

SE-031

## LOW ACHIEVEMENT OF INDONESIAN STUDENT IN PISA AND TIMSS TEST RESULTS AND THE RELATED FACTORS

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### ABSTRACT

The main objective of this study is to analyze the related factors that affect the achievement of Indonesian student in PISA and TIMSS test. Primary data is collected using questionnaire from urban schools and rural schools of North Sumatera, South Sumatera, Jakarta, West Java, East Kalimantan, and South Sulawesi provinces. Observation of teaching and learning process is also carried out at schools. Secondary data was collected from internet sources, especially related to national examination results, PISA/TIMSS results, school evaluation report, teacher competency test, and student test. The result of Indonesia student of grade 8 in TIMSS and PISA are of the lowest category of cognitive level. Compared to another country, Indonesia student are also in the lowest achievement group. This condition is relevant with the low quality of educational process reported in the school evaluation report. The quality of teaching and learning is still the main problem encountered. This condition is due to low quality of science and mathematics teacher. Another handicap in teaching and learning is low motivation and small effort of student to study, due to cheating phenomena in national examination. Indonesia must reform the education, especially the quality of teacher, teaching and learning process, and better assessment. New rule for teacher education, recruitment, and evaluation must be proposed and implemented. Reward and merit system related to teacher and school headmaster performance must be control by the society and central government. Reformation of assessment to measure student thinking ability rather than low level of thinking must be implemented at school, district, and national level.

**Keywords:** *Sciences and mathematics, PISA and TIMSS, Indonesian student, teaching and learning*

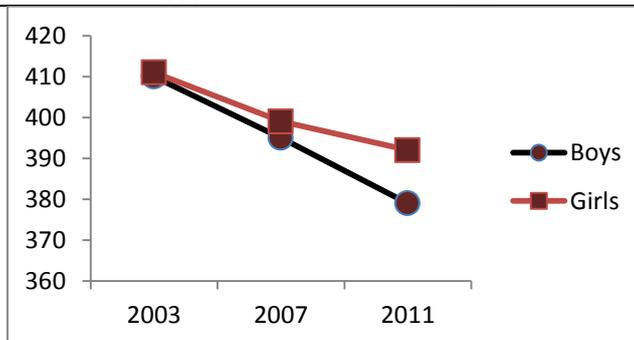
### INTRODUCTION

Based on TIMSS and PISA report, it is shows that Indonesia student is in the lowest group of test result. Indonesia student could answer low level test of TIMSS and PISA, but difficult to solve higher level because the question is not available in the text-book. Achievement is TIMSS is higher than in PISA, since the items in PISA emphasizes the use of numerical information in the form of tables and graphs taken from real world contexts, while items in TIMSS give much more attention to pure mathematics, including formal aspects of algebra and geometry. The trend of achievement in TIMSS is decline, as shown in Figure 1.

Girls are better than boys in TIMSS, relevant to their ability in school as reported by the teacher in the interview of this research. According to interview conducted in this research, most of teacher (80%) said that girls are clever than boys in almost every subject.

**Table 1.** Indonesian student achievement in TIMSS (Grade 8) (Adapted from Mullis *et.al*, 2012)

TIMSS	2003	2007	2011
Average	411	397	386
Boys	410	395	379
Girls	411	399	392



**Figure 1.** Trend of Indonesia 8 grade student achievement in TIMSS (Source: Adapted from Mullis, *et.al*, 2012)

Data in Table 2, shows that in 2003, student achievement is better in the lowest level (knowing) of knowledge in mathematics. Girls perform better in 2011 TIMSS, and their reasoning is also better than knowing and applying level of cognitive domain in mathematics. Girls and boys are performed better in algebra compared to another content of mathematics, as shown in table 3. Girls are also better in every contents of mathematics, as shown in Table 4.

**Table 2.** Mathematics cognitive domain level of 8 grade TIMSS of Indonesia student

TIMSS	Level of cognitive domain in mathematics					
	Knowing		Applying		Reasoning	
	Girls	Boys	Girls	Boys	Girls	Boys
2003	423	421	408	409	405	406
2007	400	393	401	396	406	404
2011	386	370	389	379	391	384

Source: Adapted from Mullis, *et.al*, 2003, 2007, and 2012

**Table 3.** Trend in achievement for mathematics content domains (TIMSS)

Topic	Number		Algebra		Geometry		Data and Chance	
Year	2007	2011	2007	2011	2007	2011	2007	2011
Score	393	375	399	392	387	377	382	376

Source: Adapted from Mullis, *et.al*, 2012

Indonesia student lowest achievement is in data and chance topic, which is need high reasoning. The common question related to data topic is not routine problem, and required higher order of thinking in order to solve the problem. The second difficult topic is geometry which is relevant with student responses to research questionnaire about most not enjoy topic in

mathematics. Algebra is though as easy subject according to student responses of enjoy topics, and this data is relevant with student achievement in TIMSS.

**Table 4.** Comparison of girls and boys achievement in TIMSS content domain of mathematics

Year	Number		Algebra		Geometry		Data and Chance	
	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys
2007	398	401	410	400	396	393	405	400
2011	380	370	402	382	382	372	381	371

Source: Adapted from Mullis et.al, 2007 and 2011

The main objective of the study is to further understand the related factors of learning achievement of junior high school student of Indonesia in mathematics and science. Supporting data must be collected in order to analyze any factors that affect student achievement in PISA and TIMSS test. Main focus in this study is analyzed the assessment used in Indonesia, teaching and learning process, and teacher factors. Special attention to analyze the national examination process is arise due to teacher assumption that cheating in national examination result in low intake quality of student at school.

## METHODOLOGY

This research was conducted in Indonesia, which involved several region of Sumatera, Java, Kalimantan, and Sulawesi. The data was collected in May and June of 2014, which is included secondary data and primary data. Primary data was collected using questionnaire and classroom observations from several urban and rural areas in first week of June, with total number of 5 schools for urban area and 5 school for rural area, and 4 schools for mathematics teaching observation and 4 schools for science teaching observation. Several sample for classrooms observation is different with sample of questionnaire due to unavailable schedule for teaching observations. We have choose Medan city of North Sumatera province, Palembang city of South Sumatera province, Jakarta, Bandung city of West Java province, Samarinda city of East Kalimantan province, and Makassar (Ujung Pandang) city of South Sulawesi province according to the characteristics of student and quality of education in those main Island in Indonesia. The reason of choosing area of this research is based on population, number of public schools in each province, and education characteristics based on school evaluation report from ministry of education. Based on quality of education process, Jakarta and Yogyakarta provinces is the highest performance, West Java, North Sumatera, East Kalimantan, and West Kalimantan is middle performance, and South Sumatera is the lowest performance.

Students' performance in mathematics and science is reflected in PISA and TIMSS results. Achievement and trend of girls and boys in PISA/TIMSS results is analyzed and compared to education quality identified from data of school evaluation report and teacher competency test results which are available from ministry of Education. Supporting data is collected using questionnaire and classroom observation in order to reveal any factors that could explain the existing phenomena. Questionnaire about national examination (UN) process, teaching and learning process, and teacher opinion about UN is obtained from student of several district, i.e.: Medan, Serdang Bedagai, Deli Serdang, Tapanuli Utara, Samosir, Karo, Simalungun, Dairi, Sibolga, Mandailing Natal, Labuhan Batu, Padang Sidempuan, dan Asahan. Finally, all factors are interrelated in order to identify and formulate education policy recommendations to mitigating the gap of girls and boys learning in mathematics and science.

Primary data was tabulated and analyzed using Microsoft Excel software, presented as graph and correlated with qualitative data available from the questionnaire and observation. Secondary data is obtained from another source, such as OECD website for PISA and TIMSS results, development and research center (Balitbang) website of ministry of education for national examination results, university website for graduates data, data center of ministry of education for active student data, and quality assurance center of ministry of education for national school evaluation report.

## **ASSESSMENT AND LEARNING PROCESS IN MATHEMATICS AND SCIENCE**

### **National Assessment.**

Learning assessment in Indonesia was dominantly carried out using written test. Student of grade 6<sup>th</sup> of age 12, 9<sup>th</sup> of age 15, and 12<sup>th</sup> of age 18, must follow national examination for certain subject matter. The questions in national assessment are in the form of multiple choices (objective test). Mathematics and science is also included in the national examination. The results of examination will be used to determine student graduation from school and student enrolment for the next school level. Schools are also conducting their own assessment, which is in the form of student portfolio, performance, practical test, and school cognitive test. School based assessment is varied between districts, several districts managed the same school assessment and another district allowed the school to manage their own assessment.

In 2013, the ministry of education determine new rule for student assessment. The assessment must include knowledge (cognitive) assessment, attitude (affective), and psychomotor. The national assessment is only carried out for 9<sup>th</sup> grade and 12<sup>th</sup> grade. The government announced national examination grid content before the assessment is carried out. Several problems arise in the implementation of national examination, due to the policy of district autonomy and low quality of education. It could be found that province with better

education quality have lower achievement in the national examination. Quality of education is based on school evaluation report which is documented by ministry of education. The lower achievement of student compared to another province with lower quality of education is most probably due to honesty in the process of examination. People argued about the accountability and honesty of several district in the process of national examination, since the national examination result is not reflected graduate quality. The provinces with good quality of education usually have higher student participation in university, which is not related to the result of national examination, such as Yogyakarta and Jakarta. The data of national examination results for several provinces which is less biases is given in table 5. Unfortunately that the examination result is not available by gender segregated.

**Table 5.** National examination results of mathematics of public junior high schools (maximum score is 10)

Year	Province							Average
	Jakarta	West Java	NTT	Yogyakarta	West Kalimantan	East Kalimantan	Babel	
2011	6.68	7.54	6.65	6.83	6.45	6.83	6.46	6.68
2012	7.38	7.42	6.72	6.38	7.03	6.91	6.25	6.87

Source: Ministry of Education (2014), National Examination data

**Table 6.** National examination results of science of public junior high schools (maximum score is 10)

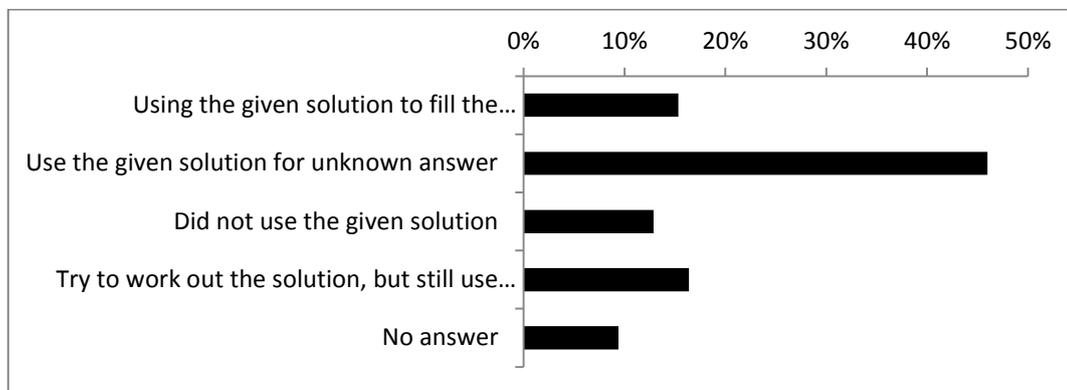
Year	Province							Average
	Jakarta	West Java	NTT	Yogyakarta	West Kalimantan	East Kalimantan	Babel	
2011	7.25	7.71	6.81	7.52	6.59	6.98	6.8	7.09
2012	7.47	7.46	6.86	6.69	6.95	7.10	6.54	7.01

Source: Ministry of Education (2014), National Examination data

National examination results is increase in mathematics and science subject, except Yogyakarta and Jakarta provinces in 2011 and 2012. According to the area, the lowest achievement of Junior High School student national examination is in rural area of Jakarta province. About 76 % of Junior High School student in Jakarta rural area (the Thousand island) is failed in national examination in 2014. This condition is a result of low quality of education in that area. The data of these two provinces is suitable with teacher opinion about student ability in recent years. According to the interviewed teacher, the student is more lazy and difficult to master school topic, especially science and mathematics. According to student responses in this research, only several students is very confidence in those topics, and most of students are though that mathematics and science (except Biology) is difficult.

The national examination (UN) results could not reflect student competency in general, since several provinces were cheating to get high achievement. Interview with several teacher

about the mechanism of cheating in national examination have been conducted, and about 500 student also returned the questionnaire about national examination process. Figure 2 described the condition of the UN process.



**Figure 2.** Student treatment about national examination cheating solution given by the school

In general, the test content of national examination for mathematics is pure mathematics, and science content also pure science without application to daily live problem solving. The test is text-book oriented and the student could solve routine problem available in text-book. The content of national examination for mathematics and science for junior high school are described in Table 7.

**Table 7.** Competency list for national examination of junior high school of 2012

Subject	Competencies (term use by the ministry of education)
Mathematics	1. Use concept of operation, number, comparison, square root, and series in solving problem
	2. Use algebra operation, equation, set, relation, and function to solve problem
	3. Use geometry concept, such as congruent figures, relation of angle and line to solve problem
	4. Use statistics concept to solve problem
	5. Use chance and probability concept to solve problem
Science	1. Use measurement devices accurately using daily instruments
	2. Apply concept of matter and heat properties in daily live
	3. Describe and apply mechanics concept (motion, forces, work, energy, pressure) in daily live
	4. Understand concept of vibration, wave, sound, and optics in technology products
	5. Understand and apply electricity concept in daily live
	6. Understand solar system
	7. Understand concept of atom, ion, and molecule and it relation to daily chemical product
	8. Understand about matter and transformation
	9. Describe the use of certain chemical substances in daily live
	10. Identify bio-diversity and the important of sustainable bio-diversity
	11. Describe components of ecosystem, interaction, and human role in environment
	12. Describe human organ system
	13. Describe plant organ system
	14. Apply concept of growth and development, live sustainability, and heredity in science, technology, and society

Source: Adopted from Badan Standar Nasional Pendidikan, 2012.

After the autonomy policy (decentralization) in 1999, student achievement in national examination is increase. Since wider decentralization in 2004, the education is no longer controlled by the central government. Study in 150 junior high schools spread over Indonesia region shows that there are no different of girls and boys achievement in mathematics, and boys performed better in science (Indonesia World Bank, 2011). Although there are no significant difference between girls and boys achievement in average score of national examination of 2011 until 2014, female student always reach the highest achievement in national examination.

### National Curriculum and International Assessment

Interesting to see that student achievement in TIMSS is related to their parent education, as shows in Table 8.

**Table 8.** Highest level of education of either parent and correlated TIMSS score of 2007 of 8 grade

Either parent highest level of education Level of education	Percentage	Average achievement of mathematics	International average
University degree (include post graduate)	9	460	485
Completed post-secondary education, but not university	6	439	467
Completed upper secondary school	25	412	444
Completed lower secondary school	24	380	418
Less than lower secondary school	28	380	396
Not known	9	369	431

Source: Adapted from Mullis, et. al, 2007

Several factors affect the ability of student in solving problem of TIMSS. The first factor is teaching and learning content which is not match with the test, and the second factor is education quality. Topics of national examination is described in table 7. is almost same with TIMSS content described in Table 9 and Table 10. However, some topics are not delivered in grade 7 and grade 8, for example: the solar system and electric circuits are taught at the 9<sup>th</sup> grade of junior high school.

**Table 9.** Missing content of science of grade 8 which is not match with TIMSS content

Domain	TIMSS Topics of grade 8 (science)	
	Topics available in the 2006 curriculum	Topics unavailable in the 2006 curriculum
Biology	<ol style="list-style-type: none"> <li>1. Major organs and organ systems in humans and other organisms</li> <li>2. Reproduction and heredity</li> <li>3. Role of variation &amp; adaptation in survival/extinction of species in a changing environment</li> <li>4. Interdependence of populations of organisms in an ecosystem</li> </ol>	<ol style="list-style-type: none"> <li>1. Cells and their functions, including respiration and photosynthesis as cellular process</li> </ol>

	<ol style="list-style-type: none"> <li>5. Reasons for increase in world's human population and its effects on the environment</li> <li>6. Human health (infection, prevention, immunity) and the importance of diet &amp; exercise</li> </ol>	
Chemistry	<ol style="list-style-type: none"> <li>1. Classification, composition</li> <li>2. Solutions (solvent, solute, concentration/dilution, effect of temperature on solubility)</li> <li>3. Chemical change (transformation, conservation, oxidation)</li> </ol>	<ol style="list-style-type: none"> <li>1. Particulate structure of matter (inside atom)</li> <li>2. Properties and uses of common acids and bases</li> </ol>
Physics	<ol style="list-style-type: none"> <li>1. Physical states and changes in matter</li> <li>2. Energy forms, transformations, heat, and temperature</li> <li>3. Basic properties/behaviors of light and sound</li> <li>4. Forces and motion (forces, basic description of motion, effects of density &amp; pressure)</li> </ol>	<ol style="list-style-type: none"> <li>1. Electric circuits and properties and uses of permanent magnets and electromagnets</li> </ol>
Earth Science	<ol style="list-style-type: none"> <li>1. Earth's structure</li> <li>2. Earth's processes, cycles, and history</li> <li>3. Earth's resources, their use, and conservation</li> </ol>	<ol style="list-style-type: none"> <li>1. Physical features of earth</li> <li>2. Earth in the solar system and the universe</li> </ol>

Source: Ministry of Education and Culture, 2013

**Table 10.** Missing content of mathematics of grade 8 which is not match with TIMSS content

Domain	TIMSS Topics of Grade 8 (mathematics)	
	Topics available in the 2006 curriculum	Topics unavailable in the 2006 curriculum
<b>Number</b>	<ol style="list-style-type: none"> <li>1. Computing with whole numbers</li> <li>2. Concepts of fractions and computing with fractions</li> <li>3. Concepts of decimals and computing with decimals</li> <li>4. Problem solving involving percents and proportions</li> </ol>	<ol style="list-style-type: none"> <li>1. Estimating, or approximating</li> <li>2. Representing, comparing, ordering, and computing with integers</li> </ol>
<b>Algebra</b>	<ol style="list-style-type: none"> <li>1. Simplifying and evaluating algebraic expressions</li> <li>2. Simple linear equations and inequalities</li> </ol>	<ol style="list-style-type: none"> <li>1. Numeric, algebraic, and geometric patterns or sequences</li> <li>2. Simultaneous (two variables equations)</li> <li>3. Representation of functions as ordered pairs, tables, graphs, words, or equations</li> </ol>
<b>Geometry</b>	<ol style="list-style-type: none"> <li>1. Geometric properties of angles and geometric shapes</li> <li>2. Congruent figures and similar triangles</li> <li>3. Relationship between three-dimensional shapes and their two-dimensional represent.</li> <li>4. Using appropriate measurement formulas for perimeters, circumferences, areas, surface areas, and volumes</li> </ol>	<ol style="list-style-type: none"> <li>1. Points on the Cartesian plane</li> <li>2. Translation, reflection, and rotation</li> </ol>

Source: Ministry of Education and Culture, 2013

Number of TIMSS mathematics topics which is taught at the end of 8 grade is presented below (Mullis et al, 2012)

**Table 11.** Number of TIMSS 2011 mathematics topics related to Indonesia curriculum

	<b>2011 TIMSS topics</b>	<b>Number of topics</b>
All mathematics (19 topics)	Topics Taught to All or Almost All Students	1
	Topics Taught to Only the More Able Students (Top Track)	4
	Not Included in the Curriculum Through grade 8	14
Number (5 topics)	Topics Taught to All or Almost All Students	0
	Topics Taught to Only the More Able Students (Top Track)	0
	Not Included in the Curriculum Through grade 8	5
Algebra (5 topics)	Topics Taught to All or Almost All Students	0
	Topics Taught to Only the More Able Students (Top Track)	3
	Not Included in the Curriculum Through grade 8	2
Geometry (6 topics)	Topics Taught to All or Almost All Students	1
	Topics Taught to Only the More Able Students (Top Track)	1
	Not Included in the Curriculum Through grade 8	4
Data and chance (3 topics)	Topics Taught to All or Almost All Students	0
	Topics Taught to Only the More Able Students (Top Track)	0
	Not Included in the Curriculum Through grade 8	3

Source: Mullis et al., 2012

Student achievement in PISA is even worse, because items in PISA is related to applied science and applied mathematics which is different with Indonesian focus in learning. Most of students are at level 1 of PISA with average score of 358, where the students can answer questions involving familiar contexts where all relevant information is present and the questions are clearly defined. Student in this level are able to identify information and to carry out routine procedures according to direct instructions in explicit situations. Some of student could achieve level 2 with average score of 420, where the students can interpret and recognize situations in contexts that require no more than direct inference. Direct inference means that student explain or interpret situations base on their knowledge without higher thinking, for example: when observe wood is floating on water, student said that the density of wood is less than water. Student at this level can extract relevant information from a single source and make use of a single representational mode. According to OECD, students at this level also can employ basic algorithms, formulae, procedures, or conventions to solve problems involving whole numbers, and they are capable of making literal interpretations of the results (OECD, 2003). Achievement of student in mathematics and science of PISA is described in Table 12. We can see that boys are perform better in 2003 (mathematics) and 2006 (science), while girls perform better in 2009 (mathematics and science). In 2012, girls perform better in science, but boys are better in mathematics.

Comparison of Indonesia student achievement in PISA 2012 by gender for each proficiency level is described in Table 13 and Table 14 (OECD, 2014).

**Table 12.** PISA results of 8 grade student of Indonesia

PISA	2003		2006		2009		2012	
	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys
MATH	358	362			372	371	373	377
		360		391		371		375
SCIENCE			387	399	387	378	383	380
	360		393		383		382	

Source: Adopted from OECD, 2014

**Table 13.** Percentage of students at each proficiency level in mathematics, by gender

Proficiency level of mathematics of PISA test 2012	Percentage of Indonesia student		OECD average (%)	
	Girls	Boys	Girls	Boys
Below Level 1 (below 357.77 score points)	43.2	41.4	8.1	7.9
Level 1 (from 357.77 to less than 420.07 score points)	33.6	33.1	15.8	14.2
Level 2 (from 420.07 to less than 482.38 score points)	16.5	17.2	23.6	21.3
Level 3 (from 482.38 to less than 544.68 score points)	5.0	6.4	24.3	23.2
Level 4 (from 544.68 to less than 606.99 score points)	1.4	1.6	17.6	18.7
Level 5 (from 606.99 to less than 669.30 score points)	0.2	0.3	8.2	10.5
Level 6 (above 669.30 score points)	0.0	0.0	2.4	4.2

Source: Adopted from OECD, 2014.

**Table 14.** Percentage of students at each proficiency level in science, by gender

Proficiency level of science of PISA test 2012	Percentage of Indonesia student		OECD average (%)	
	Girls	Boys	Girls	Boys
Below Level 1 (below 334.94 score points)	23.1	26.2	4.2	5.3
Level 1 (from 334.94 to less than 409.54 score points)	42.8	41.1	12.7	13.3
Level 2 (from 409.54 to less than 484.14 score points)	27.1	25.5	25.5	23.6
Level 3 (from 484.14 to less than 558.73 score points)	6.3	6.7	30.0	27.7
Level 4 (from 558.73 to less than 633.33 score points)	0.6	0.6	20.2	20.7
Level 5 (from 633.33 to less than 707.93 score points)	0.0	0.0	6.5	7.9
Level 6 (above 707.93 score points)	0.0	0.0	0.9	1.4

Source: Adopted from OECD, 2014.

**Table 15.** Average Percent Correct in the Science Content and Cognitive Domains

	Domains	Average percent correct
Science contents domains	Biology	33
	Chemistry	28
	Physics	31
	Earth Science	33
Science cognitive domains	Knowing	39
	Applying	28
	Reasoning	24

Source: Martin et. al, 2007

Student of 8 grade of Indonesia have lowest score in reasoning of TIMSS 2007 related to science topics, as shows in table below (Martin, et.al, 2007).

### Teaching and Learning Process

The data of teaching and learning process is reflected from school evaluation report (SER) which was conducted in 2013. The evaluation report involved 1,377,710 respondents from 33 provinces of Indonesia (Center of Education Quality Assurance, 2013). According to the data, student are able to describe information using their own sentences, but not competent in identify variable to solve problem. Low achievement of student in TIMSS and PISA is relevant with education quality reflect from school evaluation report by quality assurance center of ministry of education in 2012 and 2013. The national school evaluation report shows that most students are not able to identify variable, which is one of the competency needed to solve problem in TIMSS and PISA test.

**Table 16.** Junior high school Student competency based on national school evaluation report of 2013

<b>Student knowledge/competency</b>	
<b>Criteria</b>	<b>Percentage</b>
Describe information with own sentences	75.8
Recall information	60.5
Apply concept to explain sciences or social phenomena	41.8
Identify variables related to certain problem	28.1

Source: Center of Education Quality Assurance, 2013

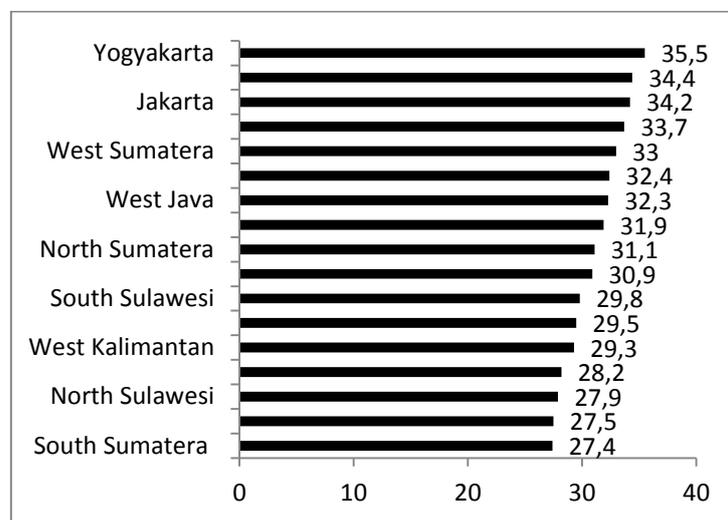
Student competency is result of teaching and learning process. According to school evaluation report, some problems are identified and described in table 16. The score for effective interaction of student and teacher, is only 64.2%. From observation in this research, it was reported that most teachers act as the only source of information and dominated teaching and learning activity. This condition gives bad impact to student creativity and motivation in learning. According to research, student could only engage in learning for 15 minutes if they are not involved in learning, especially if teacher use expository method (Wieman, 2007).

**Table 17.** The quality of teaching and learning process based on national school evaluation report of 2013

<b>Quality of teaching and learning process</b>	
<b>Criteria</b>	<b>Percentage</b>
Effectivity of student and teacher interaction	64.2
Process to develop student learning habit	59.9
Academic atmosphere	56.4
Process fostering creativity	30.9

Source: Center of Education Quality Assurance, 2013

The quality of education process as reported in School Evaluation Report from Ministry of Education of 2013, related to “teaching and learning process develop student learning habit” in several provinces is shown in the graph below.



**Figure 3.** Comparison of education quality for several province, related to process developing student learning habit (Source: Center of Education Quality Assurance, 2013)

Good school environment must be related to teacher quality and interaction of student with learning resources. The condition of teacher education level is described in table 18 and their average competency in solving teacher test is described in table 20 for highest and lowest achievement provinces. The data shows that more than 40% teacher is not fulfilled the requirement of law no 14 year 2005, that every teacher minimal must have S1 or D4 degree. However, due to previous regulation, not every teacher has S1 or D4 degree in 2004. The law no 14 year 2005 will be fully implemented in 2015, so teacher with low level qualification will be replaced.

**Table 18.** Number of teacher based on education level

No.	Teacher Education Level	Total	Percentage
1.	S1/D4	1,471,884	50.31
2.	S2	29,214	1.00
3.	S3	65	0.002
4.	D3	296,975	10.15
5.	D2	520,551	17.79
6.	D1	56,668	1.94
7.	High school	550,319	18.81
	TOTAL	2,925,676	100

Source: Education Quality Assurance and Human Resources Development of ministry of Education (BPSDM), 2013

Good teacher must competent in the subject matter, and unfortunately this condition is not ideal for Indonesian teacher. Based on teacher test result carried out by the ministry of education in 2012, the highest score for mathematics teacher is 62 (out of 100), and the highest score for science teacher of junior high school is 65 out of 100 (Education Quality Assurance and Human Resources Development of ministry of Education, 2013). Highest and lowest achievement based on province is presented in Table 19.

**Table 19.** Teacher achievement in subject matter test carried out by ministry of education in 2012

No	Highest achievement			
	SCIENCE		MATHEMATICS	
	Province	Teacher test score (out of 100)	Province	Teacher test score (out of 100)
1	Bali	56.38	Bali	51.25
2	Central Java	53.41	Central Java	45.33
3	Yogyakarta	53.12	Yogyakarta	44.24
4	East Java	52.91	East Java	44.15
5	Jakarta	51.65	Jakarta	44.11
No	Lowest achievement			
	SCIENCE		MATHEMATICS	
	Province	Teacher test score (out of 100)	Province	Teacher test score (out of 100)
5	Aceh	40.03	NTT	37.23
4	Central Sulawesi	39.84	South-East Sulawesi	37.02
3	North Sulawesi	39.66	Jambi	36.64
2	Maluku	37.44	Maluku	36.29
1	North Sulawesi	36.59	North Sulawesi	35.26

Source: Education Quality Assurance and Human Resources Development of ministry of Education (BPSDM), 2013

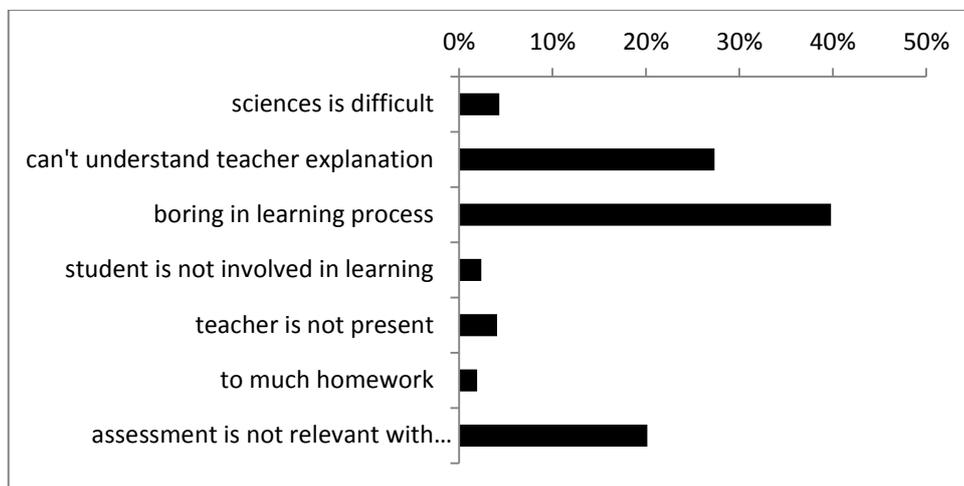
The problem of teachers competency and not optimal condition of teaching and learning process results in student low achievement at school. In order to identify student difficulty in learning, the ministry of education also involved 4,116,487 students from 33 provinces as respondent in online school evaluation report of 2013 (Center of education quality assurance, 2013). Based on the report, there are four reason of student difficulty in learning at school, which is related to teacher behavior and learning material as described in table 20. (Center of education quality assurance, 2013).

**Table 20.** Student difficulty in learning at school (student opinion)

Student difficulty	Percentage
Too much learning material	58
Difficult to understand the learning material	54
Teacher explanation is difficult to understand	38
Teacher explanation for difficult topic is not enough	14

Source: Center of Education Quality Assurance, 2013

The national condition of teaching and learning is almost the same with North Sumatera condition, especially about teacher explanation, as shown in the following graph. Most student stated that the learning process is teacher centered and proved by the observation conducted in this research.



**Figure 4.** North Sumatera student opinion about science teaching and learning

Student difficulty could arise from incompetence teacher in subject matter and pedagogy. Teacher ability in pedagogy test carried out by the ministry of education is also low, and relevant to school evaluation report (SER) data (Education Quality Assurance and Human Resources Development of ministry of Education, 2013). According SER data, most teachers blame the unavailable of teaching and learning facilities, and about 27% acknowledge that they are not competent in mastering effective teaching, as described in Table 21.

**Table 21.** Teacher difficulty in teaching and learning (teacher opinion)

Teacher difficulty in improvement of student creativity	Percentage
Problem of teaching and learning facilities	67
Problem of student competencies	48
Not enough time	45
Not competent in mastering effective teaching	27
No support from school headmaster	4

Source: Center of Education Quality Assurance, 2013

About 48 percent of teachers think that the students have low competency in learning, and 45 percent stated that the teaching allocation time is not enough. This data show that teachers are not empowered the student to study outside the classroom or learning from various sources, and they are not improved student competency based on student previous knowledge.

Compared to the result of Indonesia student of grade 8 in TIMSS and PISA, Indonesia student achievement is not good. Indonesia student are of the lowest category of cognitive level and also in the lowest achievement group compared to another country. This condition is relevant with the low quality of educational processes reported in the school evaluation report. Another handicap is resulted from the quality of school and national examination which are mainly in the low level of knowledge domain. Girls could solve routine problem better than boys, which is reflected by national examination results and TIMSS 2011. However boys could solve “reasoning” problem better as indicated by better PISA result in 2003, 2006, and 2012 (mathematics). Related to this data, we could predict that boys could solve complex problem better than girls in mathematics. In average, girl achievement is better than boys in recent TIMSS. This is relevant with girl confidence in mathematics, also their effort to have better achievement of the subject at school.

## CONCLUSIONS AND RECOMMENDATION

The main problems which affect student achievement in mathematics and science is the quality of education, which is resulted from low quality of teacher, low involvement of student in teaching and learning process, and low level problem solving in learning and assessment. The current policy of giving remuneration for teacher is not improved poor condition of teaching and learning in Indonesia.

The implementation of 2013 curriculum is a new hope for better education, but the most difficult task is to change the teaching and learning process. The approach of teaching in curriculum 2013 is the scientific approach which is consist of: 1) observation, 2) questioning, 3) data collection, 4) reasoning, and 5) communicate the results. This approach is suitable for learning science and mathematics. Indonesia must reform the education, especially the quality of teacher, teaching and learning process, and better assessment. Reward and merit system related to teacher and school headmaster performance must be control by the society and central government. The policies that must be implemented are:

- a) Teacher student must be selected from clever student at high school. This policy is important in order to have a good teacher and could help the nation to develop better human resources in all level of education. New rule for teacher education, recruitment, and evaluation must be proposed and implemented. Without reformation of teacher training and recruitment, the quality of education will not improve significantly.

- b) The remuneration must be allocated only for teacher with good performance. This policy is important in order to change teaching and learning process of science and mathematics that could foster student creative thinking. The teacher in comfort zone without any effort of improvement the teaching and learning process must not receive any remuneration.
- c) Reformation of assessment to measure student thinking ability rather than low level of thinking must be implemented at school, district, and national level. National assessment must be carried out online and measuring high level of thinking. This policy is important to solve the problem of cheating in national examination, as well as give effect to teaching and learning process. Without any reformation in this system, most students will not encourage to study better and could not improve in international test achievement such as PISA and TIMSS.

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