Indonesia’s Issues and Challenges on Quality Improvement of Mathematics and Science Education

Sumar Hendayana
Asep Supriatna
Harun Imansyah
Indonesia University of Education

Abstract

Quality of education is one of three main issues in developing education in Indonesia. Since education quality is closely related to the quality of human resources, Indonesia human resources is still far from being desirable and below that of the neighbouring countries. According to the 2007 Human Development Index (HDI) data, the Indonesia Human Development Index ranked 111th, below Philippines (108th), Thailand (87th), Malaysia (66th), Brunei (30th), and Singapore (23th). Considering that education is one of the HDI components being measured, such a condition indicates that education in Indonesia is still left behind the neighbouring countries. Quality problems in school learning may contribute to the HDI. In the field of mathematics and science, for example, the 2007 TIMSS (the Third International Mathematics and Science Study) placed Indonesia in the 36th rank for mathematics, below Thailand (29th), Malaysia (20th), Singapore (3rd) and in the 35th rank for science, below Thailand (22th), Malaysia (21th) and Singapore (1st). These data indicate that the quality of mathematics and science education is lower than that of the neighbouring countries. The factors affecting and its challenges to improve the quality of mathematics and science education will be discussed.

Background

The Republic of Indonesia is a country in Southeast Asia and oceania, which varying conditions and situations. It comprises 17,508 islands with area of 1,919,440 square kilometers, about 6,000 of which are inhabited. These are scattered over both sides of equator. Lying along the equator, Indonesia has a tropical climate, with two distinct monsoonal wet and dry seasons. Temperatures vary little throughout the year; the average daily temperature
range of Jakarta, capital city, is 26 – 30°C, with high humidity, averaging about 80%. With a population of 230 million people, it is the world’s fourth most populous country, with the world’s largest population of Muslims. Its average population density is 134 people per square kilometer, although Java, the world’s most populous island, has a population density of 940 people per square kilometer, about 60% of the population lives in Java whose area is probably about 10% of the whole land area, as can be seen on the map below. Many islands contain rugged mountains, dense jungles, swamps, and valleys. There are around 200 volcanoes, of which 60 are still active. These geographical conditions cause many areas are very difficult to reach because they are separated by dense forests, swamps, and mountains, or seas.

Figure 1. Map of Indonesia

All of this has posed communication problems among ethnic groups. In addition, the rural/remote areas are deprived of fast development due to delivery problems, they cannot be easily and adequately equipped with textbooks, curriculum guidelines and laboratories as well as other types of equipment. Certain schools in isolated areas are seldom, if ever, visited by their supervisors and their teachers, for many reasons, rarely have the opportunity to attend in-service training. Another problem is related to young teacher’s reluctance to take up teaching appointments in these areas. This has partly resulted in the mismatched teaching assignment.
Throughout Southeast Asia, this country has the greatest diversity of culture, caused by differing histories of the people’s contact with and responses to the outside world. With all of these differences, however, the people are being united by being “Indonesian” as clearly expressed in the moto “Bhineka Tunggal Ika” or Diversity in Unity. The pluralistic nature of the Indonesia society requires that people tolerate differences in order to establish a peaceful and harmonious life. Understanding each other's customs and ways of thinking is then a necessity.

Indonesia has abundant natural resources such as mines – gold, silver, nickel, oil, and natural gas; rain forests with their biodiversity; seas with their various type of fish; and fertile land on which a lot of trees and plants can grow. Indonesia’s estimated Gross Domestic Product (GDP) for 2008 is US$511 billion (nominal) with per capita GDP of US$2,239. The service sector is the economy’s largest and accounts for 45% of GDP. This is followed by industry (41%) and agriculture (14%). Major industries include petroleum and natural gas, textile, apparel, and mining. Major agricultural products include palm oil, rice, tea, coffee, spices, and rubber.

Indonesia’s high population and rapid industrialization present serious environmental issues, which are often given a lower priority due to high poverty levels and weak, under-resourced government. Issues include large-scale deforestation (much of it illegal), over-exploitation of marine resources, and environmental problems associated with rapid urbanization and economic development, including air pollution, traffic congestion, garbage management, and reliable water and waste water services. These environmental problems reflected that basic education has not significantly contributed to effective life in the community yet. Disparities of qualified teachers may be considered as one of the contributors to the environmental problems. Moreover decentralized system of government, which has been implemented since 2001, the problem has been worsened by the people’s rising regional ego, which has resulted in an oversupply of teachers in some areas but an undersupply in other areas.

**Schooling System**

Based upon Law No 20 Year 2003 (National Education System), education in Indonesia is defined as a planned effort to establish a study environment and education process so that the student may actively develop his/her own potential to gain the religious and spiritual level,
consciousness, personality, intelligence, behaviour and creativity to him/herself, other citizens and for the nation. The constitution also noted that education in Indonesia is divided into two major parts, formal and non-formal. A formal education consists of primary, secondary and tertiary education. In Indonesia, every citizen has to have nine-year compulsory education, six years at primary school and three years at junior secondary school. Ministry of National Education (MONE) and Ministry of Religion Affair (MORA) are responsible for education in Indonesia. Indonesia schooling system is shown in Figure 2.

Early childhood education. Children start going to school at age of 3 or 4 to 5 or 6 years for play group or kindergarten. The majority of kindergartens are private schools, with more than forty-nine thousand kindergartens, 99.35% of the total kindergartens in Indonesia, privately operated.

Basic education. Basic education comprises 6-year primary school and 3-year junior secondary school. Children ages 6 or 7 attend primary school. This level of education is compulsory for all Indonesian citizens, based on the national constitution. In contrast to the majority of privately run kindergartens, most primary schools are government operated public schools, accounting for 93% of all primary schools in Indonesia. There are around 22,000 junior secondary schools in Indonesia with a balanced ownership between public and private sector. After graduating from junior secondary school, students may move on to senior secondary school.

Secondary school. In Indonesia, generally known as by the abbreviation "SMA" (Sekolah Menengah Atas), senior secondary school and “SMK” (Sekolah Menengah Kejuruan), vocational senior secondary school. SMA differ than SMK in their studies. The students at SMA are prepared to advance to higher education while students of SMK are prepared to be ready to work after finishing their school without going to university/college. Based on the national constitution, Indonesian citizens do not have to attend high school as the citizens only require nine years of education. Islamic senior secondary schools and Islamic vocational senior secondary schools are managed by MORA.

<table>
<thead>
<tr>
<th>Age</th>
<th>Level of Educ</th>
<th>Academic Education</th>
<th>Professional Education</th>
</tr>
</thead>
<tbody>
<tr>
<td>27</td>
<td>Higher Educatio</td>
<td>MONE/MORA</td>
<td>MONE/MORA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Islamic Doctorate Program</td>
<td>Doctorate Program S3</td>
</tr>
</tbody>
</table>
### Figure 2. Indonesia schooling system

Higher education. After graduation from senior secondary school, students may attend a university (higher education). The higher education institution is categorized in two types: academic education and professional education. There are 3 types of higher education institution: Universities, Institutes and Academy or college. Universities and Institutes may have academic education of undergraduate, master, and doctorate programs as well as
professional education of diploma 4 (D4), first professional (SP1), and second professional (SP2) programs. Academy or colleges have diploma 1 (D1), diploma 2 (D2), and diploma 3 (D3).

**Conceptual Framework of Schooling System**

The model contains inputs (the human and financial resources available to education), processes (what is taught and how it is taught), and outputs (consequences of schooling on students from different backgrounds). Figure 3 depicts how these elements are likely to be logically related.

![Figure 3. Linkage among educational elements (Shavelson, et al., 1987)](image)

Inputs to education system include fiscal, capital, and human resources, student characteristics, and teacher qualifications, such as teacher credentials. Educational processes may be thought of as a set of nested systems. School translates resources into education, it creates an academic ethos that establishes achievement expectations, and it sets goals and policies so that these expectations can be realized. Curriculum is the content of education and medium of exchange between teacher and student. Teachers, working within curriculum, draw on their subject matter and pedagogical knowledge to translate the curriculum for students in a comprehensible way. Teachers draw on multiple instructional methods, and this
affects outputs such as achievement, participation, and attitudes. Accumulation of good educational process result better life.

**Quality issues of mathematics and science education**

Several indicators will be discussed to measure the level of Indonesian quality of human resources as well as mathematic and science education. These indicators include Human Development Index (HDI), TIMSS, mathematics and science competition, and national examination. Recently, United Nations Development Program’s Human Development released a report of Human Development Index (HDI) on October 5, 2009, compiled on the basis of data from 2007. It covers 180 UN member states (out of 192). The Human Development Index (HDI) is a comparative measure of life expectancy, literacy, education and standards of living for country worldwide. It is a standard means of measuring well being, especially for child welfare. According to the 2007 Human Development Index (HDI) data, the Indonesia Human Development Index ranked 111th, below Philippines (108th), Thailand (87th), Malaysia (66th), Brunei (30th), and Singapore (23th). Considering that education is one of the four HDI components being measured, such a condition indicates that education in Indonesia is still left behind the neighbouring countries. Since education quality is closely related to the quality of human resources, Indonesia human resources is still far from being desirable and below that of the neighbouring countries.

TIMSS (the Third International Mathematics and Science Study) is a comparative international study on mathematics and science achievement. In the field of mathematics and science, for example, the 2007 TIMSS (the Third International Mathematics and Science Study) placed Indonesia in the 36th rank for mathematics (out of 48 countries), below Thailand (29th), Malaysia (20th), Singapore (3rd) and in the 35th rank for science (out of 48 countries), below Thailand (22th), Malaysia (21th) and Singapore (1st). These data indicate that the quality of mathematics and science education is lower than that of the neighbouring countries.

In contrast, although the quality of education in Indonesia is in general far from being desirable, it should be noted that a number of Indonesia students have individually indicated world class learning achievement as evidenced in their success in the first, second, third places (gold/silver/bronze medals) in some mathematics and science competitions. In 2009, a number of primary school students received 73 medals (13 gold, 20 silver, and 40 bronze) in four competitions in mathematics and science. Those competitions are listed below.
Interestingly, individually Indonesian students have reached a high level of intellectual development through quality education, but the average achievement of Indonesian students is below that of their counterparts in the neighboring countries. It is not surprising because it is only few students who won the competition, have good opportunity to access good learning facilities and processes.

Another indicator for measuring quality of mathematics and science education is national examination. Government of Indonesia obligate all students of grade 9 (junior secondary school) and grade 12 (senior secondary school) to take national examination for main subject matters such as Indonesian, English, Mathematics, and Science for junior secondary school students and for senior secondary school students majoring in science must take Indonesian, English, Mathematics, Physics, Biology, and Chemistry. Government of Indonesia sets up passing grade of 5.5. In order to pass the national examination, a student must have at least 5.5 average score. In 2008/2009, 95% of 2,658,216 participants of junior secondary school students were passed national examination with the average scores of Mathematics, and Science are 7.60, and 7.32 respectively. Similarly, senior secondary school students did well on national examination, 96% of 622,058 passed the exam with the average scores for mathematics, physics, chemistry and biology are 7.71, 7.93, 8.30, and 7.16 respectively. It seems that student’s achievement in national examination is better than TIMSS. The different achievement between TIMSS and National Examination may be due to different set of goals and level of problem difficulties.

Results of national examination for both junior and senior secondary school students satisfied policy makers and politicians in terms of scoring. Unfortunately, the national examination has driven curriculum implementation for many teachers. They transferred content of textbooks into student’s mind by lecturing method and drilled students to practice how to answer multiple choice type questions. These students did not learn mathematics and science through experiment, instead of memorizing the mathematical and scientific formulas.

**Internationalization in Education**
In responding to globalization issues, Ministry of National Education has established international standard schools at all levels (from primary to senior secondary schools) in every district. Public schools which met requirement may offer a number of international standard classes. Parents pay relative expensive tuition fees for international standard class. The international standard classes are equipped with good facilities such as air conditioner and multimedia teaching facilities with good class size of 30 students per class. English is used as medium of instruction in mathematics and science international standard classes. If parents want for free tuition fees, their children should go to regular class with limited learning facilities. In fact, it is not many students and teachers can communicate in English so students did not engage in depth mathematics and science learning since teacher centered type of teaching dominated mathematics and science classes.

**Current situation of Indonesian education**

Current situation of Indonesian education for year 2007 is summarized in Table 1. For primary schools, there were 144,567 schools to accommodate 26,627,427 students so that the class size was 27 students per class in average. It also has good GER for primary, junior and senior secondary schools, 115.51%, 92.52%, 60.51% respectively with relative low drop out rate of less than 3% for primary, junior and senior secondary school students but high drop out rate for higher education (12.12%). With 1,445,123 primary school teachers, the average of students to teacher reatio was 18. Similarly, junior and senior secondary schools have good average class size (37 and 35 for junior and senior secondary schools) and students to teacher ratios (14 and 12 for junior and senior secondary schools). Unfortunately, decentralized government limits teachers distribution, it resulted oversupply of teachers in some districts and undersupply in others.

In case of qualified teachers, it was 22.15%, 71.18%, and 79.74% of qualified primary, junior and senior secondary teachers since goverment of Indonesia applied Teacher Law in 2005 (Table 1). Teachers must have at least bachelor degree (S1 degree) plus teacher certificate from teacher institution. Most primary school teachers have D2 degree 47.85% or 691,443 teachers (Table 2), 2 years after senior secondary school. It looks high percentage of qualified junior secondary teachers (69.86%) in terms of degree requirement but some of mathematics and science teachers, especially in remote areas did not take bachelor degree in mathematics or science major since it is not many local teacher institutes offer mathematics and science majors. Decentralized government in some cases promotes people’s regional ego in teacher recruitment, they recruit teachers from local universities regardless quality. Furthermore, it
promotes mismatch teachers. This situation will not support much improvement in quality of mathematics and science education.

Table 1. Overview of Indonesian Education (2007)

<table>
<thead>
<tr>
<th>Components</th>
<th>PS</th>
<th>JSS</th>
<th>SSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schools</td>
<td>144,567</td>
<td>26,277</td>
<td>10,239</td>
</tr>
<tr>
<td>Students</td>
<td>26,627,427</td>
<td>8,614,306</td>
<td>3,758,893</td>
</tr>
<tr>
<td>Class size</td>
<td>27</td>
<td>37</td>
<td>35</td>
</tr>
<tr>
<td>Teachers</td>
<td>1,445,123</td>
<td>621,878</td>
<td>305,094</td>
</tr>
<tr>
<td>Students to teacher ratio</td>
<td>18</td>
<td>14</td>
<td>12</td>
</tr>
<tr>
<td>Qualified teacher</td>
<td>22.15%</td>
<td>71.18%</td>
<td>79.74%</td>
</tr>
</tbody>
</table>

Table 2. Teachers condition (2007)

<table>
<thead>
<tr>
<th>Teacher</th>
<th>SSS</th>
<th>D1</th>
<th>D2</th>
<th>D3</th>
<th>S1</th>
<th>S2</th>
<th>Total</th>
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<tr>
<td>PS</td>
<td>377,476</td>
<td>19,028</td>
<td>691,443</td>
<td>37,022</td>
<td>317,355</td>
<td>2,808</td>
<td>1,445,132</td>
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<tr>
<td></td>
<td>26.12%</td>
<td>1.32%</td>
<td>47.85%</td>
<td>2.56%</td>
<td>21.96%</td>
<td>0.19%</td>
<td>100%</td>
</tr>
<tr>
<td>JSS</td>
<td>48,913</td>
<td>36,545</td>
<td>90,731</td>
<td>434,473</td>
<td>8,215</td>
<td>1,32%</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>7.87%</td>
<td>5.88%</td>
<td>14.60%</td>
<td>69.86%</td>
<td>1.32%</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>SSS</td>
<td>6,932</td>
<td>5,174</td>
<td>34,550</td>
<td>236,995</td>
<td>6,893</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.27%</td>
<td>1.69%</td>
<td>11.30%</td>
<td>77.49%</td>
<td>2.25%</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

Challenges in mathematics and science teaching

Teacher quality plays an important role in mathematics and science teaching. As mentioned earlier, there were high percentage of underqualified and mismatch mathematics and science teachers contributed to the low quality of mathematics and science teaching. These teachers tend to dominate mathematics and science classes, instead of let students learn. We still find a situation of mathematics and science teaching with teacher centered in Indonesia. Students were copying notes or listening to the mathematics or science teachers. There were no interaction among students and they got boring in mathematics and science classes. Therefore, it is challenge to shift from mathematics and science teaching to mathematics and science learning (Figure 4). Collaborating with teachers has been done regularly for 3 years in promoting mathematics and science learning applying modified Japanese tradition of lesson
study under JICA cooperation. We facilitated teachers worked collaboratively to think problems and share views to design a lesson plan that promotes student active learning through hands-on activity, mind-on activity, daily life, and local materials. Then, it was tried out at real class and students activities were observed to collect data for further discussion following class session. It is slow but sure to shift teacher’s mind set from teaching to learning. We found improvement of the teachers in facilitating student learning. They let students explore through experiment mathematical and scientific phenomenon (Figure 5). The developed in-service teacher training resulted in improving teaching quality within the district site.

Figure 4. Mathematics and science teaching in conventional ways

Figure 5. Students engaged in mathematics and science learning

Policy for improvement of eduction quality

Government of Indonesia has done tremendous efforts in improving teacher quality, massive improvement of qualification, competence, certification of teachers and educational personnel. Based on Law No. 14 Year 2005, which stipulated teacher as a profession. Theachers should meet qualification of at least 4-year Bachelor. Lecturers should meet
qualification of at least Master/Ph.D. level. Teachers and lecturers should have have teaching certificates. By year 2014, about 1.75 million teachers should achieve qualification of at least 4-year Bachelor, 150,000 lecturers should achieve qualification of at least Master/Ph.D, 2.7 million teachers, and 130,000 full time lecturers should have teaching certificates. The salary of educators should be doubled whenever they get teaching certificates. The progress in 2007, MONE was successful in providing scholarship to 350,000 teachers for qualification upgrading and certification for 147,217 teachers.

Conclusions

Quality of mathematics and science education now becomes national issues in Indonesia. Indonesia has abundant natural resources but lack of human resources to manage or process the natural resources so that Indonesians do not get maximum benefit of the natural resources. Underqualified teachers and disparities in teacher quality resulted low quality of mathematics and science education in Indonesia. Quality of Indonesia mathematics and science education needs to be improved for promoting quality of human resources with technology to be able to manage/process abundant natural resources for better living. Government of Indonesia has paid more attention on teacher quality through qualification upgrading and continuous teacher professional development through placing high priority on teacher recognition and welfare.

References


http://nces.ed.gov/timss


www.depdiknas.go.id