Factors Affecting Indonesian Students' Achievements in the International TIMSS Study

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Abstract

This research examined the structural equation model of relationships between the students' mathematics achievement and socio-educational factors (family background, beliefs, instruction, school environment, teachers, and the students' attitudes) and investigated the direct and indirect effect of the factors that influenced the students' mathematics achievement in Indonesia. The samples were 5762 eighth grade students of Junior High School of the TIMSS study 2003. There were 7 research variables, with 5 exogenous variables (family background, beliefs, instruction, school environment, and teachers), and 2 endogenous variables (the students' attitudes and mathematics achievement), with 14 indicators. The data were taken from TIMSS study 2003. The data were analyzed using the path analysis with the generating model and using Lisrel 8.50 software. The criterion used to test the model was GFI □ 0.95 or p > 0.05. The results of this research showed that (a) the structural equation model of the modification 2 - the influence of the family background, beliefs, instruction, school environment, teachers, and the students' attitudes to the students' mathematics achievements - fit with the empirical data; (b) the family background, instruction, school environment, teachers, and the students' attitudes had the direct effect on the students' mathematics achievements. Nevertheless, the school environment influenced the students' mathematics achievements conversely. The belief of students and instruction was not influential in a manner indirectly towards the students' mathematics achievements; and (c) the most significantly influential factors towards the students' mathematics achievements were the family background, instruction, and the teachers respectively.

Keywords: *mathematics achievements, socio-educational factors, structural equation model*

1. Introduction

To monitor the quality of the national education, Indonesia has been participating in the TIMSS study since 1995. TIMSS is an international study designed and organized by the International Association for Evaluation of International Achievement (IEA). TIMSS 2003 is a series of international studies involving 46 countries and 4 countries that functions as a "benchmark for participants" designed to study the development of knowledge of mathematics and science among 13 year-old students and other information related to students, teachers, and principals. One of the aims why Indonesia joins this study is to get information about Indonesian students' abilities in mathematics and science compared with those from other countries all over the world. Moreover, it is also intended to improve mathematics and science instruction by providing data on students' achievements in terms of curriculum, instruction processes, and different school environments.

The instrument used in TIMSS 2003 is mathematics and natural science test. The framework of the test consists of material and cognitive aspects. Besides, in order to get background information of mathematics and natural science studies, questionnaires were distributed to students, mathematics teachers, natural science teachers, and principals.

In the mathematics subject, the evaluation framework is divided into two dimensions, material or content and cognitive dimensions. The content dimension consists of number, algebra, measurement, geometry, and data. Meanwhile, in the cognitive dimension, there are four domains, namely knowing facts and procedures, using concepts, solving problems, reasoning. TIMSS 2003 had the students solve mathematic problems in the content dimension in order to measure students' abilities in using facts and procedures or concepts to solve various problems, from simple problems to difficult ones that need systematic reasoning.

Moreover, in TIMSS 2003, the information about some factors affecting students' mathematics achievement, internal or external, were collected. Some internal factors assumed to influence students' abilities included abilities, self-concept, attitude, and grades; meanwhile the external factors were teachers, schools, and family conditions.

TIMSS 2003 report showed that Indonesian students' abilities in mathematics and science were below average and in the 34th rank. Concerning on the achievement in mathematics, the best five ranks were occupied by Singapore, South Korea, Taiwan, Japan, and Belgium. Indonesia is better than Chili, the Philippines, Morocco, and South Africa. Among the ASEAN countries, either in Mathematics science, for eighth grade students, Indonesia is in the fourth rank from five countries. Indonesia is one level higher than the Philippines and lower than Thailand.

The results showed that the mathematics achievement of Indonesian students did not significantly become better or worse compared to the results of TIMSS 1999. They also suggested that the mathematics achievement of Indonesian students was very low. This issues are very interesting, especially for the policy makers. What factors affect students' abilities in mathematics, either directly or indirectly? What are the implications for instructional processes, school and family environments, and also students?

1.1. Factors affecting students' mathematics achievement

Syah (2005) suggests that some factors affecting the learning results are internal and external, and instructional ones. Internal factors are those from students and they consist of psychological and physiological aspects. Psychological aspects may affect the quantity and quality of the achievement of students' instruction. There are some elements considered to be important namely intelligence level, attitude towards the subject, talent, interest, and motivation of the students.

TIMSS 2003 report states that if the parents' educations, students' ideal in education, the number of books at home, and time to do their homework are high, the students' average grades in mathematics are also high. There are also some literature studies that give possible answers to the above questions on the basis of some research results. Kiamanesh (2001) states that factors affecting mathematics achievement are students' attitude towards mathematics, school environment, family background, self-concept to mathematics, teachers, external motivation, school-home interface, and other attributes. Factors affecting students' achievement in mathematics according to some experts are students' attitude towards mathematics (McMillan, 1977; Aiken, 1976; Kulm, 1980; Papanastasiou, 2002; Schereiber, 2000), students' self-concept on mathematics (Kiamanesh&Kheirieh, 2001), family background (Kiamanesh&Kheirieh, 2001).

Ho Sui-Chiu & William (1996) further explained that parents' participations at schools contribute a high influence on the achievement in reading and a low one on mathematics. Sirbani (2007) also stated that the communication between teachers and parents did not influence students' achievement in mathematics. However, Hill, Rowan, & Ball (2005) suggested that mathematics teachers' knowledge or competence also affect the first and third year students' achievement in mathematics.

Marzano (2000) stated that teachers and schools contribute 20% and students' characteristics comprising family environment, background knowledge, and students' motivation contribute 80% to the students' achievement in mathematics. Also, effective instructional factors such as preparation and instructional strategies and also principals' leadership affect achievement in mathematics. Monus (200) showed that teachers' certification, students' socio-economic status, and family background such as education are important factors in improving students' achievement.

Marzano (2000) also asserts that psychologists consider attitude as all strong feelings or beliefs or agreements or rejections to people and situations. We may have good or bad attitude towards people, politic, subject matters, and the like. Students' attitude towards a subject matter is an important factor for learning and learning achievement. Whether a student considers himself to be bad or good at a subject matter is an important factor for his academic achievement.

Meanwhile, there are some factors that build students' belief to mathematics namely the family background and attitude towards a subject matter (Kuiper &Klom, 2001) and pressure variable such as friends and pressure to learn mathematics (Martin, et al, 2003).

On the basis of the descriptions above, there are some factors that may be seen in TIMSS 2003. They are as follows:

1.2. Students' Attitude

Students' ability in mathematics is influenced by their attitude and grades. Students' positive attitude towards mathematics is an important thing in order to study mathematics well. Students' appraisal to mathematics is also closely related to students' motivation to learn.

Kiamanesh (2001) revealed that some factors affecting achievement in mathematics are students' attitude towards mathematics and external motivation which is the appraisal to the meaningfulness of mathematics for the students. Some experts stating that students' attitude towards mathematics affects their achievement in mathematics are McMillan (1977), Aiken (1976), Kulm (1980), Papanastasiou (2002) and Schereiber (2000) in Kiamanesh (2001).

In TIMSS (2003), there were some items in the student questionnaire to reveal attitude and their grades in mathematics, namely among others:

    a. I would like to take more mathematics in school.

    b. I enjoy learning mathematics.

    c. I think learning mathematics will help me in my daily life.

    d. I need mathematics to learn other school subjects.

    e. I need to do well in mathematics to get into the university of my choice.

    f. I would like a job that involves using mathematics.

    g. I need to do well in mathematics to get the job I want.

1.3. Belief

Students' belief in mathematics is their internal factor that influences their ability in this subject matter. Positive or negative belief will affect their attitudes towards, appraisal to, and ability in mathematics.

In TIMSS (2003), there were some items in the questionnaire to reveal their belief in mathematics, namely among others;

    a. I usually do well in mathematics.

    b. Mathematics is more difficult for me than for many of my classmates.

    c. Mathematics is not one of my strengths.

 d.   I learn things quickly in mathematics.

1.4. Family Background

 Family background is students' external factors in improving their ability in mathematics. The family background includes parents' education background, facilities and infrastructures available at home such as books, tables, computer, dictionaries, and the like and the use of Bahasa Indonesia in the family. Some experts showing that family background affects students' ability in mathematics are Marzano (2000), Kiamanesh (2001), and Kuiper &Klom, 2001).
  Student questionnaires in TIMSS (2003) consisted of items intended to reveal family background, among others:
 a.   Using Indonesian at home

 b.   The number of books possessed

 c.   Structures and infrastructures (calculators, computers, tables, dictionaries, type-writers)

 d.   Level of parents' education

 e.   How far in school the students expect to go.

1.5. Instruction

Instruction employed by teachers in the classroom may affect students' ability in mathematics. Syah (2005) states that instruction factors are those affecting students' achievement in mathematics. Student questionnaires in TIMSS 2003 contained some items in number 10 intended to see the instruction. The items are among others:
 a.   We work together in small groups.

 b.   We relate what we are learning in mathematics to our daily lives.

 c.   We review our homework.

1.6. School Environment

School environment is one of important elements supporting instructional processes in the classroom. A good school environment may stimulate students' interest and beliefs in studying mathematics and then also affect students' ability in mathematics. Kiamanesh (2001) stated that school environment is a factor affecting students' ability in mathematics. In TIMSS 2003, some questionnaires asked the students about the condition of their school environment, namely:
 a.   I like being in school.

 b.   I think that students in my school try to do their best.

 c.   I think that teachers in my school care about the students.

 d.   I think that teachers in my school want their students to do their best.

Based on the descriptions of the factors affecting students' ability in mathematics, the relations between students' structural ability and factors influencing it are as follows:
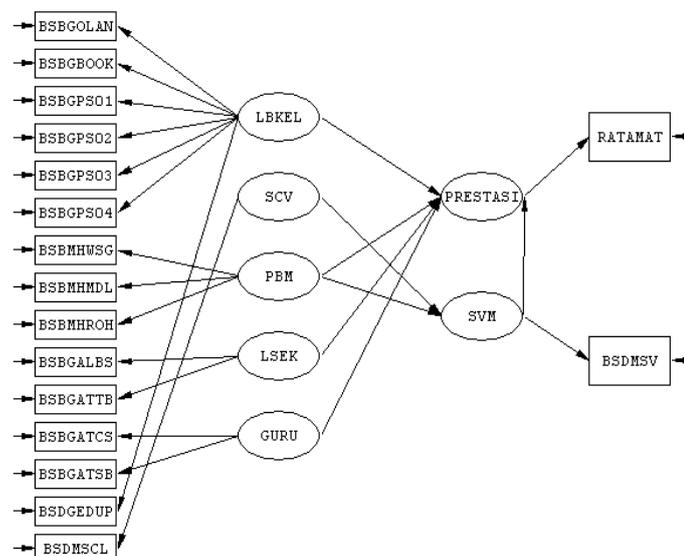

Fig 1: A Structural Equation Model of Factors Affecting Students' Ability

LBKEL is the family background; SCV is students' beliefs; PBM is instruction; LSEK is school environment; Guru is teacher; SVM is students' attitudes; and PRESTASI is achievement in mathematics.

Based on the descriptions above, the objective of this study was to examine the structural equation model of the relationships between students' mathematics achievement and socio-educational factors (family background, beliefs, instruction, school environment, teacher, and students' attitudes), and to investigate the direct and indirect effects of the factors that influenced the students' mathematics achievement in Indonesia.

2. Methodology

2.1. Population and Sample

The population of this present study was the eighth grade students of junior high school in Indonesia. The samples were all students in TIMSS study 2003 from Indonesia, consisting of 5762 students.

2.1. Variables and operational definitions

There were 7 variables, with 5 exogenous variables (family background, beliefs, instruction, school environment, teacher) and 2 endogenous variables (students' attitudes and mathematics achievement), with 14 indicators. A structural equation model was developed from the variables and indicators as shown in Figure 1, and the fit model was tested using a path analysis with Lisrel 8.54. In order to avoid misunderstanding, the seven variables should be operationally defined. They are as follows.

Achievement represented the eighth grade students' test scores on mathematic problems in TIMSS 2003 obtained from the average of 1st, 2nd, 3rd, 4th, 5th PLAUSIBLE VALUE MATH scores. The family background was the condition of education of the family, daily languages used, and facilities and infrastructures that support students' learning at home such as books, calculators, computers, tables, and dictionaries. Students' belief represented the level of students' self-confidence in learning mathematics. Instruction represented teaching-learning processes made by teachers in the classrooms; covering work activities in small groups, contextual - relating to what is learned in mathematics and daily life, and activities in discussing homework in the classrooms. School environment showed students' perception on the existence of good environment in terms of the convenience aspect in learning or in getting in touch with classmates during learning activities. Teacher variable showed efforts made by teachers to improve students' learning, either in terms of motivation or teachers' attention to the students as measured from students' perception. Students' attitudes on mathematics were students' evaluation to the meaningfulness of mathematics.

2.2. Data sources

The data were obtained from the population, namely eight grade Indonesian students with the age of 13 attending TIMSS 2003. The students participated in TIMSS 2003 were 5762 persons. The data analyzed in this study were those related to the students who had joined the mathematics achievement test, who completed the questionnaires, and who had scores in mathematics.

2.3. Data analysis

The objective of this study was to understand the relationship between the structural equation model and students' ability in studying mathematics and the factors influencing it. If the model fit, this study was to know direct or indirect effects of exogenous variables on the endogenous ones or on the way around. The technique of analysis employed was a path analysis. A model-generating approach was employed in this path analysis. This approach facilitated the researcher to develop a model of hypothesis. When the testing of the model using empirical data showed inappropriateness, the model was then modified and retested using the same data (Joreskog&Sorbom, 2003). The criteria used to test the model to fit the data was the value of GFI $\geq$ 0.95 or p > 0.05. This research used a computer software to analyze the data - SPSS 15.00 and Lisrel 8.50.

3. Findings and Discussion

Figure 2 informs that the structural model showed the effects of the family background, the students' self-confidence, instruction, school environment, and the students' attitudes towards mathematics on the students' ability in mathematics supported by the empirical data. The model was declared to fit after some modifications were made, with an assumption that Bahasa Indonesia is not only used at home, but also in school environment and in instruction and these affected the students' ability in mathematics, and also there was an error variance relationship between the students' self-belief to mathematics and students' perception about teachers. The equation model is as follows:

$$PRESTASI = 3.53*SVM + 90.63*LBKEL + 51.11*PBM - 74.42*LSEK + 23.74*GURU$$
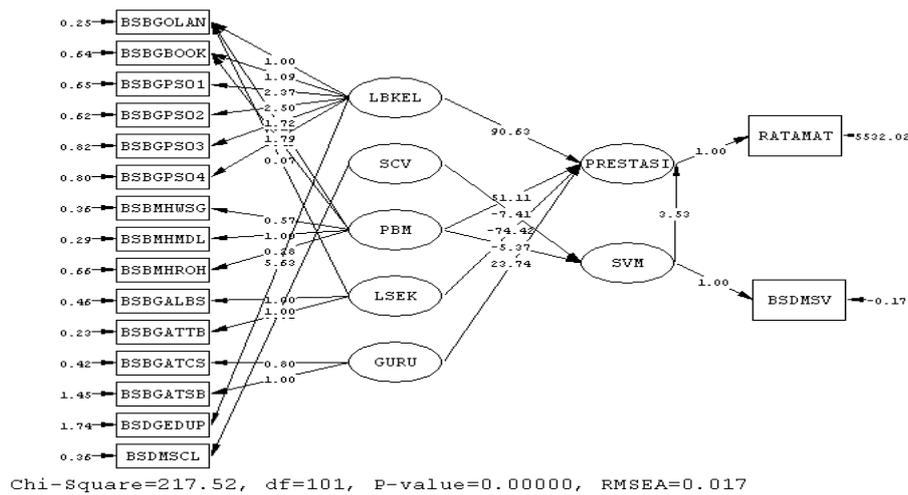
Chi-Square=217.52, df=101, P-value=0.00000, RMSEA=0.017

Fig 2: The Result of a Structural Equation Model of Factors Affecting the Students' Ability

The backgrounds of family, instruction, school environment, and teachers have contributed direct effects on students' ability in mathematics. While the students' attitude towards mathematics did not have a direct effect on the students' ability in mathematics. The students' self-confidence and instruction also did not show a direct effect on students' attitude towards mathematics. The family background, viewed from the level of parents' education, the use of Bahasa Indonesia at home, and facilities and infrastructures the students possess at home such as books, calculators, table, computers, and dictionaries gave a direct effect on students' ability in mathematics. The results of a qualitative research by Pusat Penilaian Depdiknas (2005) showed that 21% students always used Bahasa Indonesia, 57.7% sometimes, even 9.9% never used it continually in their daily life. As a result, the students' achievement in mathematics occupied the last rank compared to those from other countries. The difficulty the students faced in understanding mathematics might be caused by their limited mastery of Bahasa Indonesia, since in the process of instruction and of reading books, Bahasa Indonesia is always used.

The same condition may also be seen from the aspect of the parents' education and the availability of facilities and infrastructures the students have such as books, calculators, tables, computers and dictionaries.

In the aspect of instruction, there were three things affecting the students' ability in mathematics. First, group work was an important factor to improve the students' ability. A student-centered instruction was needed in instructional process. It is in line with student active learning developed by T.J. Joni. It is said that students should be active in learning, and one of the efforts made is to learn in groups in the classroom. Second, an instruction relating the material and the daily life was a very effective instructional approach to present material to the students. The students will be easy to understand concepts in mathematics when they are directly observing and performing in their daily life. Contextual teaching and learning is one of the ways implemented by the teachers at schools to teach effectively in order to improve the students' ability in mathematics. Third, discussing homework together was also important. Discussion activities in instructional processes were also important for the students in order to be able to know the results of their work at home. This kind of approach has enabled the students who made mistakes in their homework to correct them and they understood more when their homework was discussed together.

Based on the condition above, it is necessary for the principals and teachers to conduct instructions by paying attention to the three aspects namely group work, contextual teaching and learning, and discussing homework together.

The effect of school environment on the students' ability in mathematics was inversely proportional. The school environment indicator, viewed from the students' aspect that enjoyed studying at school and their fellows who were diligent to go to school, has given a reversal effect on the students' ability in mathematics. These two conditions have affected the students' ability in mathematics.

Teachers were the other important factors in instructional process, such as teachers who give attention and motivation to study hard. It is relevant to what is stated by Syah (2005) that attention and motivation are the factors that affect learning results. It means that teachers not only present materials to their students but also give empathy and motivation to their students both in and out of classroom.

The students' attitudes towards mathematics insignificantly affected the students' ability in mathematics. However, from the coefficient of the SVM variable, it was shown that the more positive and higher the students' attitude towards mathematics, the better their ability in learning mathematics would be. From its indicators, it shows that the students liked to study mathematics and were motivated to learn it since they felt that they needed to study mathematics for their practical needs in daily life at present and in the future. Therefore, it is necessary to implant a positive attitude towards mathematics in the mind of the students through instruction and materials in mathematics itself and to show that mathematics is important. By this way, the students' ability in mathematics will improve.

Finally, the students' self-confidence to mathematics and instruction did not directly affect the students' ability in mathematics.

4. Conclusion

This current research has concluded that (a) the structural equation model of the modification 2 - the influence of the family background, beliefs, instruction, school environment, teachers, and the students' attitudes to the students' mathematics achievements - fit with the empirical data; (b) the family background, instruction, school environment, teachers, and the students' attitudes had the direct effect on the students' mathematics achievements. Nevertheless, the school environment influenced the students' mathematics achievements conversely. The beliefs of the students and instruction were not influential in a manner indirectly towards the students' mathematics

achievements; and (c) the most significantly influential factors towards students' mathematics achievements were the family background, instruction, and the teachers respectively.

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