A Comparative Study of Mathematics Education Between Japan and Indonesia

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ABSTRACT

This paper discusses about the comparison of mathematics education (school mathematics and mathematics teacher) between Japan and Indonesia. In the topic of school mathematics, the comparison about school mathematics curriculum, school mathematics objectives and contents, mathematics textbooks, mathematics classroom practices, and technology in school mathematics is discussed. All of those are stressed in junior high school. In the topic of mathematics teacher, the comparison of mathematics teacher program at two universities (Shizuoka University, Japan and State University of Malang, Indonesia) is discussed.

Key words: comparative study, mathematics education, Japan, Indonesia.

INTRODUCTION

This paper had mainly written through the investigation by the first author. She had an opportunity to stay in Japan and to research at Shizuoka University for three months, June – September 2000.

This comparison of mathematics education between Japan and Indonesia, based on visiting four Japanese junior high schools in Shizuoka, Hiroshima, and Tokyo for observing five mathematics lessons, June – September 2000; visiting lectures on mathematics education at Shizuoka University; visiting National Institute for Educational Research (NIER) and discussing with Prof. Eizo Nagasaki (Chief of Science Education Section, Research Center for Science Education, NIER) concerning mathematics education; reading books and journals about mathematics education in Japan written in English as shown in References.

In this paper, we compare about school mathematics and mathematics teacher. In the topic of school mathematics, we discuss about school mathematics curriculum, school mathematics objectives and contents, mathematics textbooks, mathematics classroom practices, and technology in school mathematics. All of those, we stress in junior high school.

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After that, we discuss about mathematics teacher. In this topic, we compare mathematics teacher program at two universities. One university is in Japan (Shizuoka University) and one university is in Indonesia (State University of Malang). In order to gain more detail about mathematics teacher program (undergraduate/ four years program) in Indonesia, we attach Course Offering and Distribution in Undergraduate Program in Mathematics Education, State University of Malang, Indonesia (FMIPA UM, 2000).

SCHOOL MATHEMATICS

School Mathematics Curriculum

Based on JSMEa, July 2000 and JSMEb, August 2000, Japan has national standards for education in each school: kindergarten (Japanese: *Youchien*), elementary school (Japanese: *Sho-gakko*), junior high school (Japanese: *Chu-gakko*), senior high schools (Japanese: *Koto-gakko*), and special education school (Japanese: *Yougo-gakko)*. The national standards are organized in the Course of Study (Japanese: *Gakushu-shidoyouryo)* issued by the Ministry of Education (Japanese: *Monbusho)*. The objectives and contents of each subject matter are stated in the Course of Study. The mathematics teachers write the lesson plan, refer to the mathematics textbook based on the Mathematics Course of Study. Most Japanese schools adopt a three – term school year: first term (April 6-July 20), second term (September 1-December 20), and third term (January 8-March 25).

Likewise in Japan, Indonesia also has national curriculum. Each school: elementary school (Indonesian: *Sekolah Dasar/ SD*), junior high school (Indonesian: *Sekolah Lanjutan Tingkat Pertama/ SLTP*), senior high school (Indonesian: *Sekolah Menengah Umum/ SMU*), also has Course of Study (Indonesian: *Garis-garis Besar Program Pengajaran/GBPP*) issued by the Ministry of National Education (Indonesian: *Menteri Pendidikan Nasional)*. The objectives and contents are clearly stated. Based on the Mathematics Course of Study, mathematics teachers write annual program, term program, mathematics content analysis, instructional unit program, and lesson plan. Indonesian school year is also divided into 3 terms (Indonesian: *caturwulan)*: first term (July-October), second term (November-February), and third term (March-June).

In the annual program, the teachers write about mathematics concepts/topics, which must be studied by their students including the time allocation in each term. In the term program, the teachers write about concept/topics, which must be studied by their students including the time allocation in each week in certain months. After that, the teachers analyze mathematics contents in each topic/subtopic. They distribute topic/subtopic more detail including the objectives, instructional material, and teaching method. In the instructional unit program, the teachers write more detail about the objectives of a topic, subtopic and time

allocation. The lesson plan is more detail than the instructional unit program. In the lesson plan, the teachers write the detail of objective of a certain mathematics concept, teaching and learning activities, and the evaluation process for the students.

It seems that, both of countries have national curriculum. In Japan, the board of education in each prefecture produces curricula based on the Course of Study followed by public schools. National and private schools in Japan made the curricula by themselves based on the Course of Study (JSMEb, August 2000). However, In Indonesia, all schools followed the national curriculum. It means that each student in the same grade in all Indonesian area study the same topic in the same term. For example, the third graders of junior high school study about quadratic function and its graph on the second term of school year.

School Mathematics Objectives and Contents

In Japan and Indonesia, school mathematics objectives and contents in each school level and in each grade are stated in the Mathematics Course of Study. For example, the objectives in junior high school in Japan and in Indonesia are as follows.

Based on *Mathematics Program in Japan* (JSMEb, August 2000:21), the objectives of school mathematics for junior high school in Japan are as follows.

1. Students understand deeply the fundamental concepts, principles, and rules relating to numbers, quantities, and figures.
2. Students acquire methods of mathematical expressions and strategies, and to improve their ability to relate phenomena mathematically.
3. Students enjoy mathematical activities, appreciate the importance of mathematical approaches and ways of thinking, and inculcate in them the right attitudes necessary to make use of mathematics.

Based on *Garis-garis Besar Program Pengajaran Mata Pelajaran Matematika* (Departemen Pendidikan dan Kebudayaan, 1995), the objectives of school mathematics for junior high school in Indonesia are as follows.

1. Students can use *concept*, know symbol and term (*fact*), and find formula (*principle*) through topics as follows.

   Grade 1: set, counting numbers, whole numbers, fraction, social arithmetic, linear equation and inequation with one variable, cube and rectangular parallelepipeds, angle, tessellation, symmetry, square and rectangle, triangle.

   Grade 2: relation and function, quadrate and quadratic root, Pythagorean Theorem, rectangle, comparison, distance and time, right line equation, linear equation and inequation with two variables, circle, probability, statistics.

Grade 3: volume and surface, transform, congruence, quadratic function and its graph, algebraic expression, quadratic equations, circle, trigonometry.

2. Students can implement mathematics in other subject matters or in daily life.
3. Students achieve a better outlook about geometric figures
4. Students can use mathematics concepts to communicate idea and analyze data.
5. Students have critic attitude, open attitude, consistent attitude, and appreciate the importance of mathematics
6. Students start to comprehend the significance of deductive thinking (Grade 2 and 3)

Based on *Mathematics Program in Japan* (JSMEb, August 2000) and *Garis-garis Besar Program Pengajaran Mata Pelajaran Matematika* (Departemen Pendidikan dan Kebudayaan, 1995), it seems that Japanese and Indonesian school mathematics have many common elements of mathematics contents. For example, mathematics contents in junior high school are numbers and algebraic expression, geometrical figures, and mathematical relations. However, some topics are taught in the difference grades. For example, in Japan, Pythagorean theorem is taught in third grade, meanwhile in Indonesia in the second grade. In Japan, congruence is taught in second grade of junior high school, meanwhile in Indonesia in the third grade. Moreover, based on the first author observation, in Japanese junior high school mathematics lessons, geometry is taught more formally than in Indonesia.

Time Allocation

Time allocation for teaching mathematics in each grade in both countries is clearly stated in the Mathematics Course of Study. For example, standard time per year for mathematics in junior high school is as follows.

Table 1 Standard time per year for mathematics in junior high school

Grade	standard number of class periods per year		standard time of class periods		standard time per year	
	Japan	Indonesia	Japan	Indonesia	Japan	Indonesia
I	105	204	50 min	40 min	5250 min	8160 min
II	105	204	50 min	40 min	5250 min	8160 min
III	105	192	50 min	40 min	5250 min	7680 min

It seems that standard time per year for mathematics in junior high school in Indonesia is more than Japanese school mathematics.

Mathematics Textbooks

In Japan, six publishers produce mathematics textbooks based on Course of Study. The board of education of each prefecture decided the books for this prefecture. Meanwhile, in Indonesia, the ministry of education publishes mathematics textbooks used nationally as compulsory books for the students. However, both countries allow commercial publishers to produce textbooks. The books must be authorized by the ministry based on the Course of Study. Nowadays, in Indonesia, many private publishers produce mathematics textbooks. The teachers are allowed to choose the textbooks for their students.

Mathematics Classroom Practice

Based on visiting Japanese schools and reading some Japanese References in English (JSMEa, JSMEc, JSMEd, JSMEe, JSMEf, 2000), it seems that problem solving strategy is very common in mathematics classroom practice in Japan. The teaching materials, teaching facilities, and human resources in Japan are very excellent. The quality of collaboration between Japanese mathematics teachers and mathematics professor to do classroom research, and the motivation of Japanese mathematics teachers to do some innovation in their mathematics classroom are very wonderful. Moreover, the Japan society of mathematics education promotes what are the mathematics educators done by publishing mathematics education journals.

In Indonesia, mathematics teachers in each city/town have association (Indonesian: *Musyawarah Guru Mata Pelajaran/MGMP* or *Kelompok Kerja Guru/KKG Matematika*). They usually meet together to discuss about mathematics education. However, not many teachers make innovation in their classroom. We think, Indonesian school mathematics can adopt the implementation of problem solving strategy that is very common in Japanese school mathematics.

Next, we write about the mathematics problem solving strategy used Shimada Junior High School's teacher on Tuesday, July 18, 2000. The number of the students in this classroom is 40 students that same as in Indonesian classroom size. However, the teaching strategy is done nicely. First, the teacher gave a problem for the students. The students think the solution and the process of the solution of the problem by themselves. After that, the students discussed about the solution and the process of the solution of the problem in small groups (4 students in each group). The students did smoothly. It seems that, the strategy is very common used in this class. In small group discussion, each student tried to share ideas by writing in small whiteboard and explaining orally to his/her friends. The teacher observed the students' activities. He evaluated students' activities and students' thinking. After some minutes, a student explained the solution and the process of the solution for this class. The

class responded what his/her friends done. The class discussed about the solution and the process of the solution. At that time, the teacher did as a facilitator. Finally, the students and the teacher together summarized the mathematics lesson of that day.

Technology in School Mathematics

In Japan, use computer and calculator in mathematics classes is common. The uses of computer in mathematics classes are for teacher's instruction and student's activity. The computer software is commercial software or teacher-made software (JSMEa, July 2000). However, in Indonesia, only some schools use computer in mathematics classes. The use of calculator in Indonesian mathematics classes stated in *Garis-garis Besar Program Pengajaran Mata Pelajaran Matematika* (Departemen Pendidikan dan Kebudayaaan, 1995) for first graders of junior high school.

MATHEMATICS TEACHER

In Japan, 72% of elementary school teachers, 88% of junior high school teachers, 94% of senior high school teachers take four years bachelor degree (Koseki, 1999). Meanwhile, in Indonesia, many elementary school teachers graduated from 2 years colleges, junior high school teachers graduated from 2-3 years college or bachelor degree, and senior high school teachers graduated from 3 years college or bachelor degree. Nowadays, in Indonesia, 4 years undergraduate program in mathematics education is prepared for students who will become junior/senior high school teachers. However, in Japan, 4 years undergraduate program in mathematics education is prepared for students who will become elementary school or junior/senior high school teachers.

Mathematics Teacher Program.

In the next paragraphs, we discuss about undergraduate mathematics education program at Shizuoka University (Kunimune, 2000; The Research Cooperation Section Shizuoka University, 2000) and at State University of Malang (FMIPA UM, 2000; Universitas Negeri Malang, 2000).

Undergraduate Program (4 years) in Mathematics Education at Shizuoka University (Japanese: *Shizuoka Daigaku)*

Mathematics education students must acquire 24 units of 12 compulsory courses. One unit is equivalent with 45 minutes lecture. The 12 courses are as follows: Introduction to Linear Algebra, Linear Algebra, Introduction to Sets and Logic, Set and Logic, Introduction to Calculus, Calculus, Algebra 1A, Elementary Topology 1A , Introduction to Applied

Mathematics, Computer, Mathematics Education (1A) for Arithmetic, Mathematics Education (II) for Secondary School. The students also must acquire 12 units of the optional courses of Algebra, Geometry, Analysis, and Applied Mathematics. If a student who wants to obtain higher rank certificate for secondary school mathematics, they must acquire Mathematics Education (III) and (IV) for Secondary. Moreover, if the students want to study mathematics education, they can take Mathematics Education (1B) for Arithmetic, Practical Lessons, and Special Lecture.

The students must acquire 27 units of compulsory subjects for teaching profession: Introduction of Teaching Profession, Foundation of Education, Development and Learning, Education and Society, Guidance for Students, Curriculum and Educational Methods, Theory and Practice of Special Activity, Counseling, Integrated Practice, Moral Education, On-site Training, and Guidance for On-site Training. They also must acquire more than 2 units from several optional subjects concerned with pedagogy or psychology. If a student wants to obtain higher rank certificate, he/she must acquire more than 10 units

In addition, the students must acquire "the study to graduate" that is counted 7 units of compulsory Seminar. The Department of Mathematics Education at Shizuoka University has 7 professors in pure mathematics and 3 professors in mathematics education. Each student decides a professor for the Seminar. Each professor teaches 3 or 4 students for the seminar.

In the "on- site training" course (6 units), the student is as a teacher in real schools for a week in the second year. They participate in whole school life to make lesson plan, teach, evaluate, do like a real teacher in real schools for five weeks (elementary school for 2 weeks and secondary school for 3 weeks, or elementary school for 3 weeks and secondary school for 2 weeks) in the third year. The Faculty of Education has 7 schools attached to Shizuoka University (The Research Cooperation Section Shizuoka University, 2000).

Undergraduate Program (4 years) in Mathematics Education at State University of Malang (Indonesian: *Universitas Negeri Malang)*

The Department of Mathematics Education has two programs: mathematics education and pure mathematics program. Both students take about 75% of same courses. So, the student who has bachelor's degree in mathematics education can get bachelor's degree in pure mathematics by taking some more courses in pure mathematics. Also, the student who has bachelor's degree in pure mathematics can get bachelor's degree in mathematics education by taking some more courses in mathematics education.

Students in undergraduate program in mathematics education at State University of Malang must acquire minimum 150 credits (FPMIPA UM, 2000). One credit is equivalent with

50 minute lecture, 60 minute structured assignment, and 60 minute individual assignment in a week during 1 semester (16 weeks) There are 2 semesters in a year: first semester (September-January) and second semester (February-June).

The 14 credits are in "general courses" (Indonesian: *mata kuliah umum/MKU*), the 10 credits are in "educational courses" (Indonesian: *mata kuliah dasar kependidikan/MDK*), 96 credits are in "subject matter courses" (Indonesian: *mata kuliah keahlian I/MKKI*), including 3 credits an optional course, and 30 credits are in "mathematics educational courses" (Indonesian: *mata kuliah keahlian II/MKKII*). The "subject matter courses" are mathematics courses and science courses

The "general courses" are as follows: Pancasila Education, National Defense, Indonesian language, English, Religion Education, and Basic Science, and Basic Social Science. Meanwhile, The "educational courses" are as follows: Introduction to Education, Students Development, and Learning and Instruction.

The mathematics courses are divided into some group: analysis, algebra, geometry, applied mathematics, statistic, logic, and computer. The courses of analysis courses are as follows: Calculus I, Calculus II, Multivariable Calculus, Advanced Calculus, Real Analysis I, Analysis Real II, Complex Function, and General Topology. The courses of algebra are as follows: Elementary Linear Algebra, Structure of Algebra I, and Structure of Algebra II. The courses of geometry are Geometry, and Analytical Geometry. Applied mathematics courses are Numerical Method, Numerical Analysis, Ordinary Differential Equation, Discrete Method, Graph Theory I, Graph Theory II, Number Theory, Linear Programming, Mathematical Modeling, Statistic courses are Elementary Statistic, Mathematical Statistic I, and Mathematical Statistic II. The computer courses are Basic of Computer and Computer Programming. The logic course is Symbolic Logic.

Mathematics education students must take some courses in science. The science courses are as follows: Basic Physics I, Basic Physics II, Basic Chemistry I, Basic Chemistry II, General Biology, and Environmental Science.

The "mathematics educational courses" are as follows: Basic Competence of Teaching, Teaching and Learning Strategy, Evaluation of Learning Process and Product, Secondary School Curriculum Review, Development of Mathematics Teaching Program Research on Mathematics Education, Teaching Practice, and Field Course.

In the course of Final Project, students conduct library research (in pure mathematics or in mathematics education) or mathematics classroom research. Every student has 2 advisors. The students must take oral exam for the paper of his/her final project.

Based on the two mathematics teacher programs above, it seems that both universities have many commons courses. Students in both universities take courses in pure mathematics and mathematics education. The percentage of pure mathematics is higher than mathematics education. A unit of courses at Shizuoka University called 1 unit, but at State University of Malang called 1 credit.

Mathematics education students at State University of Malang take some courses in science, but they are not studied at Shizuoka University. The "compulsory seminar" course (7 units) at Shizuoka University is very interesting. One professor teaches 3-4 students in the whole of a year.

CONCLUSION

Both countries have many common elements in school mathematics and mathematics teacher program. However, mathematics classroom practice, technology in school mathematics, teaching materials, teaching facilities, and human resources in Japan are more excellent. Indonesian mathematics educator can learn many things what is Japanese done. For example, Indonesian school mathematics can adopt the implementation of problem solving strategies that are very common in Japanese school mathematics. We appreciate for the quality of collaboration between Japanese mathematics teachers and mathematics professors to do classroom research, and the high of motivation of Japanese mathematics teachers to do some innovation in their mathematics classroom.

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Finally, we hope the collaboration between the two countries increase in the future. We can do research collaboratively about mathematics education, share ideas to the development of mathematics education and to the international exchange of view on mathematics education.

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Attachment

Undergraduate Program in Mathematics Education, State University of Malang, Indonesia (FMIPA UM, 2000)

Course Offering and Distribution

1st Semester (20 credits)

Code	Course Title	credit
MKU414	National Defense	2
MKU418	English	2
MKU430	Basic Science	2
MAB401	Calculus I	4
FIB401	Basic Physics I	4
KIM401	Basic Chemistry I	3
BIB401	General Biology	3

2nd Semester (20 credits)

Code	Course Title	credit
MKU412	Pancasila Education	2
MKU417	Indonesian language	2
MAB402	Calculus II	3
FIB402	Basic Physics II	4
KIB402	Basic Chemistry II	4
BIB402	Environmental Science	3
KOB401	Basic of Computer	2

3rd Semester (19 credits)

Code	Course Title	credit
MKU40x	Religion Education	2
MKU419	Basic Social Science	2
MAB403	Multivariable Calculus	3
MAB405	Elementary Linear Algebra	3
MAB406	Symbolic Logic	3
MAB409	Elementary Statistic	3
MAB412	Ordinary Differential Equation	3

4th Semester (21 credits)

Code	Course Title	credit
MAB404	Advanced Calculus	3
MAB408	Computer Programming	3
MAB410	Mathematical Statistic I	3
MAB414	Number Theory	3
MAB415	Linear Programming	3
MAB416	Real Analysis I	3
MAB418	Structure of Algebra I	3

5th Semester (18 credits)

Code	Course Title	credit
MDK411	Introduction to Education	3
MAB407	Numerical Method	3
MAB411	Mathematical Statistic II	3
MAB417	Analysis Real II	3
MAB419	Structure of Algebra II	3
MAB423	Geometry	3

6th Semester (20 credits)

Code	Course Title	credit
MDK413	Learning and Instruction	4
MAK481	Basic Competence of Teaching	3
MAK484	Secondary School Curriculum Review	4
MAK486	Mathematics Educational Research	4
MAB424	Analytical Geometry	2
MAB413	Discrete Method	3

7th Semester (20 credits)

Code	Course Title	credit
MDK412	Students Development	3
MAK482	Teaching and Learning Strategy	4
MAK483	Evaluation of Learning Process and Product	3
MAK485	Development of Mathematics Teaching Program	4
MAB427	Mathematical Modeling	3
	Optional Course	3
	Minimum one of courses:	
MAB420	Graph Theory I	
MAB421	Graph Theory II	
MAB422	Numerical Analysis	
MAB425	Complex Function	
MAB426	General Topology	

8th Semester (12 credits)

Code	Course Title	credit
PPL490	Teaching Practice	4
KKN490	Field Course	4
MAK499	Final Project	4