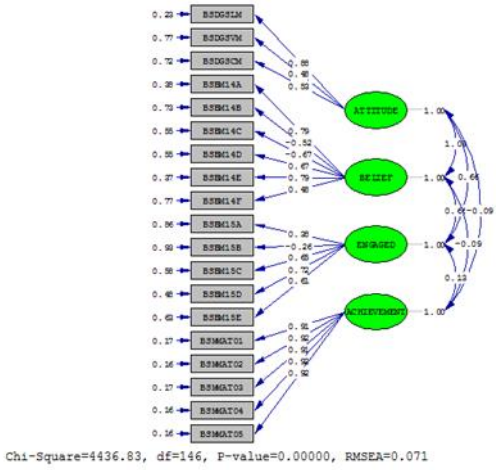


Figure 3: Standardized Solution Basic Model

The Root Mean Square Error of Approximation (RMSEA) is 0.071 < 0,08, which is large enough to reject the null that the model is good fit to the data. The standardized loading shown in figure 2 and represent the correlation between each observed variable and the latent variables. Considering first the latent variables of ATTITUDE, they are 0.88 for BSDGSLM, 0.48 for BSDGSVM, 0.53 for BSDGSCM. Considering the latent variable of BELIEF, the standardized loading are 0.79 for BSBM14A, -0.52 for BSBM14B, -0.67 for BSBM14C, 0.67 for BSBM14D, 0.79 for BSBM14E and 0.48 for BSBM14F. Considering the

latent variable of ENGAGEMENT, the standardized loading are 0.38 for BSBM15A, -0.26 for BSBM15B, 0.65 for BSBM15C, 0.72 for BSBM15D, and 0.61 for BSBM15E. And then considering the latent variable of ACHIEVEMENT, the standardized loading are 0.91 for BSMMAT01, 0.92 for BSMMAT02, 0.91 for BSMMAT03, 0.92 for BSMMAT04 and 0.92 for BSMMAT05.

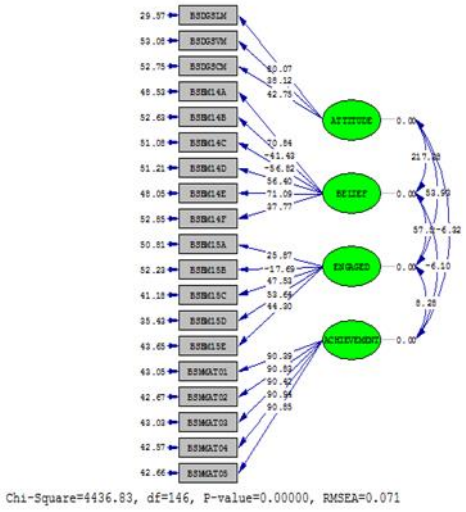


Fig 4:. t-value Basic Model

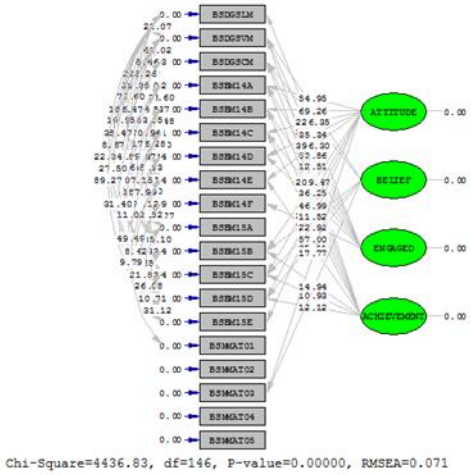


Figure 5: Modification Indices

Table 7:. Correlation among latent variables in the CFA (t value)

Varibles	ATTITUDE		BELIEF		ENGAGEMENT		ACHIEVEMENT	
	Estimate	t value	Estimate	t value	Estimate	t value	Estimate	t value
ATTITUDE	1.00							
BELIEF	1.09	217.28	1.00					
ENGAGEMENT	0.66	53.93	0.66	57.59	1.00			
ACHIEVEMENT	-0.09	-6.32	-0.09	-6.10	0.13	8.28	1.00	

Table 7 shows the correlations between the latent variables gives the results of all latent variables. These correlations are in the expected direction and all are significant at an alpha level of 0.05 (t value > 1.96). And in figure 4 shows the correlation among latent variables and observed variables and all are significant (t value > 1.96), all variables are positive correlation between latent variables and observed variable expect for BSBM14B with latent variable BELIEF (t value = -41.43), BSBM14C with BELIEF (t value = -56.82) and BSBM15C with latent variable ENGAGEMENT (t value = -17.69) It's mean that BSBM14B and BSBM14C increases, the BELIEF in mathematics decreases. As

well as the correlation between BSBM15C and ENGAGEMENT, the BSBM15C increase, the ENGAGEMENT decrease and otherwise.

5 Conclusion

In this study we have used CFA to examine the effect of students attitude toward mathematics, students self-belief and students engagement in mathematics lesson for mathematics achievement. Data analysis indicated that a strong negative relationship between latent variables, there are student attitude toward mathematics, self-belief in mathematics with their mathematics achievement and a strong positive relationship between student's engagement in mathematics lesson with mathematics achievement. Relationship between latent variable with observed variables are positive correlation except relationship wish have not to study mathematics and math is boring with self-belief about mathematics and relationship teacher is easy to understand and students engagement in mathematics lessons. This study points to future research, our focus here used how important Confirmatory Factor Analysis to analysis related laten variables and observed variables, other analysis is needed such as structural equation modeling is used to the combination of factor analysis and multiple regression analysis.

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