7.5. COLLECTIONS OF SEMINAR PAPERS

INTERNATIONAL SEMINAR
ON SCIENCE AND MATHEMATICS EDUCATION
(Comparative Study between Indonesia and Japan)
Jakarta and Bandung: July 3-7, 1995

OVERVIEW OF INDONESIAN EDUCATION

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Sponsored by:

Directorate General of Higher Education
Department of Education and Culture
Japan International Cooperation Agency (JICA), Indonesia Office
Bandung Institute of Teaching and Educational Sciences (IKIP Bandung)

OVERVIEW OF INDONESIAN EDUCATION

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1. Introduction

Indonesia is an archipelago, a country consisting of 13,667 islands, big and small, with an area of 1.9 million square kilometers. More than 60 % of area consists of water (seas and oceans). Indonesia is divided into 27 provinces, comprising 241 districts. in the whole districts there are about 65,554 villages.

Based on 1992 statistics, Indonesia has a population of 183.4 millions, where 32 % of the population live in the city, while 68 % of the population live in the villages with such a huge population, Indonesia now in the 4th rank, among China, India, and the United State of America. West Java is the province with has the biggest population in Indonesia (35,914,598).

Although family planning seems to be successful it is predicted that Indonesian population will reach 197.2 millions in 1995 and 269.9 millions in the year 2020. Percapita income of Indonesian in 1992 was 1,155,284.00 rupiahs per year.

At present, Indonesia is facing many challenges, among other things, (1) the need to increase economic development through national productivity, (2) transformation of agricultural society to industrial society needs new kinds of skills and expertise relevant to the development of science and technology, (3) global currents needs a competitive selection in economic global system. These challenges, together with economic factor, demography, and geography will produce difficult problems. Indonesian nation is facing those challenges by increasing the quality of its manpower. Therefore, the role of education in increasing the quality of manpower becomes very important in national development.

Furthermore educational system in Indonesia with some of its indicators in educational development and also some national policy in education will be presented in this paper. It is hoped that these information, will give a macro image about direction, condition, and educational problems in Indonesia.

2. Educational System in Indonesia

In the 1993 Guidelines of States Policy (GBHN) it is stated that the direction of educational development is projected to increase the quality of Indonesian people who believes in God the Almighty, has a noble character, identity, autonomy; progressive, firm, bright, creative, skillful, discipline, hard worker, professional, responsible, productive and healthy.

In the national education system, education is conducted through two pathways, they are formal and non-formal education. Formal education consists of general education, vocational education, special education for the handicapped, public service education, religious education, education for academic service, and professional education.

General education gives priority to gain vast knowledge and to increase the skills of students. However, at the end of education there is a specialization. Vocational education has a functions to prepare students to be able to work in their specialized jobs. Education for the handicapped is intended for the students who are physically or mentally handicapped. Public service education is aimed to improve the public service. Religious education prepares students to be able to carry out a role that needs a special knowledge in religion. Academic education is aimed to master a science, while professional education is directed to readiness of the application of certain knowledge and skills.

Indonesian school system consists of several levels of educations, they are pre-school education, elementary education, secondary education, and tertiary education. The school structure in Indonesia is shown in chart 1.

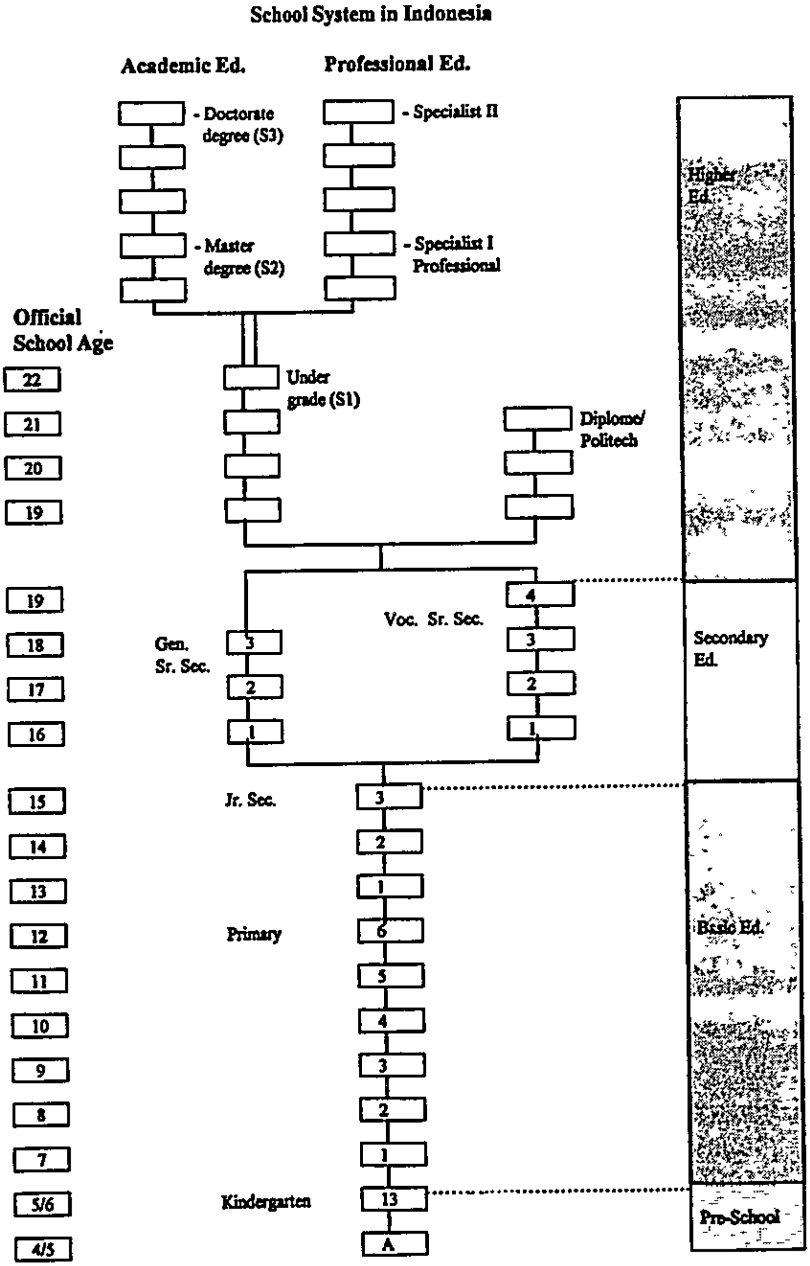

Chart 1. School System in Indonesia

Pre-school education is aimed to help the growth and development of children physically and mentally beyond the family circle before entering basic education. Basic education consists of 6 years of education in elementary school and 3 years of education in junior secondary school (SLTP).

Basic education is provided to develop attitude and ability, knowledge and basic skills needed to live in a society, and also prepares students for secondary education. Since 1993 compulsory education has been carried out for basic education (6 years of elementary school and 3 years of junior secondary school). In the basic education there are Islamic Primary School called Madrasah Ibtidaiyah and Islamic Junior Secondary Schools called Madrasah Tsanawiyah. These Islamic Schools are organized by the Department of Religion. The structure of curriculum of basic education is shown in Table 1.

Table 1
Structure of The Teaching Program for Basic Education Curriculum (Primary School and Junior Secondary School)

No.	Subject Mater	PS						JSS		
		I	II	III	IV	V	VI	I	II	III
1.	Pancasila Education	2	2	2	2	2	2	2	2	2
2.	Religion	2	2	2	2	2	2	2	2	2
3.	Indonesia Language	10	10	10	8	8	8	6	6	6
4.	Mathematics	10	10	10	8	8	8	6	6	6
5.	Science	-	-	3	6	6	6	6	6	6
6.	Social Science	-	-	3	5	5	5	6	6	6
7.	Handicrafts and Arts	2	2	2	2	2	2	2	2	2
8.	Health and Sport	2	2	2	2	2	2	2	2	2
9.	English	-	-	-	-	-	-	4	4	4
10.	Local Content	2	2	4	5	7	7	6	6	6
Total		30	30	38	40	42	42	42	42	42

PS : Primary School
JSS : Junior Secondary School

Secondary education is provided for graduates of basic education. Secondary education consists of general education, vocational education, special education for the handicapped. Duration of time for general school is 3 years, and for vocational school is 3 to 4 years. Department of Religion organizes Islamic Senior Secondary Schools called Madrasah Aliyah.

General secondary education gives priority to develop students' ability to do special job, and to develop professional attitudes. Secondary school for the handicapped is specially develop for children who are physically and mentally retarded. General Senior Secondary School has two programs. The first program of general education for grade 1 and 2, and special program for grade 3. The programs are shown in Table 2.

Table 2
Structure of The Teaching Program for General Senior Secondary School

A. General Program (Grade I and II)

No.	Subject Matter	Number of Academic Hours	
		Grade I	Grade II
1.	Pancasila Education	2	2
2.	Religion	2	2
3.	Indonesian Language and Literature	5	5
4.	The General and National History	2	2
5.	English	4	4
6.	Sport & Health	2	2
7.	Mathematics	6	6
8.	Sciences		
	a. Physics	5	5
	b. Biology	4	4
	c. Chemistry	3	3
9.	Social Sciences		
	a. Economics	3	3
	b. Sociology	-	2
	c. Geography	2	2
10.	Arts	2	-
	Total	42	42

B. Specific Program (Grade III)

No.	Subject Matter	Number of Academic Hours for		
		Science	Social Science	Language
	<u>General</u>			
1	Pancasila Education	2	2	2
2.	Religion	2	2	2
3.	Indonesian Language and Literature	3	3	3
4.	The General and National History	2	2	2
5.	English	5	5	5
	<u>Specifics</u>			
1.	Physics	7	-	-
2.	Biology	7	-	-
3.	Chemistry	6	-	-
4.	Mathematics	8	-	-
	<u>Specific</u>			
1.	Economy	-	10	-
2.	Sociology	-	6	-
3.	Civics	-	6	-
4.	Anthropology	-	6	-
	<u>Specific</u>			
1.	Indonesian, Language and Literature	-	-	8
2.	English	-	-	6
3.	Foreign Languages	-	-	9
4.	History of Culture	-	-	5
	Total	42	42	42

3. Some Indicators of Development of Education in Indonesia

In this part, it is shown some statistics as indicator of education development in Indonesia since 22 years ago. Table 3 shows the development of the number of Primary School Students (PS) includes Islamic Primary Schools (Madrasah Ibtidaiyah) compared to the population of school aged children (7- 12 years) according to the Net Enrollment Ratio (NER). It is shown that, the value of NER is increasing. This fact shows that more and more children are entering primary school.

Table 3
Number of PS and Islamic PS Students (7-12 age), population (7-12 age) and Net Enrollment Ratio (NER)

Years	PS and Islamic PS Students 7-12 age	Population	NER
1973	13,344,000	20,649,000	64.20
1978	17,073,000	21,484,000	79.30
1983	20,153,000	23,809,000	84.64
1988	23,489,300	25,802,000	91.07
1992	25,215,218	27,558,097	91.50

Source : Center for Informatics, Ministry of Education and Culture

Table 4 shows the development of the number of SLTP students compared to the population of children (aged 13- 5) projected is Gross Enrollment Ratio (GER).

Table 4
Number of Students JSS and Islamic JSS Students, Population (13-15 age) and Gross Enrollment Ratio (GER)

Years	JSS and Islamic JSS Students 13-15 age	Population	GER
1973	1,535,701	1,150,000	18.47
1978	2,673,976	9,541,000	28.03
1983	4,757,608	10,709,400	44.42
1988	6,446,966	12,512,000	51.53
1992	6,741,300	12,715,990	53.01

Source : Center for Informatics, Ministry of Education and Culture

It is shown that the GER value tends to increase, although in 1992 was still low. This reflects the low number of primary school graduated continuing their study to the SLTP.

Table 5 shows the percentage of primary school graduates continuing their studies to Junior Secondary Schools.

Table 5
Rate of Continuation: PS to JSS

Year	Rate of Continuation (%)
1974/75	59.07
1978/79	73.34
1983/84	70.80
1988/89	64.66
1992/93	61.37

Source : Center for Informatics, Ministry of Education and Culture
Rate of Continuation = New Entrants Grade I JSS/Graduates PS

Compulsory program for 9 years basic education (SD and SLTP) which is commenced by the government in 1994 is aimed to increase the rate of continuation from SD to SLTP, parallel with the improvement of quality of manpower through education.

Table 6 shows the number of senior high school (SLTA) students and the SLTA participation projected by Gross Enrollment Ratio. From the data collected until 1992, it shows that although there is an increase in the number of students but SLTA participation is relatively low. It is a challenge for Indonesians to increase the SLTA participation in the future.

Table 6
Number of SSS Students and Islamic SSS Students, 16-18 Age Population, and Gross Enrollment Ratio (GER)

Years	SSS and Islamic SSS Students 16-18 age	Population	GER
1973	696,185	7,382,000	8.59
1978	1,289,744	8,776,000	9.43
1983	2,653,819	9,923,800	26.74
1988	3,918,920	11,342,000	34.55
1992	4,114,178	11,886,000	34.61

Source : Center for Informatics: Ministry of Education and Culture

Table 7 shows the participation of higher education.

Table 7
Number of Higher Education Students, 19-24 age population, and Gross Enrollment Ratio (GER)

Years	Higher Education Students 19-24 age	Population	GER
1973	231,000	11,962,000	1.93
1978	342,166	14,747,000	2.32
1983	823,925	15,667,000	5.26
1988	1,356,756	19,464,700	6.97
1992	1,794,056	20,181,197	8.89

Source : Center for Informatics, Ministry of Education and Culture

Table 8 shows the number and educational backgrounds of the teachers in each level of education according to the 1992 data.

Table 8
Number of Teacher by Education level year
1992/1993

No.	Highest certificate	PS	JSS	SSS	HE
1	PS	877	-	-	-
2.	JSS	83,733	-	-	-
3.	SSS	5,844	49,315	-	-
4.	Teacher Training SSS	997,347	-	-	-
5.	BA Teacher Training	-	270,819	135,637	-
6.	BA Non Teacher Training	42,209	18,921	31,201	-
7.	S1 Teacher Training	-	34,141	109,327	15,987
8.	S1 Non Teacher Training	23,806	9,367	21,867	48,728
9.	S2	-	185	419	13,077
10.	S3	-	-	-	2,649
	Total	1,153,816	382,724	289,451	80,441

Source : Center for Informatics Ministry of Education and Culture

4. Policy on the Development of Education in Indonesia

The movement of Indonesia economic structure to industrial economy resulted in the changes on the structure of labor force needed, either on the aspect of education or kinds of specialization. The consequences of this changes, Indonesia needs to increase the level of education of its labor force to support the needs of qualified labor forces in the field. Therefore, the strategy designed by the government for its education development included the improvement in : (1) equity in educational opportunity, (2) relevancy of education to development, (3) quality of education, and (4) efficiency in educational management.

The improvement in the equity of educational opportunities has the consequences on more opportunities for children to go to schools through different routes, levels, and kinds of school. In the context of educational relevancy, the government established the Link & Match Policy that direct the process and product of education suitable to the needs of every sector in development. The policy to increase the quality of education has the consequences on effective teaching - learning process with the support of qualified teachers and suitable facilities. The policy on the efficiency of educational management shows the direction of innovations in the management of educational units so that the resources available can be used efficiently to reach the maximum result.

In the five year development plan (Repelita VI sixth) from 1993 - 1998), priority of education development in Indonesia includes :

1. The completion of the Nine Year Basic Education Program

   In 1984 the government announced the compulsory education program for primary school for children aged 7-12 years. Ten years later, in 1994, the government announced the 9 years of compulsory education program for basic education (Primary School and Junior Secondary School). This expansion is decided to increase the quality of Indonesian people.

   It is hoped that the conduction of the 9 year compulsory education will be finished in ten years to come. As the consequences of this expansion, the government needs to build on average about 15,000 new classrooms each year in ten year, and the promotion of about 34,000 teachers qualified to reach in the elementary and junior secondary schools (SD and SLTP).

2. Improvement of quality of all types, levels, and channels of education

   The main object in increasing the quality of education includes :

   (1) the availability of educational resources both with suitable quality and quantity, includes teachers, textbooks, educational instruments, and laboratories; (2) the development of managerial system and the evaluation of quality of education. The improvement of the quality of teachers is carried out through the increased requirement for elementary teacher (at least two years education at university level - holding a diploma 2 D-2). This also required for teachers at Madrasah Ibtidaiyah. For the SLTP teachers are required to hold the D-3 (three-year education at university level). Teachers for the SLTA (Senior Secondary School) must hold an S-1 (Bachelor degree, 4 years of education at university level). Instructors and lectures in higher education must hold an S-2 (Master) and S-3 (Doctorate) degrees.

One of many programs intended for teachers to increase their profession is through in-service training program. The government is also trying to improve the welfare of the teachers.

In the beginning of 1994 the new curriculum was developed for primary and secondary education as one of the many efforts to increase the quality of education by developing a curriculum which is more flexible relevant, up to date, and students can digest the materials easily the 1994 curriculum has been implemented for one year.

3. Expansion, quality improvement and relevancy of vocational and technical education

   The problem of the readiness for work of the vocational school graduates gets a serious attention for the government. One of the government efforts to increase the readiness of vocational school graduates is by adopting "dual system" concept, that is to make schools and jobs both as a place for learning, so that vocational education is oriented more towards practice than theory. The implementation of this system in vocational education it is hoped, will produce skilled workers. Dual system applied by the government needs a close cooperation between schools and industries in providing training places for students.

4. The improvement of mastery in science and technology at the higher education level

   In Indonesia, there are about 51 government higher education institutions and more than 100 private higher education institutions. The improvement of the quality of higher education is focused on master's and doctorate programs, and more oriented towards subject masters in higher education which have high benefit for Indonesian development in the future, recanography, and microelectronics.

   The quality of higher education is geared to research. Research in higher education has functions to increase the quality of instructors, lecturers, and researchers, to help solve problems in development, and to develop science and technology although only in limited member, the government has provided funds for research activities in higher education. Besides that the government supports a cooperations between higher education institutions and another institutions in research activities. In 1986 the government built the Inter University Center to develop certain sciences that need big investment, such as biotechnology, biology, food and nutrition, microelectronics, material science, social science, economics, and education as well.

5. Problems of Mathematics and Science Education in Secondary Education Level and the role of Growth Centers in Mathematics and Science Education in Teacher Education Institutions

In the overall strategy of education development in Indonesia in facing the era of industrialization and globalization, mathematics and science education in each educational level has an important position. Substantively, math and science education in primary and secondary levels gives students knowledge which directly support the ability to understand science and technology. Furthermore math and science education in primary and secondary education is potential to develop students' interest to choose careers in pure science which is badly needed, and to train students to think logically, rationally, and operationally.

Mathematics and science education is facing a challenge on how to conduct teaching-learning process in schools which is not yet maximized. From the point of view of learning product, some studies show the low achievement of student in mathematics and science compared to the other subjects both in elementary and secondary schools (Djojonegoro, 1994). From the point of view of a process, mathematics and science teaching at schools is still conducted in lecturing method, mainly giving facts and information to the students, without giving students a chance to do activities which will stimulate them to train their ability to observe, to think, and to investigate.

In facing the development of science and technology, those challenges need to be answered through innovations in teaching - learning process in math and science. For this purpose qualified and professional math and science teachers are need

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Correction for Dr. Achmad Hinduans' papers on page 67, last sentence:

For this purpose qualified and professional math and science teachers are need..............

For this purpose qualified and professional math and science teachers are needed. The development of good pre-service and in-service training for mathematics and science teachers are needed beside instruments and equipment for math and science education, good teacher's guide books, etc.

Mathematics and science teachers play an important role in improving the quality of education. Therefore, step by step, the government tries to increase the qualification of tecahers. For example, in fifties elementary school teachers were graduates of SGB (Junior Secondary Teacher Training School). In the sixties, elementary school teachers were graduates of SPG (Senior Secondary Teacher Training School). In the nineties elementary school teachers are graduates of D-2 program (2 years diploma program).

At present IKIPs and other teacher training Institutions are responsible for educating high school graduates to become primary and secondary school teachers.

Effort by the government to develop Growth Centers for math and science education in some Teacher Education Institutions (e.g. IKIP Bandung, IKIP Yogyakarta, IKIP Malang, IKIP Padang, and IKIP Ujung Pandang) seemed to be the right effort. The main tasks of Growth Center for math and science education are to develop an effective model for science and math education, math and science teachers education, continuous self-development, and to help other teacher education institutions in developing their math and science education. Through activities in research and development done by the Growth Centers, it is hoped that the products will be disseminated and will have an effect on the improvement of the process and the results of math and science education in Indonesia.

Cooperation among IKIP's, Schools, Universities, Office of education, P3G (Center for Science Teacher Training), should be established Commitment of JICA to help develop Growth Centers in the form of facilities and technical assistance is very much appreciated, since such kind of assistance will help to accelerate the development of the Growth Centers.

Although the information provided in this paper is very limited and mainly focused on general education in primary and secondary education but it is hoped that the information will give you direction, condition, and problems of education in Indonesia; and also efforts are being done and will be done to solve those problems. It is hoped that this paper will also help the participants of the seminar to focus on the problems of education in Indonesia, and alternative solutions to the problems will be found.

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BRIEF INTRODUCTION OF SCIENCE AND MATHEMATICS EDUCATION IN JAPAN

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1. Educational System.

Fig 1. Shows the Educational system of Japan, which is very similar to that in the United States of America. The numbers in the figure indicate the enrollment of each school.

2. Mathematics and Science Course in pre-University Courses.

The Ministry of Education and Culture (Monbusho) provides the "Course of Study (GAKUSHU SHIDO YORYO) " for every subject required in Pre-University schools, not only the contents but also number of class hours of each subject.

Table 1 shows the requrement of mathematics, and Table II indicates those for Sciences Course.

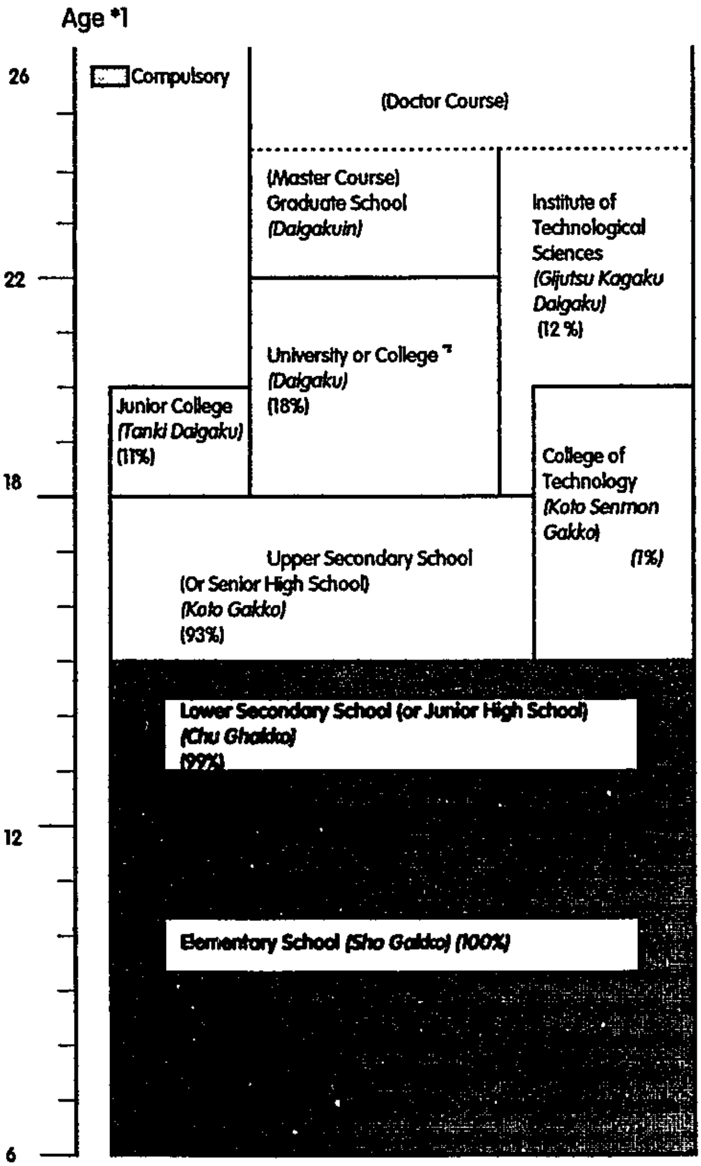


Fig 1. Outline of the present School System
*1 Standard Age
*2 Some Universities (Colleges) accept the graduates of Junior Colleges or Colleges of Technology as their second or third year student

TABLE I
Credits required in Pre-University Schools

	Elementary School Arithmetic			Lower Secondary School Mathematics	
I	136		I	105	
II	175		II	140	
III	175		III	140	
IV	175				
V	175				
VI	175				
	1.011	14,8%		385	36,7%)
Total hours	6.800		Total hours	1,050	

TABLE II
Mathematics at Upper Secondary School

Mathematics	I	4	Compulsory
	II	3	
	III	3	
	A	2	
	B	2	
	C	2	
Total		16	

Table III

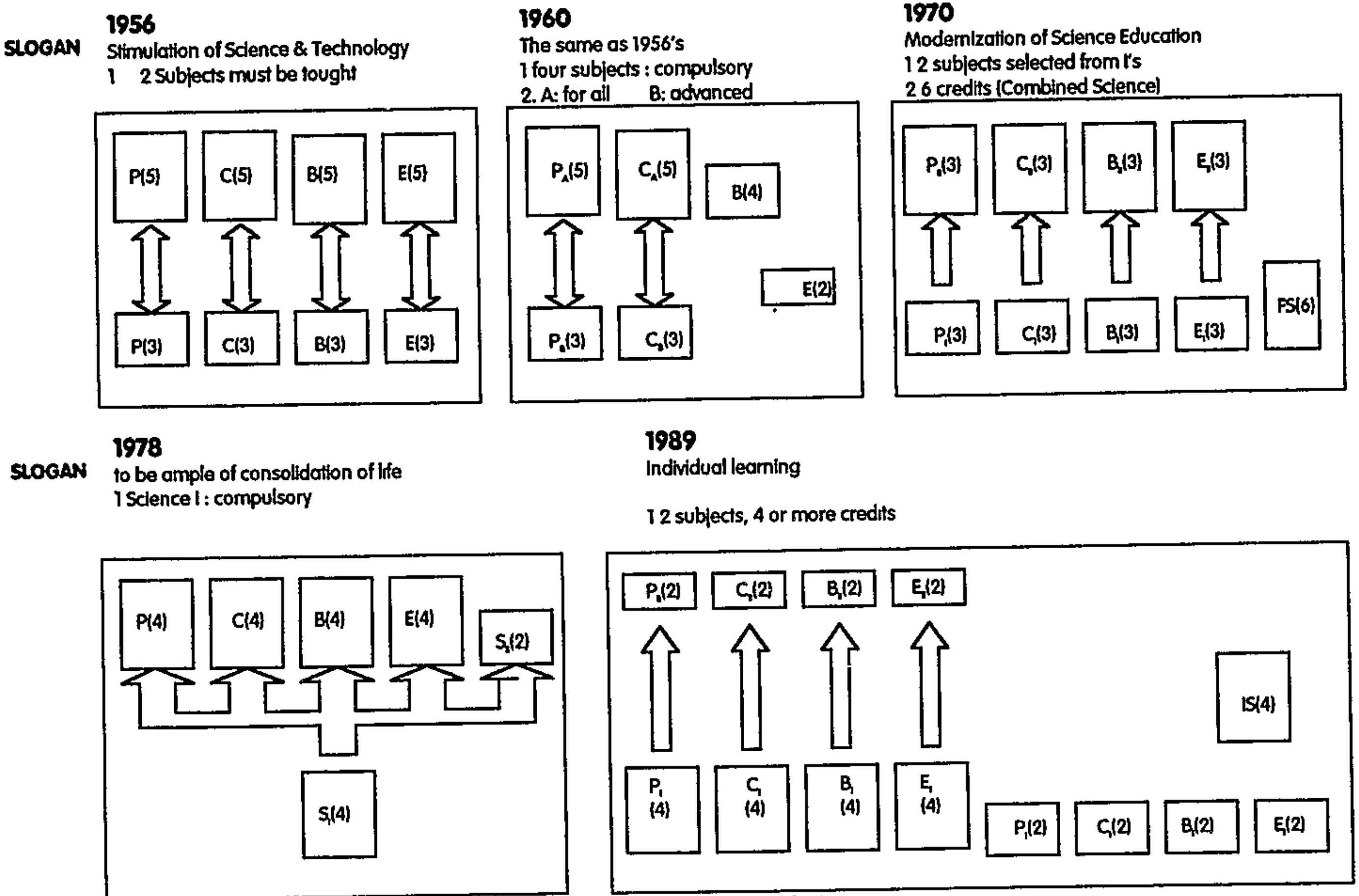
	Science Elementary				Lower Secondary
I	(102)	(Life	Environmental	I	105
II	(105)	Studies)		II	105
III	105			III	105 - 140
IV	105				
V	105				
VI	105				
	420 (207)				315 - 350
Total	627 (9.2%)				(30%) (33.3%)

Table IV
Science Upper Secondary

Integrated Science *		4
Physics	IA	2
	IB	4
	II	2
Chemistry	IA	2
	IB	4
	II	2
Biology	IA	2
	IB	4
	II	2
Earth Science	IA	2
	IB	4
	II	2
	Total	10-16

* One subject each from two subject groups of these live

The course of Study revised almost every 7 years, for Upper Secondary School as an example Fig. 2. Because these slogans shows the reasons of revision of the course of Study fairly clearly, and other subjects were also revised along with these slogans.



NOTES : S:Science, P:Physics, B:Biology, E Earth Science, FS:Fundamental Science, IS Integrated Science

Fig2. History of the Revision of the Course of Study

Here, it is notified that Japanese speakers of this Seminar will mainly give talks taking into account the mathematics and science education at Upper Secondary School, but the other subjects are also revised along with the same principle.

However we are facing difficulties on the Mathematics and Science Education.

Actually, Professor Hara will show you example of the difficulties of Teaching of Physics in Upper Secondary School level, and Prof. Igoh is going to explain the difficulties in the Teaching of Eart Science. One of the difficulties is the decreasing enrollments in these subjects, and the reasons may be summalized as follows:

1. Requirements are so difficult to teach,
2. Influence of the Entrance Examination
3. The lack of adequate teaching materials
4. Teachers are so traditional in the way of Teaching.

What you see here, are problems of very similar fashion that happened in other countries including RI.

How to solve these problem ?

There are several trials proposed by Monbusho and also both by Academics and other organizations.

3. Proposed Ideas to solve Difficulties.

First, Monbusho has revised the Course of Study as already shown in Fig 2. Upper Secondary Schools (pupils toward 97%),) the quality of pupils varies widely, and some of them are not interested in taking Traditional Science Courses (Systematics, Theoretical, Academic Approached), so the Courses in Math & Science are devided into at least two : e.g., IA for non-Science-Oriented Pupils Group, and II for Science-Oriented Pupils Group.

Second, the Academic Societies such as Physics Education Society, the Chemical Society of Japan, and the Japan Association of Science Education etc. made proposals how to solve these difficulties. Prof. Hara will give his talk on this in Session II.

Thirdly, Industrial People also are very affraid of these situations. For example, the salaries of working industries are lower than that of Banking, Real Estate, and Insurance Companies; therefore, Industries try to attract young people to the manufactures though makers increases of the employees' salary.

4. Factor to be considered by Educators.

There are many different opinions raised by Society on these difficulties the so-called "To ESCAPE from the study of math and Science Courses, (RIKA BANARE)".

The current fashions of young people in the world can be expressed as "3K" (K means Kiken, Kitanai, Kitsui), where 3K in Japanese can be replaced as 3D in English, which are Dangerous, Dirty and Difficult.

It seems to me quite natural that people like to live with good payment without hard working, the so-called "Easy-going way of living".

Whereas, we required Math & Science in schools. This is the reason why I have raised the question "why do we teach Science in Schools ?" at the opening ceremony.

One possible be answer to this question is "because we need people with full Scientific knowledge in our daily lives". Is this enough as the answer ?

Next, I would like to mention about the method of Teaching in Math and Science. I would like to take some examples to make comparisons between the Automobile training School and Regular Schools. I know this comparison may be too much of an extreme argument, but please hear a little while.

The aim of the Auto School is to teach how to drive a car. Teachers there merely teach the way to start the car, etc. as techniques. They never explain why you do such actions. If learners are skilled enough to follow to teachers' guide, they will receive a Driver's license.

We must reflectgustion whether this is an education or not?

According to my opinion, this is part of Education but not enough, because teachers at drivers school only teach technique, but they never mention the reasonings. Therefore although learners surely are able to drive a car. If a car has trouble, the driver cannot discover the trouble. Ideally, it is better that all drivers should know more about mecanism or background of physics, chemistry and even biology. Therefore, again, according to my personal opinion, the definition of the good driver is, of course, he can drive safely, and also, he should know everything about the automobile including mechanism, Science, even Social aspects.

Is it possible that idealistic people who have strong backgrounds on every aspect will be cultivated in driving Schools? the Answer is obviously No.

The subjects required in Regular Schools seemed too much and too difficult, but those who acchieve too through understanding are desired in the 21st Century.

How to establish such an idealized Education ? There may be one possibility to establish this situation, e.q.: to teach subjects in a more integrated way. That means do not teach individual subjects such as Physics, Chemistry, Biology, independently, but integrate these subjects by taking teaching materials from pupils' daily experiences.

One example is an "Integrated Science course". This approach was proposed in our Revised Edition of the Course of Study, which will be explained by Prof. Igoh at Session VI.

In order to teach such 'Integrated Science", we have to have teachers who are able to explain natural phenomena as integrated aspects. Also, the teachers should make interaction between pupils during the talks. That means to give question to pupils every five minutes, and allow discussion with their classmates as well. This method of Teaching is call the "DEBATE" method. How ever the Debate method has some difficulties, (1) inefficient in the teaching, (2) teachers will face difficulties to handle the Debate.

However, in order to invite all pupils to the field of science and Math in the 21st century, we have to cultivate such a teachers in schools, who are able to conduct classroom vividly, and to guide pupils into the world of

"Enjoy Science & Math". It does not mean every boy takes a job in Science or Technology. This may be the answer for the Question 2 that I raised at the Opening Ceremony; What is the definiton of Qualified Teacher ?. I hope, the resolution of the Seminar will be achieved through our discussions based upon the two question raised at the Opening Ceremony.

Thank you for kind attention.

INTERNATIONAL SEMINAR
ON SCIENCE AND MATHEMATICS EDUCATION
(Comparative Study between Indonesia and Japan)
Jakarta and Bandung: July 3-7, 1995

MATHEMATICS EDUCATION IN INDONESIA

by:
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Sponsored by:

Directorate General of Higher Education
Department of Education and Culture
Japan International Cooperation Agency (JICA), Indonesia Office
Bandung Institute of Teaching and Educational Sciences (IKIP Bandung)

MATHEMATICS EDUCATION IN INDONESIA

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1. Introduction

The government has always endeavoured to improve the quality of education, including the school (pre-college) mathematics education. This does not imply that similar action on college mathematics education has not been carried out by the government.

One of the government efforts was the introduction of the standardized National Curriculum of 1975 to the whole school system. The activities included the provision of teaching and learning materials and the improvement of the quality of teachers (Suryadi, 1992). The curriculum for the Elementary Schools was reformed in 1984 (The Curriculum of 1984) and rereformed in 1993 (The Curriculum of 1994), while the curriculums for High Schools were reformed in 1984 (the Curriculum of 1984) and rereformed in 1993 (The Curriculum of 1994). On the introduction of the Curriculum of 1994, at present grades 1, 4, 7, and 10 use the Curriculum of 1994, while the other grades the Curriculum of 1984.

In addition to the reformation of the curriculum, there are government efforts to improve the teaching of Mathematics. Yet most of the students performance in everyday life computations and in the examinations on Mathematics is very poor. It is the responsibility of the Mathematics educators to find the cause of the poorness of the performance, and then try to improve it.

2. The School System

The school system in Indonesia has undergone some reformation. In the current system, we have Kindergartens, Elementary Schools, Junior High Schools, Senior High Schools, Colleges, and Universities, with the following features:

Level	School Years	Age of Students
Kindergarten	1-2	5-6 (4-5)
Elementary School	6	7-13 (6-12)
Junior High School	3	14-16 (13-15)
Senior High School	3	17-19 (16-18)
College	2 to 3	over 18
University	over 4	over 18

Talking about High Schools, we are led to thinking of the existence of religious High Schools called Madrasahs and Pesantrens which are excluded from this discussion. In connection with that, there are two kinds of Senior High School: the General Senior High School and the Vocational Senior High School.

The General Senior High School is intended for the college-bound students.

The curriculum is centralized; the topics of each subject matter and the textbooks for every state school are determined by the Curriculum Centre of the Department of Education and Culture. Elementary Schools, Junior High Schools, and Senior High Schools have their common curriculum respectively, all with a little space for regional adjustment. In the Curriculum of 1994, the number of periods for mathematics and the total number of periods at each grade are as follows:

Grade	Number of Periods per week		Length of Periods
	Mathematics	Total	
1	10	30	30 minutes
2	10	30	30 minutes
3	10	30	30 minutes
4	8	40	40 minutes
5	8	42	40 minutes
6	6	42	40 minutes
7	6	42	45 minutes
8	6	42	45 minutes
9	6	42	45 minutes
10	6	42	45 minutes
11	6	42	45 minutes
12 (*)	8	42	45 minutes

(*) In the 12th grade, only the students of the Science and Mathematics Major take the mathematics lesson.

3. Mathematics in the Elementary School

In the Curriculum of 1994, the curricular objectives of the Mathematics instruction are to develop:

a. computational skills;

b. certain transferable capabilities;

c. basic mathematical knowledge for further study;

d. logical, critical, accurate, creative, and discipline attitudes.

The mathematical content of the curriculum covers: arithmetic, introduction to algebra, geometry, measurements, and introduction to statistics. In the Curriculum of 1994, algebra is a very small part, much less than that in the Curriculum of 1984, set-theoretical vocabulary is not used, and the teachers are required to use more essay type tests than multiple choice ones.

4. Mathematics in the Junior High School

In the Curriculum of 1994, the curricular objectives of the Mathematics instruction are that the students have:

a. certain transferable capabilities;

b. mathematical knowledge for further study;

c. mathematical skills for their everyday life;

d. a broad view; logical, critical, accurate, creative, and discipline attitudes; appreciation of the usefulness of mathematics .

To achieve these objectives, the mathematical content of the curriculum covers: arithmetic, algebra, geometry, probability, and statistics. It is mentioned that some contents of the geometry are constructed as a local axiomatic-deductive structure. But the detailed contents do not show this clearly. The content of the Curriculum of 1984 consists of arithmetic, geometry, algebra, trigonometry.

5. Mathematics in the Senior High School

In the Curriculum of 1994, the curricular objectives of the Mathematics instruction are that the students will have:

a. Mathematics knowledge required for college study;

b. mathematical skills required for various works and for evryday life;

c. a broad view; logical, critical, accurate, creative, discipline, and innovative attitudes; appreciation of the usefulness of mathematics .

The mathematics content of the Curriculum consist of: arithmetic, algebra, geometry, statistics, mathematical logic, probability, trigonometry, calculus, and introduction of graph theory.

6. Pre-Service Training of Mathematics Teachers

a. Elementary School Teachers

In the past, we had Senior High Schools for Teachers (SPG's) with the responsibility of producing elementary school teachers. In 1990 the government establihed Elementary School Teachers Colleges (PGSD's) to replace the SPG's. The Elementary School Teachers Colleges Program is a 5 semester study program after Senior High School, of which mathematics is offered in the first three semesters [3, 3, 4 periods per week, respectively]. Most of the experienced Elementary School teachers, therefore, studied mathematics and the method of teaching in the Senior High Schools for Teachers [for two periods per week, most of which was Arithmetic, and no Algebra]. Only a very few elementary school teachers studied mathematics after the High School Mathematics.

b. Junior High School Teachers

The Junior High School Mathematics Teachers' experiences in Mathematics Education are heterogeneous. Some of them studied Mathematics and the Teaching Method in a Two-Year's College of Mathematics Education (PGSLP, or D-II, or B-I), some others did at the Department of Mathematics Education of IKIP (No less than 4 years).

c. Senior High School Teachers

The Senior High School Teachers' experiences in Mathematics Education are as heterogenious as the Junior High School Teachers'. Some of the Senior High School Teachers studied Mathematics and the Teaching Mathod in a Two-Year's College of Mathematics Education (PGSLA, or B-I), some other teachers did at a Three-Year's College of Mathematics Education (D-III), and still some other teachers did at the Department of Mathematics Education of IKIP. (No less than 4 years).

7. In-Service and On-Service Training of Mathematics Teachers

IKIP offers Mathematics Courses as welll as Method Courses (including Microteaching and Student Teaching). To keep the teachers up with the development of Teaching Methodology or to broaden the teachers view of Mathematics and Teaching Method, there are in-service and on-service trainings for the Mathematics Teachers. The goverment has chosen a number of experienced teachers of Mathematics as "Instructors", "Key Teachers", "Tutors", and "Guides" of Mathematics. The instructors and the tutors meet (or have a workshop) periodically to discuss and set up training courses or workshops for the key teachers of High Schools or the guides of Elementary Schools. In each region, the teachers meet periodically under the supervision of the key teachers or the guides to discuss the problems they have encountered, and to write lesson plans for their coming class sessions. In their last few sessions of each training or workshop, the teachers try out their lesson plans to their group, and then revised the plans if necessary. After completing the in-service training the teachers teach their own classes, based on the (revised) lesson plans. Some of the actual teachings are observed by one of the key teachers or guides, and then the teaching-learning processes observed are discussed by the teacher and the key teacher or the guide, for improvement.

To enable the instructors to conduct the appropriate training courses or workshops for the guides and key teachers, the instructors have been given the opportunity to observe the teaching of Mathematics in several countries. Some of them have been given the scholarships to study Mathematics Education abroad, in a graduate degree program or a non-degree one.

When the instructors hold a regular meeting, sometimes they invited some lecturers of Mathematics as consultants. In the training the instructors share their knowledge and skill of Mathematics teaching with the key teachers or guides, and in the other training the key teachers and guides share their knowledge and skill with the other teachers. In addition, the government often conducts an in-service training at the Development Centre for In-Service Training of Mathematics Teachers

(PPPG Matematika) for the improvement of the participants kowledge of Mathematics and Teaching Method.

8. Students Performance in Mathematics

The elementary as well as the high school students performance on their final examination (examination at the end of the final academic year of each level) in Mathematics is not satisfactory, and the mean score on mathematics has always been lower than those those of all other subjects. (Sunardjo, 1995; 6-7). Most parents blame the teachers for the poorness of the performance in Mathematics.

9. Research in Mathematics Education

There are a lot of research reports in Mathematics Education available. Most of the researches have been carried out by the lecturers of the Department of Mathematics Education of FPMIPA of IKIP. Some of them were done when the lecturers were doing their garaduate study (for their theses). A sample of 83 researches in Mathematics Education done in the last two years by our colleagues at the Department of Mathematics Education of IKIP Malang, IKIP Surabaya, and IKIP Yogyakarta, and the theses written by the graduate students (S2) of Mathematics Education at IKIP Surabaya from 1985 to 1994 , can be classified as follows:

IKIP/S2	The Problem of Mathematics Education at			
	Elementary School	Junior High School	Senior High School	FPMIPA IKIP
IKIP Malang	1	1		11
IKIP Surabaya	1	1	1	6
IKIP Yogyakarta	2		7	9
S2	13	9	16	5
Total	17	11	24	31

A few of these researches tried to find out whether there was a correlation between some factors and the students understanding of mathematical concepts, but none of the 83 researches were intended to find the cause of the poorness of the students performance in Mathematics.

10. The Problems

The current problems in Mathematics Education are:

a. Why is the performance in mathematics of most of the students poor?

b. How can we improve the students performance in mathematics?

We will not be able to solve these problems by one seminar. But by some discussions we will be able to take the correct action to find the solution.

11. Discussion

To be able to solve the later problem, we have first to find the solution to the earlier one. To solve the first problem is to find the cause of the poorness of the performance. The research reports sampled above give no solution to the first problem.

I have not found the cause yet, but we can carry out a research to find it. Begle (1979) summarized variables that are likely to effect the students performance in Mathematics. We can use Begle's findings as a guide in addition to our findings from our observations. Based on this guide there is one question to answer:

What factors have contributed significantly to the poorness of the students performance in Mathematics?

This question covers the followings:

a. In what content of mathematics and on what levels: Is it arithmetic, measurements, geometry, algebra, or tigonometry that counts? Is it about computation, comprehension, application, or analysis?

b. What teachers characteristics? Is it their knowledge of Mathematics, their background, their teaching experience, or their attitude?

c. What curriculum variable? Is it the difficulty of the materials, the sequential ordering of the mathematical contents, or another factor?.

d. What students variable? Is it an affective factor, a cognitive factor, Mathematics knowledge background, or a nonintellective factor?

e. What environmental variable? Is it the family background, the physical factor, or another factor?

f. What instructional factor? Is it the learning aid/manipulatives, the teaching approach, the textbook, or another variable?

g. What evaluation variabel? Is it the type, the validity, or the administration of the tests?

Answers to the above questions will enable us to construct a program that, with a high degree of confidence, will improve the students performance in mathematics. We can find the correct answer by means of research. We can utilize several documents to conduct the research: (1) the final examination papers of the students, (2) the expert judgement on the curriculum, and (3) the evaluation results of the in- and on-service training of the teachers of Mathematics.

The mathematician group of Yogyakarta, after a serious study, concludes that the mathematics content of the Curriculum of 1994 for the Senior High School as well as that for the Junior High School is too broad to cover, so that it is very likely that the students achievement will not be better, or even worse, than the students achievement from the Curriculum of 1984.

Drost (1995-a & b), an experienced teacher, (who is also an experienced principal of a Senior High School), claimed that: (1) the mathematics content for grade 10 of the Curriculum of 1994 was more difficult than that of the Curriculum of 1984, and (2) the whole mathematics content of the Curriculum of 1994 for the Senior High Schools was too difficult for most (70%) of the students to study.

The evaluation of the in- and on-service training program of the Teachers Performance Development (PKG/ SPKG) showed that: (1) the professional performance of the teachers developed satisfactorily, while (2) the performance of their students showed no significant improvement. (Hamid Hasan, 1995). The PKG/SPKG Program has been reformed to become the Program of Mathematics Teachers Deliberation (The MGMP Program).

My experience of teaching some teachers of Mathematics of High Schools indicates that many teachers still need an intensive training in Mathematics, not only in method of teaching. Many teachers have, for a long time, not taught mathematics by a deductive approach. They are not ready to teach mathematics by a deductive approach as expected by the Curriculum of 1994.

12. Suggestions

Based on the above discussion I would like to suggest the following points:

a. Restructuring the minimum Mathematics Program to be taken by all students, by dropping some of the difficult parts.

b. Increasing the axiomatic deductive section of the Curriculumof 1994, and thereby offering the resulting curriculum to the students with high mathematical ability from grade 10 or lower. The Advanced Program is not a major program, but isoptional. As such, there will be a Minimum Program and an Advanced Program. A similar policy shall also be applied to both the Language and Social Study Programs.

c. Investigating the contribution of the above variables to thestudents achievement in mathematics in order to find the cause of the poor performance of the students in mathematics.

d. Restructuring the PKG/SPKG Program or revising the MGMP Program so as to improve students performance as well.

e. Setting up an intensive training in deductive proof for HighSchool teachers of Mathematics.

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INTERNATIONAL SEMINAR
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HOW TO LINK AFFECTIVE AND COGNITIVE ASPECTS IN MATHEMATICS CLASS

(Comparison of Three Teaching Trials on Problem Solving)

by:
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Sponsored by:

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HOW TO LINK AFFECTIVE AND COGNITIVE ASPECTS IN MATHEMATICS CLASS

---- Comparison of Three Teaching Trials on Problem Solving ---

Prof. Dr. Nobuhiko Nouda

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1. Background:

For about a hundred years, computational skills in mathematics have been highly emphasized in the elementary and secondary school mathematics curriculum in Japan. Computational skills have been emphasized in classroom lessons and solutions by paper-pencil, abacus and mental computation have been used to solve problems in the classroom activities. Japanese pupils have studied some skills in computational problems. It was a well known fact that the Japanese pupils got higher scores in international acheivement test during the first and second IEA study of mathematics, and recently, international Mathematical Olympiad.

We would like to assert some tentative conclussions on the effectual link between affective and cognitive aspects in the use computational tools on problem solving, in particular; the pocket calculator. Pocket calculators seem to be a more efficient way in bringing pupils thinking into the mathematical problem solving than paper-pencil. This report on the comparison of the three teaching trials on problem solving has some effectual outcomes in connection with the effective and cognitive aspects.

We conclude in asserting the value in the use of pocket calculator in the process of understanding, solving and retention of the effect. This research suggests that higher-order thinking of mathematical problem solving in developed especially by the use of the pocket calculator. It is easier for pupils to operate on the complex number given using the pocket calculator since it is transformed into a more simple one.

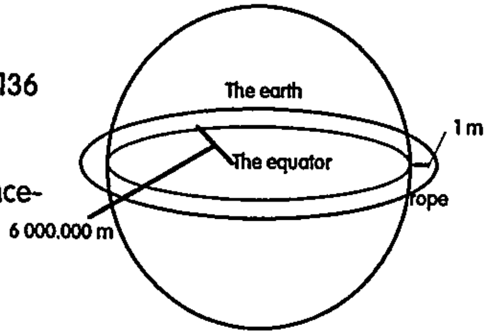
2. Three teaching plans with computational alternatives in problem solving:

Three teaching plans were done to study the effects of teaching trials by using estimation, calculator and paper-pencil computation as computational alternatives in mathematical problem solving context. These lessons were conducted in the fifth grade classroom of an elementary school at a small city near Tsukuba City in December 17, 1990. The problems and processes of the lessons were almost the same as except for the differences in the lessons as the results of computations gotten by estimation, by calculator and by paper-pencil.

The lessons that have used estimation and calculator were don by the same teacher and the other lessons was done by a different teacher.

Problem used in the lessons

Imagine the earth as a big globe. Its radius is about 6378. 136 Km. If we tie a rope one meter above the equator of the earth, what is the difference- between the original circum- ference and the length of at the rope?



We chose the earth problem because of the following reasons:

We thought first that a true problem should satisfy the following three factors.

(1) Pupils should be able to understand the problem

(2) Pupils should not beable to solve the problem by the use of routine method.

(3) Pupils should have a desire to solve the problem.

Second, we thought that problem solving in a process and a problem solving process use acquired mathematics knowledge and skills, which can be applied to solve the problem by an individual or in group discussion.

The specific characters of each lesson were as follows:

(a) Lesson which emphasize pupils to use estimation

1) To understand a problem by replacing a given situation with more simpler numbers, that is an idealization of complicated situation into clear situation by replacement.

2) To solve problem with simpler numbers.

(b) Lesson which emphasize pupils to use calculator

1) To get an answer easily by calculator

(c) Lesson which let pupils compute by paper-pencil.

1) Let pupils compute numbers which come from real situation and are complexed.

Three were some common characters among these lessons such as a whole class teaching style and the proceeding of lesson were mainly guided by teacher, and sometimes teacher asked each pupils some questions or opinions individually. In these lessons, teacher asked pupils to forecast an answer and solution way before they solve the problem, teachers tried to emphasize verification of solution and teachers let students to reflect this process. Also teachers posed additional problem.

3. Practical trials to each the lessons in problem solving context: (1) Teacher explained the earth problem using a big terrestrial globe.

Pupils were asked to forecast the difference of the length and their forecasts were as follows :

Table 1. Pupils forecast (%)

	Calcu (35)	Estima (35)	Paper-P (35)	Sum (103
a) about 6000 Km	8,6	2,9	5,7	5,7
b) about 1000 Km	22,9	2,9	31,4	19,0
c) about 1000 Km	31,4	57,1	14,3	34,3
d) about 6 m	37,1	37,1	48,8	41,0
e) we can't guess	0	0	0	0

Table 2. Pupils expression, calculation and correct answer (%)

	Calcu (35)	Estima (35)	Paper-P (35)	Sum (103
f) expression	60,0	71,4	25,7	52,4
g) calculation	57,1	71,4	14,3	47,6
h) correct ans.	68,6	71,4	11,4	60,0

Table 3. Characterization of pupils expression

	Calcu (35)	Estima (35)	Paper-P (35)	Sum (103
I) synthesis ex.	51,4	34,3	11,4	32,4
j) analysis ex	5,7	22,9	8,6	12,4
k) , X expre.	2,9	0	2,9	1,9
l) special num	0	14,3	2,9	5,7

Table 4. Students Answers to the Application Problem (%)

	Calcu (35)	Estima (35)	Paper-P (35)	Sum (103
0) Correct ans.	94,3	91,4	74,3	86,7

4. Conclusion:

We conclude in asserting the value in the use of Pocket calculator in the process of understanding, solving and retension of the effect. This research suggests that higher-order thinking of mathematical problem solving is developed especially by the use of the pocket calculator. It is easier for students to opperate on the complex number given using the pocket calculator since it is transformed into a more simple one. The value in the use of calculator process on understanding, solving and extending the problem lies in its usefulness for the students to get the structure of the problem more easily. Also, it is useful for the students to forecast solutions and to make similar and general problems.

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PHYSICS EDUCATION IN JAPAN
PRESENT STATUS AND TRIALS FOR ITS IMPROVEMENT

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Sponsored by:

Directorate General of Higher Education
Department of Education and Culture
Japan International Cooperation Agency (JICA), Indonesia Office
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Physics Education in Japan Present Status and Trials for Its Improvement

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1. Physics education is important

Physics education is important. Physics is a basis for science and technology, but it is more than that. It helps us to understand the relationship with our natural environment, and how to protect it. It helps promote culture quality for all. Additionally, the study of physics provides a wide range of career opportunities. Understanding and ability in science and technology will enhance their ability to hold meaningful and productive jobs in the future.

In Japan importance of physics education was noticed more than 100 years ago. In 1882 the founder of Keio University, Yukichi Fukuzawa, delivered an address "Usefulness of Physics" in which he pointed out that physics education is very important because of the following two reasons ;

(1) **Physics is universal**. For example, water boils at 100 °C in both Tokyo and London from ancient times until now. The Universality is a Characteristic feature of laws of physics. On the other hand, laws of economics and commerce are local. For example, trade policy in england was free trade, while that in the U.S. was protective trade.

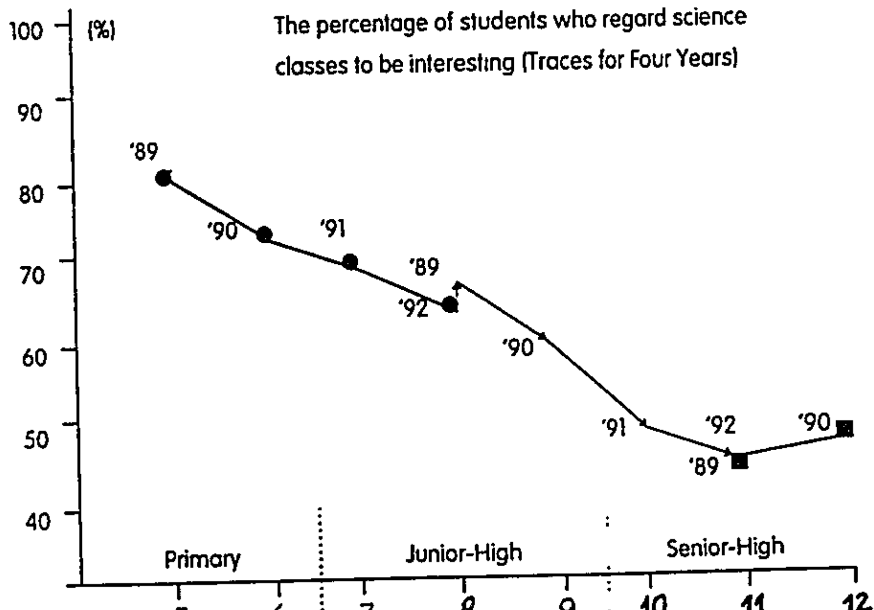
(2) **Physics is the driving force of western civilization .**

Because of these two reasons, physics was taught to all freshmen as an introductory subject in Keio University in19th century.

2. Science and engineering are not popular among young people.

In spite of its importance, physics is getting be not popular subject among young people, recently.

Interest in science is strong among primary school pupils. For example, 80% of 5th grade students regard science classes to be interesting, since they can enjoy observations and simple experiments such as experimental confirmation of isochromision of pendulum with pupils as heights and observation of attraction of magnets se P.2 the study of magnetic attraction between nails and magnets. However, interest in science classes decreases as they preceed to uppergrades, because understanding and memorization of basic concepts and laws become an important goal of science education; According to the recent survey, science classes are regarded to be interesting by 63% of 8th grade pupils and 44% of 11th grade pupils, respectively. (Fig.1).



Among physics, chemistry and biology, physics is least popular subject. At present less than 30% of upper secondary school pupils study physics science physics is not a compulsory subject. About a half of upper secondary school pupils wish to attend universities after graduation. As it shown in Fig.2, the percentage of pupils who applied to engineering majors has decreased in the last ten years, while interest in economics majors has increased. Interest in science majors has been keeping low.

3. Physics has changed in 20th century.

Now let me mention the fact that there is a profound difference between physics in 18th ang 19th centuries and physics in 20th century. In 18th and 19th centuries most objects of physics were phenomena that we can feel directly through our feelings, such as movement of stones in the sky that we can be see by our eyes, heat that we can feel by our hands, and sound that we can hear by our ears and attraction of magnets that we can be see by our eyes.

To understand laws of physics that govern visible phenomena, we have to understand atomic and subatomic world which we cannot see by our eyes nor touch by our hands. For example, we cannot explain the fact that water boils at 100 °C at both Tokyo and London without introducing invisible molecules of water and the laws that govern these molecules.

4. Why is physics not popular in upper secondary schools ?

The progess of physics has made Japanese educators to emphasize the method of deduction from basic laws and concepts and theoretical and abstract thinking in teaching physics, rather than to emphasize the method of induction from physical phenomena and to foster ability in experimentation and skillfulness in handy work. An additional reason for this mode of physics education is the fact that it requires more time than the former.

Emphasis of the deductive method and theoretical and abstract thinking is a reason why physics is not popular among upper secondary school pupils. In addition, there is another and more important reason, i.e., pupils are forced to memorize various laws and formulas and to practice to solve difficult problems in physics classes. This is due to the fact that they have to solve difficult problems of physics in written tests in University entrance examinations if they wish to become engineering or science majors. As the result, physics classes are not interesting to pupils, especially in tertially level to those who do not intend to become science nor engineering majors in tertially level.

5. Different kinds of courses and curricula are needed.

The percentage of upper secondary school pupils who take written tests of physics in university entrace examination is only 5%. Because most physics teachers try to teach physics for only 5% of pupils as preparatory education for physics education in universities and do not care about 95% of pupils, physics classes are not interesting to the majority of pupils.

Different kinds of courses and curricula are needed for different kind of pupils. Particularly, new kinds of curricula should be developed for pupils who are not interested in careers in science and tecnology. Hance, the first step toward the goal is taken in the present Course of Study for Upper Secondary Schools, i.e., a new course, physics IA, has been introduced.

Physics IA is a course for pupils who are not interested in careers in science and technology and the goal of the course is to make pupils scientifically literate citizens. " Scientific Literay" is defined in the National Science Education Standard discussed in the U.S. as follows : Scientific literacy is knowledge and understanding of scientific concepts and processes required for participation in civic and cultural affairs, economic productivity, and personal decision making.

The contents of the second course, physics IB and physics II, are designed for pupils who are interested in careers in science and/or technology.

6. Physics education and Japan lower and upper secondary school.

In Japan there is the "Course of Study" for pre-university schools. The syllabus of science education in these schools are announced and enforce as the ordinance of the Ministry of Education (Mombusho).

In lower secondary schools all pupils study physics one hour (50 minutes) every week on the average. They learn following items :

(1) Familliar with physical phenomena such as light and sound, heat and temperature,

and various forces.

(2) Motion and energy such as equilibrium of forces, speed and velocity, Newton's laws of motion, free fall (in air and on a slope), work and energy (pulley, slope and work), power, potential energy $\propto$ h.

(3) Phenomena associated with electric currents such as Ohm's law, Joule's heat, magnetic interaction of current, and the fact that electric current is a flow of electrons etc. rather qualitatively.

They also learn about influence of development of sciences and technology such as the invention of new materials and energies, and computers on human life.

In upper secondary schools pupils are required to study more than two subjects out of physics, chemistry, biology and earth science for more than 210 hours. Physics is not a compulsory subject.

The content of Physics IA, which emphasize the role of physics in technological society and industrial products, and the study life 2 P.5, and which is expected to promote and develop scientific way of thinking and judgements, are shown in Table I. It is required to teach 3 subject including (4) out of 5 subjects.

Table I : Contents of Physics IA (70 hours)

(1) Light and sound (light and eyes, sound and ears),
(2) Motion (description of motion, friction, collisions),
(3) Energy and everyday life (heat and temperature, electric energy, transformation of energy among various forms, solar energy and atomic energy),
(4) Information and its processing; transfer of information, processing of information, memory of information),
(5) Influence of physics (change in life style and physics, world view and physics).

The contents of physics IB and physics II, the purpose of which is to promote and develop undestanding of basic concepts of physics are shown in Table II and III.

Table II : Contents of Physics IB (140 hours)

(1) motion (force and motion, momentum),
(2) Energy (mechanical energy, heat and energy),
(3) Wave motion (properties of waves, sound, light),
(4) Electric current and elektrons (electric field and electric current, electrons and atoms.

Table III : Contents of Physics II (70 hours)

(1) Motion and energy (circular motion, universal attraction, motion of gas molecules),
(2) Electricity and magnetism (electric current and magnetic field, electromagnetic induction and and electromagnetic waves),
(3) Atoms and atomic nuclei (particle property of light and wave property of electron, atomic model, transmutation of atomic nuclei, elementary particles).

Though calculus are taught in upper secondary schools in the Mathematic Courses rather independently from Science Course, both Physics IB and Physics II are taught without using calculus.

7. Is the Course of Study educationally effective ?

In Javan textbooks used in pre-university schools are inspected by inspectors appointed by the Ministry of Education. They check textbooks if the textbooks follow the Course of Study. The problems given in entrance examinations into universities are also restricted by the Course of Study. Thus, textbooks and entrance examinations are influenced strongly by the Course of Study.

Unfortunately, there is no national assessment standarts. as the result, there are some upper secondary schools where physics education is not offered. All upper secondary school pupils must be guaranteed the opportunity to study physics by national standards.

Since 95% of graduates of lower secondy schools go on to upper secondary schools, upper secondary school pupils haves a variety of goals, abilities and aptitudes. As the result, they are given grades if they answer correctly more than 25 to 30% of problems in examinations. This is a very sad situation. The course of Study must be assessed by checking if required level of scienctivic literacy is achieved.

8. Handy physics experiments for teachers and pupils are important.

Unfortunately, most physics teachers in universities are research oriented. They regard physics as a theoritical system composed of laws, concepts and principles, and teach physics deductively with mathematical rigor without carrying much about students' conceptual structures and changes in learning physics such as preconcepts and misconcepts. Traditional cook-book style laboratory experiments do not allow students to try anything new based on thier own ideas.

Here, I explain handy physics experiments for teachers and pupils as important means to make physics familiar to pupils and to help them understand physics intuitively through direct experience. Handy physics experiments provide means to overcome above mentioned defects because of the following reasons.

(1) They provide concrete examples of abstract concepts and laws, which can be found around us in everyday life, but have been unnoticed by pupils.

(2) They activate pupils' attitude toward physics, since they learn that objects of physics are found in their surroundings in everyday life.

(3) Besides pupils, physics teachers are activated because of the same reasons.

(4) Simple, attractive, but unexpected results of well- prepared handy experiments may remedy pupils' intuitive preconcepts or misconcepts.

For this purpose, pedagogical realization of cognitive-conflict situation by simple and clear-cut handy experiments is important.

Let me show some examples of handy physics experiments such as "Joule's experiment" with a pet-bottle halt-filled by water.

Now let us discuss requirements for handy experiments.

(1) The experiments should reveal the essence of concepts and laws of physics clearly in the phenomena.

(2) The experiments should be simple and easy to be understood once the key concepts are known.

(3) Experiments using familiar materials are desirable because students can repeat the experiments by themselves.

9. Conclusions

Physics education is important to all students.

It must promote the joy of physics to all students.

Interactions between students and teachers are important.

Conferences and workshops on science education like this seminar which permit personal interactions among science teachers from different countries are very important.

INTERNATIONAL SEMINAR
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PHYSICS EDUCATION IN INDONESIA

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Sponsored by:

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Department of Education and Culture
Japan International Cooperation Agency (JICA), Indonesia Office
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Physics Education in Indonesia

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In the Indonesian education system physics education as a separate course starts in the junior highschool, which is the stage following the 6 year gradeschool education. In the old days the curriculum for each grade was organized as a one-year packet. The curriculum was then changed into semester system, and in the last curriculum system which was just implemented last year, the curriculum was organized into trimester system. The same pattern of curriculum change was done in the senior highschool system.

The physics teacher education is carried out in teacher education institutes (IKIP and FKIP). The curriculum for the physics teacher education has undergone several changes, swinging from one extreme to another in the proportion of the educational aspect with respect to the dicipline subject matter aspect. The latest one being a proportion of about 65% of dicipline subject matter, and the rest consists of pedagogy and the teaching and learning aspect of the respective subject matter. Six years ago the effort to improve the curriculum for the highschool teacher education in the basic sciences was started, and the new curuculum took effect about 4 years ago. The curriculum reform was followed by massive training of the lecturers at the Institute of Technology Bandung and the University of Gadjah mada. The curriculum reform and the training program of the lecturers in order to enable to carry out the curriculum was funded by World Bank Loan and conductied by special team, called the Basic Science LPTK team. The team members were selected from lectureres of IKIP Bandung and ITB. Up to now more than 1000 lecturers from the four basic sciences fiel (Math, Physics, Chemistry, and Biology) have been trained.

The education of professional physicists is is carried out in the department of physics of the Faculty of Mathematics and Sciences. Currently there are about 18 such faculties in the state universities all over the country. The enrollment ranges from 30 students to 85 students/year. In terms of the number of PhD's the leading physics departments are from ITB (26 PhD's), University of Indonesia (20 PhD's), and the University of Gadjah Mada (12 PhD's). The three departments of physics also conduct graduate education in physics.

The paradigm

The core curriculum for the physics teacher education is very similar to the core curriculum of the bachelor of physics program. The difference is in the total curriculum. While the curriculum of the physics teacher education has to include subjects in education subject, the teaching and learning process, and the highschool physics curriculum , the total curriculum of the bachelor of physics consists of the core curriculum and the electives in the field of applied physics or in the gray area between the undergraduate and graduate education. The curriculum is based on the paradigm of physics as shown in Fig. 1.

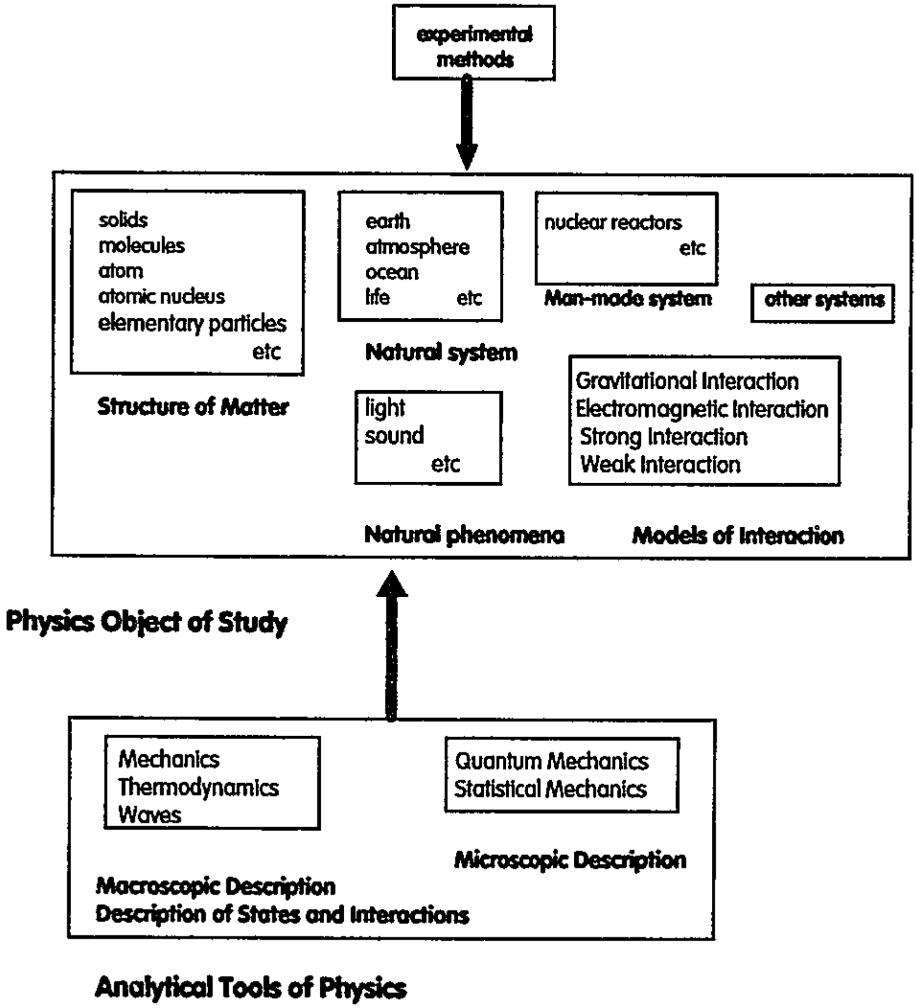

Fig. 1. The paradigm of physics used the design the physics curriculum for physics teacher education and bachelor of physics.

The analytical tools of physics consists of the existing body of knowledge used to explain the various phenomena of nature, the structure of nature, and to predict how nature will behave under certain condition. Thus the analytical tool consists description of states and interaction for *macroscopic* system, which consists of *mechanics* (for describilng mechanical interaction), *thermodynamics* (for describing thermal interaction), description of *wave phenomena.* The analytical tool also includes the description of states and interaction for atomic or microscopic systems, which consists of *quantum mechanics* and *statistical mechanics.*

The analytical tool is applied to derive models of fundamental interactions (the gravitational, the electromagnetic, the weak, and the strong interaction) through the concept of force or through the concept of potential energy. The analytical tools combined with model of interactions are used to derive model of the structure of the structure of matter, such as model of atomic nucleus, model of atom, model of molecules, model of crystalline and amorphous solids, and to give quantitative explanationof various properties of matter such as the electronic, thermal, magnetic, optical, and model of the structure of matter can be used to design man-made systems, such as nuclear reactors, accelerators, lasers, planes, ships, etc.

Physics as an empirical science uses observations through experiments or quantitative measurements of physical quantity to test the truth of a hypothesis derived from a theory. In physics the demontration of the truth of the hypothesis is used to prove the correctness of a theory. The combination of inductive process through experiments or field observation, and the deduction using the existing body of knowledge embodies what is known as the *scientific method.* This powerful method is now used in other fields such as biology, agriculture, education, medical sciences, engineering, etc.

At present the design of physics equipment involves some interfacing with a computer in order that the measurement can be automated. In this way the physics will be freed from the mechanical details of the observation so as to be able to concentrate on the theoretical and computational aspect of the experiments.

The language of the analytical tools of physics is mathematics which is guaranteed to be logically sound, and the language of inductive logic is statistics. The tools for mathematical solution of the problems of physics is the use of computer to give quantitative result to be compared with the result of the measurements of the appropriate expriments or field measurements. The computer can also be used to make simulation of physical phenomena that can be tested by scientific method. The use of computer simulation of physics phenomena is now considered to valid prove of hypothesis, although some may still have doubt as to the validity of its predictive power.

The curriculum

Based on the paradigm described above the physics core curriculum for teacher education and bachelor of physics can be designed as shown in fig. 2. Basically the curriculum model is based on the curriculum used internationally, but is just arranged such that the spiral pattern can be seen. In this model the first cycle of the curriculum consists of Basic Physics which functions as a bridge between highschool physics and the university physics. The basic physics consists of the full cycle of the highschool physics, consisting of mechanics, thermodynamics, electricity and magnetism, waves and optics, and modern physics, but the mathematical techniques used are at a higher level using differential and integral calculus, dot-product and cross-product of vectors, line and area integrals, and phasors.

The dot product and the line integral is used to describe the concept of work, i,e.

$$W = \int_c F.dr$$

The concept of line integral is needed to define potential energy and also to define conservative vector field. Also the concept of line integral can be used as the basis to introduce surface integral for the students to learn about Gauss's Law in Electricity and Magnetism and also to be used in discusing Ampere's Law.

The cross-product is used to define angular momentum vector for a particle and especially for the angular momentum of rigid bodies and the corresponding concept of the moment of inertia.

For non-physics students the basic physics course should function as a strong foundation to the more advanced courses in the respective curriculum. The content and the sophistication of the mathematical background shold be adjusted to the particular need of the study programs served. The basic physics course should cover physics as shown in the paradigm discussed above. Mechanics as the most fundamental analytical tool to think about states interaction of a small number of macroscopic particles should be mastered well by the students since it is the foundation to the rest of physics. The interaction can be represented by the concept of force as the source of state change. Here the state of the system is represented by the concept velocity. In the case of conservative

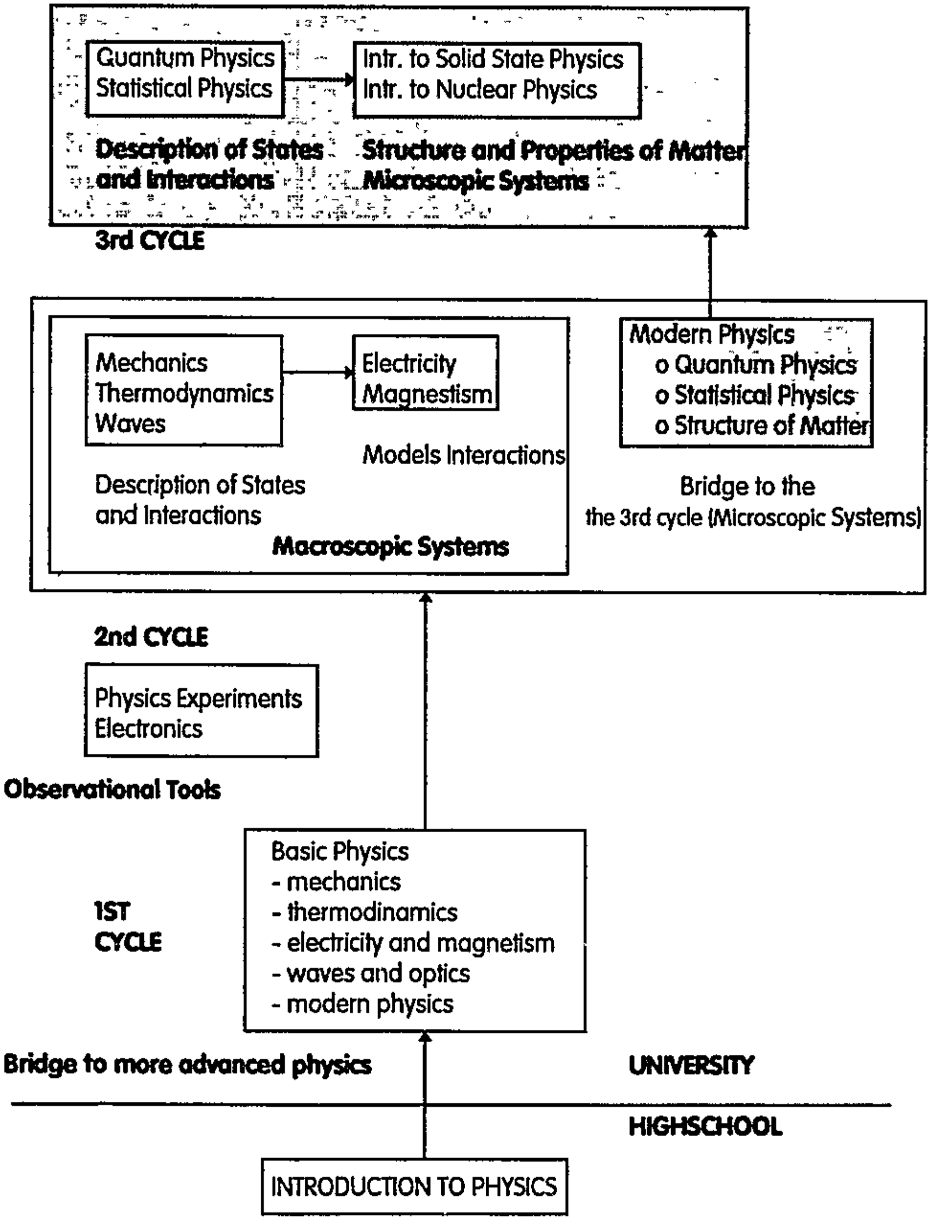

Fig. 2 Diagram of core curriculum for physics teacher education and bachelor in pysics

force field, the interaction can also be represented with the potential energy, when one uses energy as a description of state. Interaction can also be described by the concept of impuls, when momentum is used the state description.

The basic pysics course should include experiments in physics The function of the experiments is to give hands-on experiments with the various concept learned in the class-room or in textbooks. The experiments should also teach basic skills of using various techniques in experiments such as statistical processing of experimental data, the use various measuring apparatus, the techniques of measurements, etc. Finnaly experiments in physics should make the student feel the function of experiments in the scientific method in establishing the scientific truth. The experiments in physics should change the attitudes of the students with regards to scientific question about scientific truth claims.

For senior highschool the physics level should use minimum level of calculus, but vectors and vactor addition and subtraction should be used. Physics for senior highschool should enable the student to use physics concept to solve simple problems. The problems should serve as an illustration of the use of principles beside as exercise to think in physics.

The physics course in the junior highschools should function as the very first introduction to physical concept and principles. The stress should be on the conceptual aspect of physics rather than the use of physics as an intelectual excercise or excercise in problem solving. In this level of education the students should be introduced with concrete examples of concepts and principles, and should be related closely with concrete examples of concepts and principles, and should be related closely with their daily experience.

The instruction

The physics intruction in all levels of education is still far from the ideal situation as indicated above. In most cases physics is still considered as a diffiuclt and unintersting or boring subjects. Starting with the junior highschool physics the textbooks do not have good pictures or visual illustrations of the various concepts and principles in physics. Many of the teachers are not obsessed by physics, so that it becomes very difficult to impart the enthusiasm toward physics to students.

The effort by government in improving the quality of junior highschool physics teacher in the past has not been not very much. More attentions are being paid to the senior highschool teachers. At present the government is in the process to negotiate a world bank loan for the junior highschool education.

The effort of the government to improve senior highschool basic science education is relatively good. The effort to improve the teaching in the field basic sciences can be divided into two large groups. One is the in-service training, and the other is the preservice education. The in-service training for the teacher in the field is done through special programs. There are hundreds such centers in the country, one in every regency (kabupaten). The program has been going on for about ten years, but the effect to physics instruction in the country is still reamin to be seen.

For the pre-service training, the effort to improve the quality of the graduates in the physics education institution is done through curriculum improvement followed by massive training of the lectures. This program has been going on for about 6 years. The trainings consist of short term training (3 month) and pre-graduate training followed by graduate education (Master of Science program).

For the basic sciences (mathematics, physics, chemistry, and Biology) study programs in the faculty of sciences a special program to improve the quality of the graduates was set up about 3 years ago. The program was funded as part of a World Bank loan. The component of the program consist of staff development through overseas and domestic degree program, overseas and domestic short term training, provision of equipments, books and journals, technical assistance, and research award program. Other programs funded by ADB and bilateral adreements with several countries such as Australia, Canada, the USA, etc. has also been going on for several years. The Australian program include a scheme called the basic Science Bridging Program has been going on for about 6 years. The distribution of qualifications of the lecturers in the various physics departments is shown in figure 3.

It is seen that most of the PhD's in physics are concentrated at the University of Indonesia in Jakarta , Institut Teknologi Bandung in Bandung, and University of Gadjah Mada in Yogyakarta. In those places graduate education in physics leading to Master and Doctorate degree is also conducted.

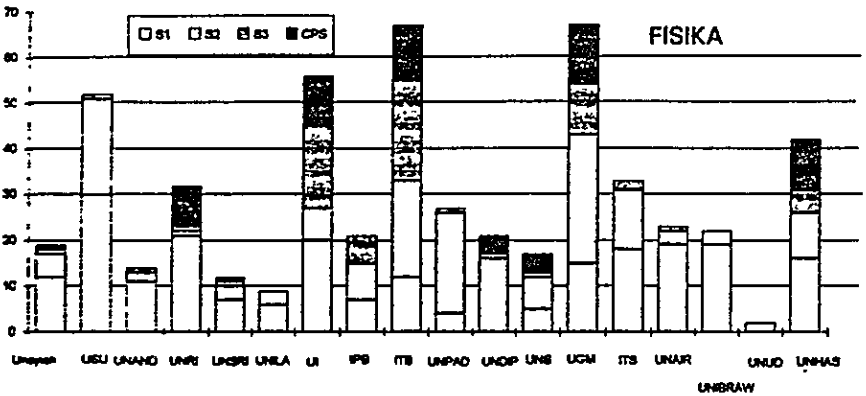

Fig.3. The distribution of lecturers in various physics departments .

Conclusion

Physics education in Indonesia needs to be developed so that quality instruction can be realized. Curriculum should be designed so that the core part will be compatible vertically, from the curriculm for junior secondary education to the curriculum at the senior secondary education, to the first year curriculum in the university, and even to the physics in the teacher education institutes, and to the education of physicists in Indonesia. Using a physics paradigm as discussed in the paper and using a spiral model of curriculum it is hoped that the compatibility problems between various levels of education can be minimized.

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ON SCIENCE AND MATHEMATICS EDUCATION
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BIOLOGY EDUCATION IN INDONESIA

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Sponsored by:

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Department of Education and Culture
Japan International Cooperation Agency (JICA), Indonesia Office
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BIOLOGY EDUCATION IN INDONESIA

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Abstract

It is a matter of facts that biology and science as well are not really socialized in Indonesia. This Dutch colonial legacy, however, must be changed. Some efforts toward a better academic environment had been done, and recently is beginning to have impact, especially in some recognized university in Indonesia. But, The more difficult and complicated problem which regard to science-literate among most of young Indonesian is remain a big problem. We discuss the problems and give some suggestions. We think, it is important way to see the real implementation problem and its' solvability, through an action research which is a collaborative works involving teachers.

1. Introduction

Biology was introduced to Indonesia by western people, namely Dutch and Englishman at about 200-300 years ago. They began with collections, identifications, and explorations of plants. Thus, biology in Indonesia was started with botany. A lot of well known biologists, in that era, worked mainly for agricultural purposes other than to increase their scientific credibility. They, however, succeeded to produce many famous biological conceptions, such as Wallace concep tion which is telling about the effects of territorial isolation to the specific determination between organisms living in Sulawesi and Kalimantan. As a matter of facts, this conception, later on, inspired Charles Darwin to works for his very famous evolutionary theory. We can also mention other famous botanists such as Jung Hun, Backer, and van Stenis who become famous due to their scientific works over Indonesian islands. Later on Du Bois, an archeologist, found important humanoid fossils. His finding brought Java island to become a well known place in the world where we can possibly trace human origin. All of these showed that the Indonesian Islands is the prosperous place preserving data which might elucidate many biological mysteries. In Indonesia, biology in the past, however was the privilege for Europeans people who predominate by Dutchman. Only a few, if any, the participation of the color people including native Indonesians on the scientific works. It means that, during the Dutch colonial era, biology was not really socialized to the Indonesian. Thus, reasonable that the frequency of biological researches and explorations were much reduced after the end of Dutch colonial era. This cultural impacts remained to continue in the past 50 years, in facts, very few internationally published biology articles were written by Indonesian scientist. Neither new recognized ideas nor reexamination of old ideas (developed by Dutch scientist) had been produced by Indonesian.

This poorly academic climate in Indonesia, however, must be improved. A short term program, and might be simpler and easier to do is improvement program at the university level. In the past 40 years, efforts toward better academic quality had been done by sending young people to study abroad. The priority was given to the people willing to study natural sciences including mathematics and technology. Recently, the government also had pay much more attention by boosting research funding, support for the developed institutional building process given to many research institutes and universities in order to stimulate much better academic environment as well as to achieve a critical mass of scientists and facilities for better research capabilities. These efforts are beginning to have impact, especially in some universities at Java. Some good scientific publications written by Indonesian had already seen in some recognized scientific journals.

The more difficult and complicated problem facing by Indonesian community is due to poor (scientific-literacy) among most of young Indonesian people. Their poorly motivation and enthusiasm to science especially natural science and mathematics must be well improved in order to prepare people to lead personally fulfilling and responsible lives. This might be a long term program covering almost all aspect of education system which may difficult to implement in the field toward conducive and effective teaching. We are aware that this is a very hard work facing to huge and complicated problems ranging from the low quality of teachers to the lacking of facilities and inadequate evaluation programs. It seem to be useless to provide all of biological materials to the students, we must select the materials which only considered to have impact to the better Indonesia's future (sustainable development and secure in a world torn by hostilities including pest and diseases). The biological curriculum itself must be emphasized and explaining the dependency of living things on each other and on physical environment. The biology education should bring the student to respect for nature, and should well inform 'with interdisciplinary view' to the compassionate uses of technology to ovoid destroying our life.

The presence paper tells about the biology education in Indonesia: its definitions, function (and goals) of the national curriculum, and its implementations. We also offer some ideas, which is, in a part, inspired by our research finding.

2. Biology Education and the National Curriculum

Since the 1994/995 academic year, Indonesian schools use the 1994-curriculum. In this new curriculum biology is taught as separate compulsory subject beginning at the first grade of junior high school until the second year of senior high school. The students will choose their emphasis at the end of the second year. Biology will be learned only by third year students who choose mathematics and science (MIPA) emphasis.

The curriculum for the biology education is developed centrally by a committee pointed to do the job. The member of the committee comes from different institutions, however their names have never been written in the published curriculum. The "given" biology curriculum then become the guidelines for biology teachers and supervisors to be implemented in the classrooms. As compared with the 1984-curriculum, the 1994-curriculum is simpler and more flexible. The teachers will have more opportunities and flexibility to suit the materials and teaching-learning strategies to local conditions and situations (Isponida, 1994).

Biology education in junior high school is the enlargement and deepening of science taught in elementary schools. It studies the interaction pattern of natural components and the human efforts to preserve their existence on earth. At the senior high school level, biology education is defined as study of living organisms and their living aspects in the past as well as at present. It studies also the application of biological concepts for daily living in technological development.

The function of biology education in 1994-junior high school curriculum is as follows:

- to give knowledge about the natural environment
- to develop skills, insight and technological awareness related to its usage in daily living
- to be able to serve as prerequisite to continue to the senior high school level
- to improve the awareness of the power of almighty Creator

The function of biology education in 1994-senior high school curriculum is to help students for the following :

- understand biological concepts
- develop scientific attitude in daily lives problem solving
- use and develop process skills in studying biological concepts
- apply biological concepts and other basic in technological development
- prepare to continue to higher level studies
- develop awareness of the importance of preserving natural resources and living environment

3. The Teaching and Learning of Biology in the Classroom

The educational background of biology teachers are various. Most of the junior high school teachers (60%) got a diploma degree (D1 and D2), and some have bachelor (S1) degree (30%) (Winarno et al., 1994). Our study showed that over 353 high schools in East Java, have nearly 60% teacher who teach biology are holding S1 degree in educational biology. The rest are either holding diploma degree (43%) or S1 degree in pure biology (5%) (Susilo et al., 1993).

In general the biology teachers have low motivation and enthusiasm to develop their knowledge in biology. Most of them use only one or two the biological textbooks to prepare teaching in the classroom, Susilo et al., 1993). In the last decade there have been tendencies that more and more biology textbooks have been written. A survey in big book stores revealed that for junior as well as senior high school level there are more than 10 sets of biology textbooks with very little diversity in the way discipline is presented to students. All of the books was written based on the curriculum guidelines with the exact sequence, other wise the books will not be sold out. It is common that teachers might assign a book as a compulsory textbook for students, or let the students use any book they want to read.

Lesson plan construction for each topic is compulsory for the biology teachers. This duty is felt as administrative work. To ease this responsibilities during the last decade the biology teachers work together within a program called PKG (Pemantapan Kerja Guru) whose main issue was the teaching learning process. PKG was seen as the sources of information for teaching and learning process. PKG often proceeds workshops where innovations in biology education, and sharing experiences can be done. Unfortunately, there is a tendency that the teacher serve as a "machine in teaching and learning biology, they do what is written in the "common lesson plan" produced through PKG's workshops.

Therefore we might remained to find similarities or uniformity in biology teaching and learning process for certain topic in a region (municipalities and/or districts). Usually the biology teachers has no time to develop their further creativities in teaching and learning biology outside what is written in those lesson plans. Most of teachers are not used to serve as a model of "curious learners" for their students. They are not knowledgeable about current issues and problems. They are not effective in seeking ways to encourage student curiosity and to follow up on it which may rise the interest of student to study biology in class. Seem likely, teachers feel not necessary to discuss materials related to the students, because these things will only "wasting time" while they have to finish the targeted curriculum.

There also a tendency that the biology teachers work as a transmitter or disseminator of biological knowledge, mostly with lecture methods with references that all topics should be covered before the end of the school year. We do not know exactly the percentage of biology teachers who conduct the demonstration or laboratory works if the lesson plan suggest to use those methods, but our teaching experience at the university, showed that most of our first year students reported that they never work in the laboratory before entering college. There should be investigations about the usage of science laboratories in Indonesian schools which may answer the question: How much does it's contribution to the understanding and improving laboratory skill of the students ?

In Indonesian schools, students tends to be recipients of what the teacher dictates or lectures. According to Samsuri (1994), the students tends to feel that they have not learned the materials unless the teacher explain the materials in front of classroom. It means that the students have high dependency to learn biology on the teachers presentation and activities, they tend to prefer to listen and take note. Ironically, the teachers conform to their students' requirements by lecturing to them. So there is a tendency that students are seen as what Yager and Tweed (1994) called "necessary evils", as recipients of the teachers's teaching, as challenges for the teacher to break into, as clay to mold.

Finally, in conclusion, although the curriculum suggest that the teachers should based their teaching learning process on "student active learning" (CBSA: Cara Belajar Siswa Aktif), there is no indicators that students really learning actively by internalizing activities and engaging in classroom dialogues. As the consequent, most of the students do not have good habit of looking up new information from a variety of sources. When there is question, during assessment, most of the students tend to find direct answers for their problems. They used to only replicate the assigned information recalling what have been presented to them. We felt that typical assessment do not facilitate development of creativity skills nor positive attitudes, most often limited to successful recall of information presented by teachers in the class. We convince that this habit is difficult to be change, and remain to continue in the university biology education.

4. Suggestions

We have to try to choose major concepts and processes necessary to be developed in high school students like what Wivagg (1989) said that 'certainly courses should change as new information becomes available, but continued expansion is unwarranted and eventually impossible'. In order to do that we should ask our self what the "take-home message" of our courses should be, what do we want biology them to have as the "big picture" of what biology is all about. Our courses and text should create an understanding of the major ideas at the expense of completeness. Recommendations of project 2061 in the United States to the areas of Biology that should be the most emphasized in high school course are diversity of life, heredity, cells, interdependence of life, flow of matter and energy, evolution of life, and the human organism (to include human identity, life cycle, basic functions, learning, physical and mental health) (Leonard, et al., 1991). The students then should realize that biology system is complex obey the physical and chemical laws. It can be understood by interdisciplinary approach.

Of course, there will be a very "hard work" in changing the role of teaching from being a "machine" to a really "professional teachers" because it relates to their philosophy of teaching. We should try to find ways how to change their perceptions (Philosophy, rationale, believe system) of science teaching including commitment to human welfare and progress; how to change them to become "model learners" who are eager to know and find new information, current issues and problems in biology, who are a life learner themselves.

We should improve communication among biology teachers, biology educators and scientists (biologists) in improving the biology education in the country. We need better coordination in preparing better in service training as well as preserves training for biology teachers. In near future, may be a good idea, to have a collaborative action research between biology educators and biology teachers on problem they both seen as necessary to be solved together. According to Hopkins (1993), undertaking research in their own and colleagues classroom is one way in which teachers or lecturers can take increase responsibility for their action, and create a more energetic and dynamic environment in which teaching and learning can occur. This is usual for lectures at the university where education or teaching must be done concomitant with research activity. The students, then, can learn not just by hearing but be able to see how their lectures do and develop knowledge stand alone with academic attitude.

There needs to be more emphasis upon the quality of how biology is to be taught. We may consider the recommendation for science teaching in project 2061 which originally for American (in Leonard et al., 1991). In general the recommendations are as follows:

1. To ensure the scientific literacy of all students, curricula must be changed to reduce sheer amount of material covered.
2. To weaken or eliminate rigid subject-matter boundaries
3. To pay more attention to the connection among science, mathematics and technology
4. To present the scientific endeavor as a social enterprise that strongly influence - and is influenced by human thought and action
5. To foster scientific ways of thinking

Finally, we must provide facilitation such as biology teacher journal which can be access by teachers. This will facilitate teachers to improve their knowledge as well as to share their experience to each other.

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INTERNATIONAL SEMINAR
ON SCIENCE AND MATHEMATICS EDUCATION
(Comparative Study between Indonesia and Japan)
Jakarta and Bandung: July 3-7, 1995

BIOLOGY EDUCATION IN JAPAN

by:
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Sponsored by:

Directorate General of Higher Education
Department of Education and Culture
Japan International Cooperation Agency (JICA), Indonesia Office
Bandung Institute of Teaching and Educational Sciences (IKIP Bandung)

BIOLOGY EDUCATION IN JAPAN

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Since olden times, neighboring countries as well as Indonesia had influenced cultures on Japan. Especially, agricultural Japanese had been interesting in imported fruits, vegetables and medical plants. Agricultural knowledge's become high level on Japan. And also by the Dutch collectors of medical plants, Japan medicine attended to European level under the apprentice system in Japan, before Maji age.

Subjects on natural science appeared first in school education in Japan, after the Promulgation of School Ordinate in 1872. At that time, physiology and natural history as well as physics and chemistry, had exsited instead of science. With the Promulgation of Elementary School Ordinance in 1886, the subjects were abolished from the elementary school curriculum. The subject called Science was used in place of the abolished subjects. Through the course, natural science subjects were integrated under the subject named science. With the introduction of science as a subject, the relationship between life and science was emphasized. Course contents focused on nature and natural phenomena which children experience in daily life. Moreover, technological advances brought about by science, such as the use of machines, equipment's and other instruments that facilitate life, are also learned. Then, through the many time of reforms (1900, 1909, 1911, and 1919), the contents of science education and the grade level where science subject will be taught were slight modified. The basic policy, however, had not changed until the National School Ordinance was enforced in 1941.

Through teenage of twenty century, the theory of evolution was spreaded by Darwin, on all over biological world and also on Japanese society. The concept of ecosystem was settled and the experimental morphology was already started. But, the Mendelian heredity was not yet rediscovered on USA, only on Japan but also on all over the world.

At the Second quarter century, brilliant many scientific discoveries had been succeeded by a few scientists, majority of the people did not become aware to such impotency that covered with the first and second world wars. From the ruin of a school library by bombarding fire at may 1945, a boy found out a volume of Modern Physics 1938 that was a special issue of Biophysics. He knew existence of gene that was described with the appearance probability. The probability conserves through the hybridization and the segregation without the mutation nor the selection. N. Bohr admired the Mendelian expression at fifty years before, and developed the eigen function of the particle and of particle system. Conversely, from the mutation probability induced by X ray, cross sections of genes had been estimated. It was predicted that genes are larger molecule of which molecular weight is higher than that of enzyme protein related with the heredity phenotype. Such facts were too far from the science education curriculum, it seemed to go back Maiji age.

After the promulgation of the National School Ordinance, science and mathematics were integrated as Science Math Course. Science was designated as part of the Science Math Course. Further more, Science in the lower grades: 1st to 3rd grade of the elementary school, dealt mainly with observation of nature. This was a remarkable event in the history of science education in Japan.

The Course of the Study after the war has changed as follow, Science for Daily living, Systematic Science, Inquiry Science. Especially on biology education, the revision (1968) was aimed to obtain the following objectives: to fill the gap between recent natural science natural science and school science, to rear pupils who will become scientists and technical experts, and to teach fundamental scientific concepts. In 1977, Pollution problems protection of environment and investigation on what makes up a well-off society were add as topics for learning. For too much contents, selection was done based on the following : enjoyable activity, high regard for direct experience, and rearing and development of creativity.

The standard of science curricula prescribed in the course of study is a characteristic of science education in Japan. As a result, standard science education is guaranteed for all students in the country. With this system, it is also possible to provide a uniform science education nation wide.

And the promulgation of the for the Promotion of Science Education in 1953 is unique. Under this law, for the administration of school, half of the expenditures for facilities and equipment needed for science education has to be subsidized by the government. The list of laboratory facilities, needed instruments, apparatus, specimens, models and so on were examined thoroughly and were proven substantial whenever the course of study is revised.

Now, the biology education in Japan is based on Interrelation of Science Subjects and School Hours.

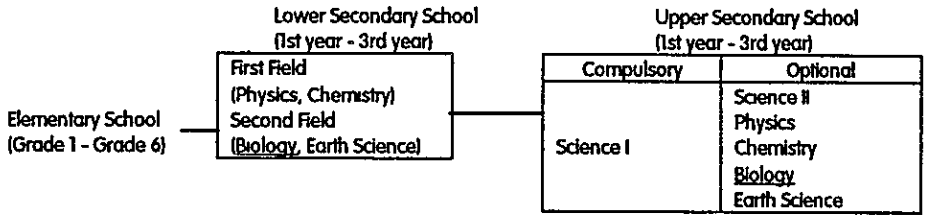

Figure 2-2 Interrelation of Science Subjects in Elementary School. Lower Secondary and Upper Secondary School

Table 2-3 Number of Yearly School Hours in Elementary School and Lower Secondary School

	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6
Elementary	68	70	105	105	105	105
Lower Secondary	105	105	105			

* One unit of School hour shall be 45 minutes in Elementary School and 50 minutes in Lower Secondary School

Table 2-4 Standard Number of Credits for Upper Secondary School

	Subject	Standard No. of Credits
Science	Science I	4
	Science II	2
	Physics	4
	Chemistry	4
	Biology	4
	Earth Science	4

* One unit of school hour is 50 minutes and 35 school hours constitute one credit

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INTEGRATED SCIENCE AND EARTH SCIENCE EDUCATION IN JAPAN

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Sponsored by:

Directorate General of Higher Education
Department of Education and Culture
Japan International Cooperation Agency (JICA), Indonesia Office
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Integrated Science and Earth Science Education in Japan

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Recently, Monbusho (Ministry of Education, Science and Culture of Japanese Government) has revised the Course of Study for upper secondary schools. the purpose of the present revise is to properly educate the new generation who will lead in the 21st century. The revised Course of Study put into effect year by on year from the first year classes beginning in April 1994. In the subject area of science, the following subjects are required of all upper secondary school students regardless of course, namely; one subject each from two subject groups of the following five: 1) Integrated Science, 2) Physics IA or Physics IB, 3) Chemistry IA or Chemistry IB, 4) Biology IA or IB, 5) Earth Science IA or Earth Science IB. The standard number of credits is 4 in the subject with IB and 2 with IA. In Integrated Science, however, the number of credit is 4. The Course of Study prepared each field of Science with II, Phisics II for instance, as the optional subject with the number of credit 2. The course Content of the Integrated Science is shown in Table I.

Concerning Integrated Science, we faced to serious problems at the beginning of this new reform of education. Most of the problems, however, were already expected by persons concerned. One problem is that students in general courses do not major Integrated Science as an optional subject. Other problems are difficulty to edit the textbook in accordance with the scheme of the Course of Study and the lack of commercial base for textbook publishers.

In Japan, textbooks must follow the procedure of authorization, adaptation, and others before they are actually used. The draft textbook of Integrated Science edited by one of the experienced leading publishers was refused by the Textbook Authorization and Research Council of the Ministry. Another word this draft textbook was not adopted to the Ministry's guideline. Therefore, students who majored Integrated Science in 1994 and 1995 do not have any authorized textbook. Monbusho already expected this situation and tried to edit Teacher's Guide of Integrated Science in 1993. Professor Shimozawa and myself joined to the Editorial

Committee of this Teacher's Guide and supervised editorial works of the gudiebook. This Teacher's Guide was published by Monbusho in March 1994. During the editorial works of this guidebook, Monbusho urgently amended the original editorial guideline and planned to include subjects, which can also be used as the required reference book for students.

Another reason of unpopularity of Integrated Science among students is related with the subjects of university entrance examination. Each university and junior college selects its entrants according to its own admission procedure, using scholastic tests and other means. As one of the scholastic tests, a standard nation-wide test called the NCUEE (National Center for University Entrance Examination) examination is conducted in January every year.

The Content of the Integrated Science is shown in Table I

Table I Content of the Integrate Science

(1) Investigation of nature

a. Recognition of nature
b. Planning of observations and eksperiments.
c. How to arrange and report the results of observations and experiments.

(2) Nature and common features in nature.

a. Variety and common features in nature
b. Changes, equilibrium and interaction appearing in nature
c. Energy and its conversion

(3) Human being and nature

a. Natural resources and/or energy and their usage.
b. Environment and its protection.
c. Progress of technology and its benefits

(4) Training in special topics

a. Training in special topics
b. Investigation of the environment.
c. Reinvestigation of experiments in the context of the history of science.

Points for Special consideration in deatling with 'Contents' (1)

Consideration should be given to the following items in organizing and dealing with 'Contents'.

All national and local public universities make use of this examination. Integrated Science is included as one of the science subjects in this NUCUEE, however, most of the universities already officially announced that the second-stage examination does not require Integrated Science. Furthermore, requirement of subjects for entrants who wish to enter Faculty of Science, Industry, Medical Science, and other science courses in most of national universities is restricted to Physics, Chemistry or Biology. Integrated Science and Earth Science are excluded from entrance examination science subjects.

Table II shows the adopted numbers of science textbooks in 1994 and 1995. This statistic shows the tendency of students' interest for subjects of science.

Table II Number of Textbooks Adopted

	(1994)	(1995)
Physics IA	131,102	237,915
Physics IB	109,081	444,364
Physics II	0	25,244
Chemistry IA	275,566	456,817
Chemistry IB	735,735	1,071,252
Chemistry II	0	49,277
Biology IA	260,639	348,191
Biology IB	528,545	963,657
Biology II	0	21,304
Earth Science IA	77,293	98,961
Earth Science IB	57,089	128,355
Earth Science II	0	1,720

The exact number of students who took Integrated Science is unclear because students do not have any authorized textbook of Integrated Science. According to the Upper Secondary School Division of Monbusho, approximately 50,000 students major the Integrated Science course in these years. This small number means less than 1% in the total number of students in upper secondary schools. This also shows that Earth

Science and Integrated Science are minor subjects among the upper secondary school students in Japan.

Professor Shimozawa and myself also participated in the committee to prepare the Course of Study in science Education of Monbusho and gave guedance and advice to the committee. Characteristics, aims, and themes of Integrated Science, all members of this committee believed, are suitable and proper subject to comprehend common knowledge in science, particularly in environmental science as a general Japanese citizen in the 21st century. Content of Integrated Science in Teacher's Guide consist of "Umbrella," "Package," and "Module, " which imply stratified concept. Important umbrellas include the following major contents such as : 1) Inquiry of Science, 2) Change in Natural World, 3) Humankind and Nature, and 4) Subject Research. Each umbrella includes several packages consisting of concrete modules of laboratory investigation, observation, interpretation, research, and others.

Earth Science education in upper secondary schools are treated with the same level with other basic sciences, however, this is also minor and unpopular subject among students. Earth Science education cannot be overlooked as basic and applied natural science including the prevention against natural disasters, preservation of environment, and exploitation of natural resources. As you perhaps know, our country has seriously experienced the mentioned problems. Your country is still favored with beautiful nature and some kinds of natural resources, so far as I know, but according to our experience, destruction of nature and exhaustion of natural resources are rather easy and very rapidly progress.

Let's grow together with Science Education!

Terima kasih.

INTERNATIONAL SEMINAR
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INTEGRATED SCIENCE COURSE IN INDONESIAN SCHOOLS

by:
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PPPG IPA Bandung

Sponsored by:

Directorate General of Higher Education
Department of Education and Culture
Japan International Cooperation Agency (JICA), Indonesia Office
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INTEGRATED SCIENCE COURSE IN INDONESIAN SCHOOLS

Hadiat

PPPG IPA Bandung

I. INTRODUCTION

Since 1968 biology and physics subjects at Primary Schools (SD) have been changed into integrated science course based on the curriculum. In the mean time, science teaching at Junior Secondary School (SMP) is done separately into biology and physics subjects, while at Senior Secondary School (SMA) into biology, chemistry and physics subjects. Earth science was taught separately, either at SMP or at SMA.

In 1962-1972 there was an effort to integrate biology and physics subject into general science course (IPA). The first step of try out was done at SMPN III Bandung. Beginning from grade 1, general science course was introduced. Topics were organised correlatedly. The first topic might be correlated with physics, and the next topic was correlated with biology. In grade 2 students continue learning science course. Then, try out was also continued in grade 3.

The Course which has been tried out was improved based on the input from the try out. Then it was disseminated and implemented at other schools in West Java. Dissemination was done step by step. Finally all SMPs in West Java implemented integrated science course, instead of separate course (biology and physics).

Based on science teaching at SMP in West Java, there were two kinds of curriculum; science teaching curriculum for West Java province, and biology and physics teaching curriculum for provinces outside West Java.

There was an impact of science teaching in West Java on the school report book. Biology and physics subject in the report was changed into IPA. Schools which taught physics and biology separately instead of IPA, put the combined physics and biology marks into the report book.

In 1975 all school curriculum was changed. Science course at SD was still implemented but with better structure, and the topics were more integrated. Based on 1975 curriculum science course at SMP in West Java was changed again into separate subjects i.e. biology and physics. The main reason was because almost all science teachers at SMP had only one qualification, as biology teacher or physics teacher. Generally physics teachers were not able to teach biology and vise-versa. Besides, text books issued by the government (PUSBUK) were biology and physics books. However, although the students got science as separate subject (physics and bilogy), their achievement in school report was called science course (IPA). The students got the science report-mark from the combined physics and biology marks.

Science teaching at SMA is still separated as biology, chemistry and physics. However, there is an effort to integrate them. Physics teaching supports biology teaching and vise versa. Another effort for integration can be seen at the topic which is called daily chemistry.

In 1984 the school curriculum was revised and adjusted with students need. The revised curriculum was not very different from the previous one.

In 1994 the school curriculum was changed again. It was called the 1994 curriculum. Science curriculum at SD is more integrated because concepts in one topic are correlated and the topics are integrated. Besides, concepts in technology is also added. Science curriculum at SMP is still seperated into biology and physics. Science curriculum at SMA is also separeted into biology, chemistry and physics.

In general, SD science curriculum, SMP biology and physics curriculum and SMA chemistry, biology and physics curriculum has the following characteristics: 1) several topics can be developed in accordance with local environmental, 2) technological components are integrated, 3)environmental education components can be developed. Based on those charasteristics, the integration of subject material is possible in accordance with the current curriculum.

II. INTERPRETATION OF THE MEANING OF INTEGRATED SCIENCE.

There are many interpretations of integrated science as follow:

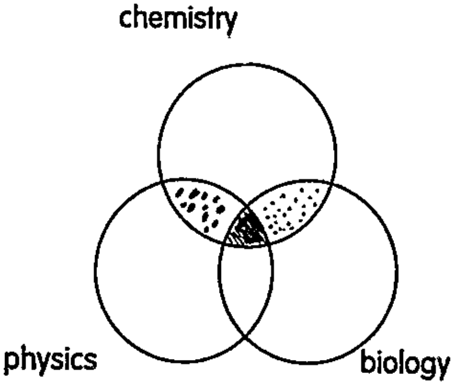
a. Integrated Across Science Subject Area.

One topic is studied from various aspects of biology, chemistry and physics. Biology, chemistry, and physics teaching are developed from the main aspect.

Example:

Rice plant can be studied from various aspect of biology, chemistry, and physics. From the biology aspect, students learn plant morphology and plant pest. From physics aspect students learn temperature, energy and soil physics. From chemistry aspect students learn ion exchange in soil and elements needed by rice plant.

Briefly, integrated pattern can be described as follows.



It is difficult to implement integrated science course pattern in SMA because there is a tendency that if that approach is used, physics, biology and chemistry subject will be superficial. Besides it, the structure of knowledge becomes vague.

If this pattern of Integrated Science will be implemented in SMA, the students should do the project in a special time and finalize it as an extra curricular activity. This kind of activity is very good for the students to practise problem solving comprehensively.

Chemistry, biology and physics subjects should be programmed seperately but correlation among the subjects should be considered.

b. Integrated Topic Center

Some concepts or subtopics in one topic are designed correlatedly. The type of this integrated science can be seen in SD science curriculum.

WATER

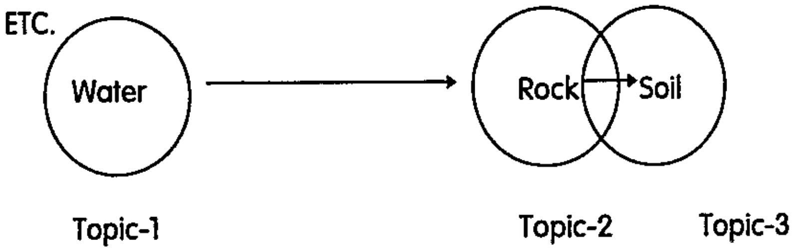
Volume and weight of water, water surface, water flow, solution, water pressure, water absorpsion, changing of state of water, usage of water movement, floating, drifting, sinking.

ROCKS

Some kinds of rocks and its use, characteristics of rocks, and rock demineralisation.

SOIL

Parts of soil, soil fertilization, erosion.



The type of integrated science shown above can be seen in Scotch Integrated Science project.

c. Correlated Topics

Another interpretation of integrated science is massive correlation between one topic and the other. Teaching material can be designed separately. Biology is designed separately, and so is physics. This type can be found in SMP biology and physics curriculla.

Example:

The topic of sense organ is taught at the end of the third threesemester (cawu III) in grade 2. Topics of sound and light are taught in paralel time. In this way, the students can see the correlation between the topics. However, this kind of integration has many weaknesses because each topic is taught by different teacher. So the integration really depends on the cooperation of the involved teachers.

d. Integrated Across Subject Area

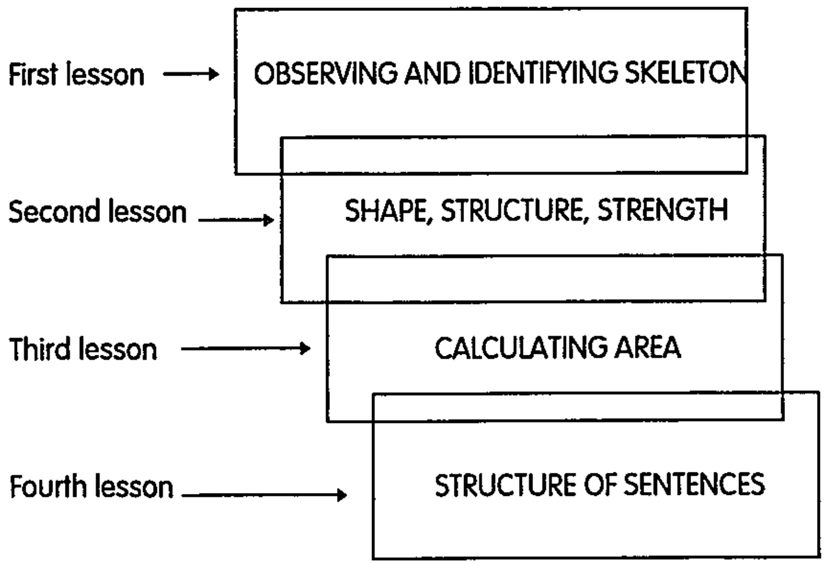
There is a tendency to integrate science, mathematics, language, even art teaching. At SD this is easy to be implemented because one teacher teaches all the subjects.

So, integration is not limited in biology, chemistry or physics only, but also across other subjects.

Example:

Grade IV, SD

First Threesemester (CAWU -1)



Students activities can be designed as follows:

Students observe the skeleton. Then the students may say that the shape of rib bone is curve, and skull bone is curve. After that, problem can be presented to students. 'Does the shape affect the strength?' Students do the activity to observe it. The activity can be continued to observe the effect of the size to the strength. The next lesson is calculating the width of objects which are used in the activity to observe the effect of size on the strength. Students will get a better motivation when they study by using familiar objects.

Next lesson is Indonesian language about the structure of sentence. Students report on the activity above can be used. So the teacher use the sentences in students report for discussion. At the end of the lesson, a teacher can ask students to correct the sentence in their report. In this way, the students learn from their own mistakes. The result is usually better and the students can remember the lesson longer because there is a high intrinsic motivation.

Based on the example above, we can define integrated science as follow.

Integrated science course is organising teaching materials in such a way that there is a correlation and integration among concepts/subtopics. This correlation may occur among concepts in one topic, across topics, even across subjects.

III. WHY INTEGRATED SCIENCE?

Some reasons why integrated science approach is considered a good approach, especially in primary education level (SD), are as follow.

a. Problem is a product of various aspects.

Problems which occur in our daily life are usually a product of various aspects. So one problem is correlated not only with biology or physics but also with other subjects, even with social factors. Therefore, problems could only be solved through understanding of many as-pects integratively. For example: water polution problem.

This is not biology problem only or chemistry problem only, but also correlated with many other aspects including people attitudes.

Therefore integrated science approach gives chances to the students to see and feel that science course at school is not a strange thing because it is correlated with nature phenomena in their environmental. The more correlation between science course and nature phenomena the more intrinsic motivation occur in the students.

b. Aspect of Learning theory

Based on the learning theory point of view, teaching does not mean pouring knowledge to student's mind, but it's an activity to provide new experience which is correlated with students' knowledge. Correlation between new experience and students' knowledge makes the students modify and reconstruct their knowledge. When correlation between concepts occurs more, the student will be more active to reconstruct and develop their own knowledge. Thus there will be a harmony between new experience and their knowledge. If this happens, it means that the students have learned.

Below are some theories presented by some experts which correlate with learning.

1. Ausubel (1968): The most important single factor influencing learning is what the learner already knows; ascertain this and teach him accordingly.
2. Wittrock (1974): find the meaning and concepts that a learner has already generated from his or her backround, attitudes, abilities, and experiences and determine ways of so that the learner will generate new meaning and concepts that will be useful to him or her.

   The emphasis on the learner having to actively construct or generate meaning is one we have found expecially useful in thinking about, analysing, and planning science teaching and learning.
3. Piaget considered that knowledge is constructed by the individual as he or she acts on objects and people and tries to make sense of it all.

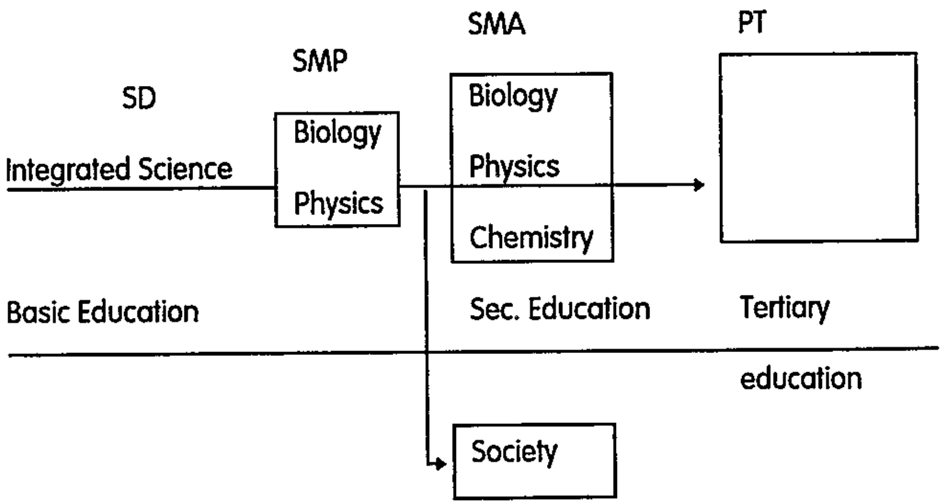
Those are some theories which support the statement that effective learning process can be achieved if there are many correlations among concepts, and correlated to the knowledge known by the students.

IV. IMPLEMENTATION OF INTEGRATED SCIENCE AT SCHOOL

a. Implementation of Integrated Science at SD and SMP

Integrated science at SD has been implemented since 1968.

A pattern of integrated science teaching is as follow.



Science teaching at SMP is designed separately into biology and physics. Earth science element is integrated into physics and it is taught by a different teacher.

An effort to correlate both subjects (biology and physics) can be seen in the curriculum. For example, teaching sense organ is followed by teaching sound and light.

However, sometimes the correlation between both subjects can not be achieved because the subjects are taught by different teacher.

The main reasons why biology and physics teaching is separated are as follows.

a) Usually the teachers at SMP are qualified in one science subject only, i.e. biology or physics. Therefore biology teacher will teach biology more easily than teach physics.

b) The available books are biology books and physics books.

Considering compulsary education until the age of 15 (end of SMP) and education at SMP is a part of basic education which should be followed by all students, biology and physics teaching should be designed as science education for all. Science education is for all students with various abilities. Therefore it would be very good if biology and physics teaching at SMP is integrated as Integrated Science teaching. At least it should be organized as Correlated Science.

b. Integrated Science at SMA

Implementing integrated science approach at SMA is very difficult because biology, chemistry and physics subjects will become superficial. Therefore science teaching should be done separately. However, in every subject there should be some topics which integrate the three subjects.

Example:

Food topic from biology subject can be discussed by integrating energy topic from physics and the topic of molecule structure which forms the food (topic from chemistry). Thus students can apply their knowledge in a new situation. It means the students have a chance to reconstruct and develop their knowledge easily.

There is another effort to implement integrated science approach at SMA by designing teaching module correlated with problems in society. It is called Science, Technology and Society. PPPG IPA has developed some modules to integrate students' knowledge. For example:

AIDS, GLOBAL WARMING, RENEWABLE ENERGY, USING ENERGY AT HOME, DOMESTIC WASTE, WIND ENERGY, POLUTION, etc.

Those modules are discussed when teaching biology, chemistry, or physic. So the teacher does not need a special time. In this activity the students have a chance to practise solving the problem with integrative science knowledge.

V. TEACHER PROBLEM

Implementing integrated science at SD does not happen automatically although science curriculum has been organized in a form of integrated science. It depends on the teachers who are involved in it because the teacher should organize it based on the school condition. Thus implementation of integrated science at school depends on the process of preparing teacher at IKIP. IKIP students who will be teachers should have experiences to organize integrated science. They should also have experiences to learn with integrated science approach.

Implementing integrated science at SMP will be more difficult because SMP has subject matter teachers. Generally SMP teachers has qualification as biology teachers or physics teachers. If their qualification is science teachers, implementation of integrated science will be easier and better. Beside that, the teachers should have an experience to organize subject matter in the form of integrated science. They should also have an experience to learn through Integrated Science approach.

The above problems are inputs for IKIP. IKIP should provide learning program for their students and provide teaching practise using Integrated Science approach.

VI. EXPECTED QUALIFICATION OF TEACHER

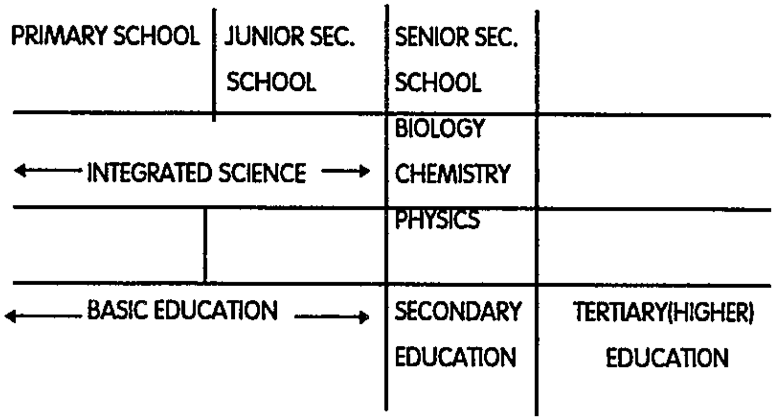
Educational act No. 2, 1989, section V, clause 12, paragraph 1 & 2 stated:

(1) Education level which is included in school education line consists of basic education, secondary education and higher education.

(2) Besides education levels mentioned in para 1 above, preschool education can be carried out.

The goverment has implemented compulsary education until the age of 15. It means that Indonesian citizen should at least follow basic education.

Therefore education at SD and SMP should be in the form of education for all students who have various abilities (education for all). Thus biology and physics teaching at SMP should be changed into Integrated Science teaching program.



Basic education level has (a) different characteristic compared to secondary education. Therefore it is the time to consider the preparation of teachers for basic and secondary education. Basic education teachers (SD, SMP) should master the methodology of science teaching. They should also understand the psychology of learning. Secondary education teacher should master one of the science subjects (physics, biology or chemistry) plus minor programs in another science subject.

VII. CONCLUSION AND SUGGESTIONS

1. Although Integrated Science curriculum has been implemented at SD, it still should be developed and designed better so that the correlation to students experience become higher.
2. Regarding compulsary education until the age of 15, students should follow all basic education level. Therefore physics and biology curriculum at SMP should be modified into science education for all. Integrated science approach can be implemented.

3. Regarding the importance of integrating biology, chemistry and physics teaching at SMA, students should do some projects which reflect the integration of some science subjects. It is very important to understand the problems related to science which arise in the society. The problem is not a one sided problem, but it is correlated to various knowledge.
4. Basic education level and secondary education level has a different charastericitic. Therefore two kinds of teacher's qualification are needed. They are teachers for basic education (SD, SMP) and teachers for secondary education (SMA).
5. For the sake of developing and implementing Integrated Science approach at school, a continuous research to develop Integrated Science course continuously at school would be necessary.

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INTERNATIONAL SEMINAR
ON SCIENCE AND MATHEMATICS EDUCATION
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SCHOOL SCIENCE

by:
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Sponsored by:

Directorate General of Higher Education
Department of Education and Culture
Japan International Cooperation Agency (JICA), Indonesia Office
Bandung Institute of Teaching and Educational Sciences (IKIP Bandung)

SCHOOL SCIENCE

Niida Satoshi
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Pada makalah ini akan disampaikan bagaimana perbandingan kondisi mata pelajaran IPA yang diberikan di SD, SMP dan SMA antara Jepang dan Indonesia.

Perbandingan tersebut lebih jelas akan dipaparkan pada tabel di bawah ini.

Yang termasuk di dalam mata pelajaran IPA pada makalah ini adalah Fisika, Kimia, Biologi dan Ilmu Bumi. Di Indonesia mata pelajaran ilmu bumi di SD tidak diajarkan, akan tetapi isi materi ilmu bumi pembelajarannta di selipkan pada mata pelajaran IPA yang lain.

Selain itu, mata pelajaran tentang lingkungan disampaikan tidak secara khusus.

1. Keadaan IPA di SD

Tabel perbandingan materi pelajaran IPA untuk murid di Jepang dan Indonesia.

	Kelas III		Kelas IV		Kelas V		Kelas VI		Keseluruhan	
	Jepang	Indo	Jepang	Indo	Jepang	Indo	Jepang	Indo	Jepang	Indo
Fisika	40	10	25	30	20	60	20	50	±30	±35
Kimia	0	0	5	10	10	0	20	0	<9	<2
Biologi	40	50	50	30	50	30	30	40	±40	±40
Ilmu Bumi	20	20	20	20	20	10	25	10	±20	±15
Lain-lain (Lingkungan)	0	20	0	10	0	0	5	0	<1	<8

Pembelajaran IPA untuk kelas I dan II baik di Jepang ataupun di Indonesia tidak dilaksanakan.

2. Keadaan IPA di SMP

Perbandingan jumlah jam pelajaran IPA dalam seminggu dapat dilihat pada tabel berikut ini.

	Kelas I	Kelas II	Kelas III	Jumlah
Jepang	3-4	3-4	3-4	9-12
Indonesia	6	6	6	18

Sedangkan perbandingan materi pelajaran IPA untuk siswa SMP di Indonesia dan Jepang dijelaskan pada tabel di bawah ini :

	Kelas I		Kelas II		Kelas III		Jumlah*	
	Jepang	Indo.	Jepang	Indo	Jepang	Indo	Jepang	Indo
Fisika	V	V	V	V	V	V	25	50
Kimia	V	-	V	-	V	-	25	0
Biologi	V	V	V	V	V	V	25	50
Ilmu Bumi	V	-	V	-	V	-	25	0

V: ada, - = tidak ada

* dalam prosen

3. Keadaan IPA di SMA

Karena di Jepang digolongkan ke dalam mata pelajaran pilihan, sedangkan di Indonesia Fisika termasuk mata pelajaran wajib, sehingga sulit untuk dibandingkan. Meskipun demikian agar mudah kita pahami perhatikan tabel berikut.

JEPANG		INDONESIA		Perbandingan waktu
Fisika	2 atau 4 atau 6		kelas I 102 jam	3 jam/minggu
Kimia	2 atau 4 atau 6	Kimia	Kelas II 102 jam	3 jam./minggu
Biologi	2 atau 4 atau 6		Kelas III 204 jam	6 jam/minggu
Ilmu Buki	2 atau 4 atau 6			
Ipa	2			
Keseluruhan	(dari mata pelajaran tersebut dipilih minimal 2 dengan waktu lebih dari 6 jam/minggu)	Jumlah 12 jam/minggu		
- minimal dipilih 2 pelajaran dengan waktu selama 6 jam/minggu - maksimal 4 mata pelajaran dengan waktu 16-18 jam/minggu				

Dari tabel di atas diketahui bahwa perbedaan di Jepang dengan di Indonesia yaitu pada bidang Kimia. Dan untuk mempelajari Ilmu Alam diharapkan agar semua isi dari materi tersebut disesuaikan dengan pengetahuan dasar dan perkembangan siswa, sehingga keseluruhannya dapat dipelajarinya. Di Jepang juga Konsep Kimia yang sulit tidak diajarkan kepada Murid SD, tetapi baru diajarkan kepada siswa SMP atau SMA.

Seperti yang sudah kita maklumi, bagi murid SD diutamakan untuk mengamati secara langsung benda-benda alam atau gejala-gejala yang berhubungan dengan alam, sehingga mereka dapat memahaminya. Hal ini bisanya menyangkut pengamatan terhadap tumbuh-tumbuhan dan yang lainnya. Bidang Kimia pun misalnya dengan mengamati (memperagakan) bahwa "Air dapat melarutkan benda yang lainnya (benda padat)", hal ini mudah kita lakukan sehingga siswa dapat mempelajari dan memahaminya dengan mudah.

Bagi siswa SMP Ilmu Alam secara keseluruhannya sama penting dan diajarkan, tetapi konsep-konsep IPA yang dianggap terlalu sulit baginya harus diakhirkan (diajarkan setelah konsep mudah). Hal ini dimaksudkan untuk menanamkan dasar-dasar IPA yang dijadikan dasar di SMA nanti yang merupakan salah satu mata pelajaran.

Baik di jepang maupun di Indonesia banyak memiliki alam yang sangat indah. Sebagai dasar untuk memelihara dan melestarikan keindahan alam tersebut, peranan pelajaran IPA tentang alam/ lingkungan ini sangat penting. Kalau pelajaran Kimia hanya dipelajari oleh mereka yang melanjutkan ke SMA saja (tidak oleh semua siswa), maka banyak siswa yang mengetahui tentang Kimia dengan sangat minim. Diharapkan minimal sampai SMP dengan menyesuaikan kondisi yang ada, bukan hanya Kimia saja Fisika juga sebaiknya di ajarkan. Memang susah kalau kita ingin mengadakan perubahan secara mendadak, meskipun kita ingin sekali mengajarkan kimia kepada siswa SMP tapi sangat sulit. Salah satu cara kita memilih suatu konsep kimia yang praktis dan mudah untuk dimengerti oleh siswa di suatu tempat secara langsung.

Misalnya, tema salah satu materi tentang "lingkungan" di dalamnya mesti kita selipkan konsep Kimia yang berhubungan dengan tema tersebut untuk dipelajari oleh siswa.

Tema tentang "AIR" misalnya, dikaitkan dengan "air alam, unsur benda yang larut dalam air, penguapan, pembekuan, benda-benda yang dapat dilarutkan oleh air" dan lain-lain. Tentang "Pencemaran Udara" misalnya, didalamnya dikaitkan dengan "pembakaran, Oksigen. unsur-unsur pembakaran" dan lain-lain. Hal ini bisa dilakukan dengan menghubungkan antara yang satu dengan yang lainnya secara praktis. Bukankah kita perlu untuk melestarikan alam dan meningkatkan pola hidup yang baik serta sebagai upaya dalam rangka menanamkan rasa cinta lingkungan hidup di masa mendatang.

Dua bulan yang lalu saya datang di Indonesia, dalam waktu tersebut telah mendapat berbagai macam pengalaman. Dalam rangka merealisasikan didirikannya Pusat Studi...... (Lembaga) ini, kalau boleh ada beberapa saran dari saya.

Dalam rangka pelaksanaan penataran guru-guru di lapangan, seyogyanya dipahami dan dikuasai terlebih dahulu tentang kurikulum yang berlaku di lembaga atau sekolah masing-masing secara mendalam. Kemudian hal-hal yang bisa dilakukan di lapangan dijadikan suatu tujuan dan pusat perhatian. Tentunya hal ini tidak akan dapat diselesaikan dengan penataran dalam waktu yang hanya beberapa hari saja (memakan banyak waktu).

Oleh karena itu bagaimana jika kita menggunakan dan menyajikan bahan/materi pengajaran secara bervariasi dan terpadu, yaitu dengan memilih topik utama misalnya dalam pendidikan "lingkungan" dengan tema "air dan unsur/senyawanya" seperti berikut ;

1. Macam-macam air di dalamnya mencakup : air alami, air untuk kehidupan, unsur-unsur yang terkandung dalam air dan lain-lain.
2. Berbagai cara untuk menjernihkan/memelihara kebersihan air seperti : penyaringan, penguapan, perubahan ion dan lain-lain.
3. Unsur-unsur yang terkandung dalam air : seperti :pengukuran kualitas air.
4. Zat-zat yang bisa larut dan yang tidak larut dalam air (peleburan/ pelarutan).
5. Makhluk yang dapat hidup dalam air.
6. Air dan makhluk hidup
7. pH air (Zat Oksigen, zat garam)
8. ..... hal-hal yang bisa ditentukan atau dipilih bila memungkinkan.

Materi-materi seperti tersebut yang perlu kita laksanakan dan kita sajikan, jika memang belum termuat di dalam kurikulum baik kurikulum SD maupun kurikulum SMP, maka kita perlu memasukannya. Kegiatan seperti inilah yang perlu dilakukan dalam penataran guru-guru seperti ini dan nantinya harus dilaksanakan atau direalisasikan di lapangan masing-masing oleh guru tersebut.

Saya membicarakan hal ini karena saya beranggapan bahwa untuk meningkatkan kualitas kehidupan kita dimulai dari air yang selalu kita gunakan.

Terakhir, mohon maaf kalau ada hal-hal yang kurang berkenan di hati semuanya.

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日本とインドネシアの小学校、中学校、高等学校の理科の履修状況を、理科の分野毎に、どのくらいの割合で学習しているかを大変おおざっぱな数値で示すことを試みた。理科の分野は物理、化学、生物、地学に分けた。インドネシアには地学がないことと、小学校においては、学習内容をもとに配分した。

また内容から判断できる環境も別に分類した。

（１）小学校の場合

理科全体を100%として、それぞれの分野の学習の割合を%で示す。

(分野)	3年生		4年生		5年生		6年生		全体（%）	
	日	イ	日	イ	日	イ	日	イ	日	イ
物理	40	10	25	30	20	60	20	50	30	30
化学	00	00	05	10	10	00	20	00	09	02
生物	40	50	50	30	50	30	30	40	40	40
地学	20	20	20	20	20	10	25	10	20	15
環境	00	20	00	10	00	00	05	00	01	08

（日本、インドネシアとも１、２年生は理科はない）

（２）中学校の場合

１週間の理科の授業時数を比較　　（時間／週）

	１年生	２年生	３年生	合計　（時間／週）
日本	３～４	３～４	３～４	９～１２
インドネ	６	６	６	１８

中学校において理科の各分野の学習状況とその割合を示す。

(分野)	1年生		2年生		3年生		全　体	(%)
	日	イ	日	イ	日	イ	日	イ
物理	○	○	○	○	○	○	25	50
化学	○	なし	○	なし	○	なし	25	00
生物	○	○	○	○	○	○	25	50
地学	○	なし	○	なし	○	なし	25	00

（3）　高等学校の場合

日本の場合は選択科目となり、インドネシアは化学が必修となることから、比較は難しいが、わかりやすく表にする。

日本（2分野から選択）		インドネシア（化学だけ）	
物理	2か4か6	1年生	102時間（3時間／週）
化学	2か4か6	2年生	102時間（3時間／週）
生物	2か4か6	3年生	204時間（6時間／週）
地学	2か4か6		
総合理科	2		
	（時間／週）		
2科目を	6～18時間／週	化学だけ	12時間／週

以上のように、日本とインドネシアの違いは、化学の学習である。自然科学を学ぶとき全ての分野を、生徒の知識や発達の程度に合わせ、理科全体を学習することが望ましい。日本では化学の分野のうち難しい概念を含む部分は小学校では教ず中学校や高等学校で教えている。

小学校では自然の事物・現象を直接に観察し、理解できることに重点が置かれているのはご存じのとうりで、植物の観察などが多くなっている。化学の分野でも物が水に溶けることなどは観察しやすい。また理解しやすい部分は学習している。

中学校では理科全体のどの分野も均等に学習し、難しい概念などは極力避けている。そしてそれらは高等学校で学ぶ理科の各分野（高等学校では科目という）の基礎になる学力を育成している。

高等学校では生徒の能力、興味、将来の進路などを考慮し、科目を選択にしている。

日本にもインドネシアにも大変美しい豊かな自然がある。この自然を保持し、きれいな国土を維持するための基礎には自然科学が大切である。もし化学を学習するのは高等学校に進学する者だけであると、進学率なども考えると化学的知識をもつ人は大変に少ないのではないだろうか。中学校までにその能力に合わせて化学だけでなく、理科の全分野を学ぶことが望ましい。しかし急な変更はできないであろうから、また化学を学ばせるといっても難しい概念もあることから、直接的に観察できるところや、理解が容易な部分だけでも選んで学習させるのも一策である。

例えば、「環境」というテーマの科目を設定して、その中でそれらの化学的分野の一部を学習させてはどうだろうか。「水」について、天然水、生活水の混入成分、水の浄化、水の蒸留、水に溶ける物な。「大気汚染」似ついて、燃焼、二酸化炭素、燃料の成分、など。多くのことが盛り込むことができると思う。豊かな自然の保守、日常生活の充実、身じかな環境の整備にはこような考えもあるのではないか。

私は二か月前にインドネシアに来て、いろいろな経験をした。このことから具体的なグロースセンターが設立されたときを想定した提案がある。

現職の教員の研修は現行のカリキュラムの内容を十分に理解し、活用できることを目的とすることであるが、一年に何日かの研修では完全に消化できない。

そこで、環境教育に重点を置いた水の科学をテーマに、それを多角的にとらえた教材を用意したらどうだろうか。

例　(1) 水の種類（天然水、生活水、水を持ち寄る）

(2) 水をきれいにするいろいろな方法（ろ過、蒸留、イオン交換など）

(3) 水に溶けるもの、溶けないもの（溶解）

(4) 水の中の成分、

(5) 水の中の微生物、

(6) 水と生き物、

(7) 水の酸性、塩基性　　など

このような内容を一貫性をもたせた、小学校、中学校のカリキュラム上の化学の無いことを念頭にいれた教員研修プログラムを完成させる。そして研修、さらに学校教育で実践へと移行する。生活の向上は水からであるとする考えから発したが、失礼の段はお許しいただきたい。

A COMMENT ON THE ITEMS TO BE THOUGHT IN SCIENCE COURSE OF ELEMENTARY SCHOOLS

Satoshi NIIDA

Tokyo Gakugei University Attached Upper Secondary School

I. Introduction

I am a school teacher in Tokyo, and teaching Chemistry at Upper Secondary School.

Since I came here Indonesia in last May, I was able to make a comparison between Indonesia and Japan, although only a three weeks investigation. I have found many differences in between two countriesmainly on the teaching of Chemistry in schools. So I would like to make some suggestions on the science curriculum for particularly Elementary school level, but these comments may not be adequate for Indonesian schools. I am afraid, that situation may not be applicable for you, because my comments only based upon a few investigation in Bandung Aren.

II. Comparation of school hours for science course between Indonesia and Japan.

Table I shows the school hours for Science in Elementary and Lower Secondary Schools.

Table I. School Hours of Science Courses

1. Elementary Schools (number indicates %)

Subject	Grade	3	4	5	6	Total
Physics	Japan	40	25	20	20	30
	RI	10	30	50	50	30
Chemistry	Japan	0	5	10	20	9
	RI	0	10	0	0	2
Biology	Japan	40	50	50	30	40
	RI	50	30	30	40	40
Earth Science	Japan	20	20	20	10	20
	RI	20	20	20	25	15
Environmental Science	Japan	0	0	0	5	1
	RI	20	10	0	0	8

2. Lower Secondary Schools

Subject	Grade	8	9	10	Total
Physics	Japan	0	0	0	25
	RI	0	0	0	50
Chemistry	Japan	0	0	0	25
	RI	x	x	x	0
Biology	Japan	0	0	0	25
	RI	0	0	0	50
Earth Science	Japan	0	0	0	25
	RI	x	x	x	0
Hours for Science per week	Japan	3-4	3-4	3-4	9-12
	RI	6	6	6	18

As was shown in Table I, there are less emphasize Chemistry in Elementary and lower Secondary Schools in Indonesia, teach only Chemistry as a part of the "Science".

I could imagine that why Teaching of Chemistry was postpone until upper secondary level are the following reasons:

1. Atoms and molecules are invisible, and pupils may not be able to catch such microscopic at the early ages.
2. We needs many glassware for the experiments in Chemistry which are not able to provide to all pupils, and, reservers for chemicals including Storages for them which are very difficult to maintain in each school.

However, we are facing many problems on environmental, such as water pollution, hazard, and gabages. We must give such problems to young pupils to find the way of solve such problems.

And also, we are living in the world of materials how to use materials efficiently with cousios handling, because materials on the glove is limitted. Therefor, Chemical concepts should be introduce at the Elementary School level, however, these concepts should not be based on theoritical concept but more easy treatments without using sophisticated apparatus.

Now, I would like to propose to include the items relating to Chemistry en Elementary School Science Course, which can be named as "Chemistry of Water".

For example :

1. Ask pupils to bring water from their houses,
2. Ask pupils whether those water are pure or not,
3. Any to think pupil how to purify the water,
4. Filtration of water will be thought,
5. To classify the material soluble to water or not soluble,
6. Examine the contaminates in water; inorganic materials, bacteria's etc. by Reagents.
7. Properties of water, such as acidity and base.

III. On the In-service Training

I have heard that these are many unqualified teachers in Elementary Schools who are not familiar with basic knowledge of science, so local Governments provede In-service Training Courses.

However, if the items required in Elementary Schools level covers all Science Subjects, it seem impossible to train every items within short training period.

INTERNATIONAL SEMINAR
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(Comparative Study between Indonesia and Japan)
Jakarta and Bandung: July 3-7, 1995

OVERVIEW OF SCIENCE EDUCATION IN SCHOOLS

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Sponsored by:

Directorate General of Higher Education
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OVERVIEW OF SCIENCE EDUCATION IN SCHOOLS

Tatang Suryana
High School Teacher

INTRODUCTION

I had been asked to write a paper with the above mentioned topic to be presented in an International Seminar which will be held in FP MIPA IKIP Bandung, on 3rd to 7th July, 1995, with a suggestion to discuss education from the view of educational subject (teacher, educator).

Science which was included in the topic means Natural Science and schools are all schools which are under the authority of Directorate General of Secondary Education (SMA).

Discussion about this Science Education will be observed according to 1975 and 1984 Curriculum Program. In this curriculum, Natural Science should be introduced or taught since Primary School.

In the secondary school (SMP), science course is focused on Biology and Physics. Chemistry is only introduced in a small content.

In High School (SMA) this science course is divided into Physics, Chemistry and Biology, which is taught (each) by a definite teachers.

Although Science in High School is distributed into three study courses, the discussion doesn't involve in depth each matter of the course or the method of presentation from each teacher of Physics, Chemistry and Biology, but more emphasized on education in general.

The speaker of this paper himself is a Physics teacher, so it will be possible that the influence of this experience may be dominant.

In performing his duty, a teacher should refer to the present curriculum in order to make a directed educational attitude for reaching educational objectives.

Educational objectives are included in the Curriculum Objectives mean while in the implementation of teaching, a teacher is directed by Instructional Objectives, because Instructional objectives will determine the correct Teaching method. The meaning of teaching method is a method or away applied in teaching definite object.

In 1975 curriculum, teaching was more emphasized in objectives and to reach an objective teachers need apparatus as teaching aid. In the presentation, teacher should minimize his type of lectures and to activate pupils becomes priority. The teacher should guide the pupils to do their activities as :

- thinking,
- observing / trying
- problem solving / drills to answer questions.

The teacher must establish scientific attitude and scientific method which is opened to other opinions, rational, objective and the acts preceded by observation. Other aspects that must be attained are :

- Intellectual aspect = to practice logical and critical thinking to give a knowledge base to continue study.
- Interest aspect = to grow (practicing) interest, to observe surrounding nature, to develop technology.
- Skill aspect = to perform observation and experiment capable to use apparatus in solving various scientific problems.

Referring to the mentioned objectives, we can choose inquiry approach. In this inquiry method, pupils are encouraged by the teacher to find by themselves (such as) scientific, concept, principle, law, etc. Beside facts, the process should also be performed by pupils (observation and experiment).

According to 1984 curriculum, process skill was more emphasized. The pupils should really work/active to do one of their jobs. In this case, there had been developed CBSA system or Learning Method of Active Pupil. The teacher must prepare theoretical matters to explain to the pupils how a process is going on so they will understand it exactly.

TEACHING SCIENCE COURSE

Before the1975 Curriculum was applied, Teachers in Science field (Physics, Chemistry, Biology) promoted their teaching programs according to the 1958 curriculum; generally, teaching with lecture method where teachers explained most of the lessons verbally by writing on the available blackboard: with this method all theoretical concepts or principles were not sought by pupils themselves, but teachers informed the theory directly and pupils listened/noticed and noted down. Then, sometimes the teachers asked pupils whether they had understand the explained theory or not.

And (if available) he gave example of the problem. And at last they made problem drill. This method is the easiest way to be done by a teacher and usually teacher's program to accomplish the matter was fulfilled. Lab work was performed out of class (time) separately. Such condition happened to physics, chemistry and Biology in general.

The above situation was considered not good as no guaranty to obtain qualified pupils and even pupil became less self confident and were not able to solve their own programs. They only believed and received matters from their Teacher.

We need some changes in the curriculum with various methods. Then curriculum changed in 1975 and 1984.

SOME TEACHING METHODS

Teacher and pupils involved in leaning-teaching activity or KBM. There are two interaction of teacher-pupil , i.e. direct and indirect, at communication base. In teaching method, this teacher-pupil communication can be characterized as:

"One-way communication" : communication between teacher and pupil as in lecture method.

"Two-way communication" : Communication between teacher and pupil as in question and answer method or responsive method.

In direct interaction, a teacher stands face to face with pupils.

The prepared program made by the teacher was delivered directly in classroom. The teaching methods used are :

- Lecture method
- Question and answer or responsive method
- Task assignment method
- Study tour method
- Group work method
- Demonstration method
- Experiment method
- Inquiry method

The above various methods basically want to make pupils active in leaning process, to overcome their own problems which they face in their lives.

The implementation of KBM with practice apparatus, either demonstration or experiment was done during leaning hours without extra time, because practice become a part of KBM.

In chemistry, experiments were done more frequently, than Biology, or Physics. Demonstrations were done more frequently for Physics, than Biology or chemistry.

Such condition is not equal in all schools for so many school which do not have apparatus to perform practice and even do not have laboratory or lack of apparatus. This is one of the many reasons why teachers in some school always use the lecture method.

PKG - IPA

A training equipment for improving the teaching quality of teachers is called PKG (Pemantapan Kerja Guru or Job ..... for Teacher). It is located in Bandung, specially for science. PKG was established according to the delivery of many laboratory apparatus to state owned schools all over Indonesia. With so many teachers who can was perform well with expectation to reach the objectives as indicated in 1975 curriculum.

A Teacher who has received PKG training is expected to accomplish his or her teaching jobs by using laboratory apparatus continually, either experiments or demonstrations. The Teacher should prepare LKS (Pupil Job Sheets) before teaching hours. In that job-sheets pupils do their leaning process. With inquiry method, pupils look for answers without being informed by their Teacher before. The answers can be checked up to the theory or examined by Teacher.

The benefit of this PKG system is seen in the activity of pupils to perform learning process, capable to work with their experiments, practicing responsibilities for what they have done. But some weaknesses in it are not getting the depth of theory, less problem solving practices, pupils confused at the beginning of leaning so they spend too much times to find out the observed problem, causing teaching matters cannot be accomplished at the expected time. Besides the evaluation system doesn't refer to process, but still to the deepening of matters, then the teachers who had joined PKG training activity were not able yet to apply PKG result consequently, mainly in big cities, considering the purpose to bring pupils entering the enhance test UMPTN.

SOME DIFFICULTIES

A couple of handicaps which make difficulties are :

1. No qualified laboratory

2. Small member of practice apparatus and have bad quality (easily damaged).
3. Do experiments or demonstrations not continuously which will spend too much time. Needs a longer and proper preparation time including paper for LKS which are limited in quantity.
4. The Teacher was not skilled enough or not ready to work in the laboratory and also no proper laboratory; there were some apparatus unknown to the teacher/the Teacher could not use them.
5. Current evaluation is still oriented to the depth of matters, so it has support to practice process.
6. Teacher taught in many parallel classes, each class had too many pupils in practice, so the situation in laboratory was uncontrollable. In class changes, laboratory was not ready for next use.
7. Basically, pupils didn't like science (especially physics) so there was less motivation or interest.
8. No sufficient funds to support laboratory, either for personal welfare or for (physics) apparatus maintenance.

Generally, other difficulties are how to attract pupils interest to prefer natural science and to think about the surrounding nature. Difficulty in mathematics bring difficulty in physics problem solving so generates opinion that physics is a difficult course how to make pupils become always creative, thing logically and process skill.

MGBS and MGMP

The effort to make uniformity in course plan, semester program and to increase communication among Teacher made by the government through Department of Education and Culture arranged a formal forum for Teacher to make discussion activity etc. Which called MGBS and MGMP. I my self as the chairman of MGBS South of Bandung.

In these forum, all teachers of science would do the activities for instance to make the semester program, Unit lesson plan and also could discuss all problems which they found in their schools.

Suggestions.

Laboratory : Completed with :

a. Good apparatus

b. Laboratory assistants

The apparatus in laboratory must be kept up, and for these case necessary budgeting.

INTERNATIONAL SEMINAR
ON SCIENCE AND MATHEMATICS EDUCATION
(Comparative Study between Indonesia and Japan)
Jakarta and Bandung: July 3-7, 1995

COOPERATION BETWEEN INDONESIA AND JAPAN ON SCIENCE EDUCATION

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Directorate General of Higher Education
Department of Education and Culture
Japan International Cooperation Agency (JICA), Indonesia Office
Bandung Institute of Teaching and Educational Sciences (IKIP Bandung)

COOPERATION BETWEEN INDONESIA AND JAPAN ON SCIENCE EDUCATION

John. T. Shimozawa
JICA Experts

I. Abstracts of the topics and findings from the talks given by Japanese.

1. Illustration of Present Status of Science Education in Japan.

(1) Philosophy of the Revised Education of the Course of Study :

School Education has two different purposes.

(I) To cultivate specialists in the field of Science & Technology.

(II) To foster good citizens with good understandings of the field, hence to cultivate persons who are able to make decisions by themselves.

(2) Problems in the Teaching of Mathematics and Science.

(i) the requirements of the Entrance Examinations strongly influence the regular classroom activities.

(ii) Most of the lessons are used on "How to solve the requirements within a short time". In other word, every school looks like "Juku" Training Course.

(iii) Although Science should be based on Experimental work, the time share for lab work decreases year by year.

2. The ways to resolve such problems and difficulties.

(1) We should reinvestigate the roles of School. The aims of school education in this age have been mainly focused on the cultivation of specialists, but this purpose should be reconsidered, because the enrollment of secondary education has increased, and the quality and/or interests of pupils is changing nowadays.

(2) Specific feature of Mathematics and Science Education.

In the case of the Teaching of Mathematics and Science, we need to examine the facts derived by former scientists through experiments.

However, other subjects such as Human Science & Social Sciences, are not able to be examined by experiments, so no special facilities are required in the Teaching of such subjects.

Therefore, the teaching of Natural Science requires many more facilities for the experimental works which must be used in the certification of the facts and/or the derivation of laws, etc. So, only school education is able to facilitate such equipment, but it costs much.

At the same time, the experimental works should be used more aggressively in school education, and the requirements at the entrance examination should include the problems relating to the findings of experiments.

3. Science Education in the 21st Century.

We have been teaching Natural Science classified in the traditional ways of separate items; i.e., Physics, Chemistry, Biology and Earth Science. There may be several reasons to teach Natural Science in accord with such classification, but Natural phenomena are not divided into four fields classified by academics. Take for example the consideration of Environment; this is really an inter-disciplinary field of all Natural Science including even Social Science.

For primary and Secondary pupils, how do they observe their surroundings? They cannot discriminate nature by four different scopes of traditional academic Scientific eyes, but observe directly whole patterns comprehensively. So, it may be much better to emphasize the way of thinking with pupils eyes, and not to force theoretical results. This is the reason why the Revised Course of Study tried to add the new Course called "Integrated Science" in the upper secondary science course.

How to inspire young people to the Science field ? There are many trials provided by Industries, and Teachers' Effort, etc.

Suppose teachers teaching Science have no interest in Science, and/or no self-confidence in the Scientific knowledge, how can such teachers carry on the teaching of science in the classroom ? Teachers should be experts in Science.

I have recommended to introduce the following three item :

1. the "debate method" in the classroom,
2. the "Integrated Science" course
3. to give many Experiments.

We are hoping to have such teachers capable to carry on their classrooms with these approaches.

It can be said that those who try to carry on the classroom activities fit the good definition of the qualified Teachers.

II. From Indonesian side, what are your problems ?

We understood through the presentations of Indonesian Speakers that you are facing many problems in the teaching of Math and Science.

May I summarize your comments in the following ways.

1. There are too many items required in your National Curriculum, and the contents designated are too difficult to be understood by pupils.
2. Too many classes must be handled by each teacher, so no extra hours for research and/or preparation of classes.
3. Not enough equipment and articles of supplies are provided, and therefore no experimental works are able to be demonstrated or required to be done by the pupils.

We understand your situations quite well, please do not be pessimistic in the teaching of Math and Natural Science.

If teachers have their own ideas to improve classroom activities, I am sure the course contents will become more attractive for pupils even without sophisticated facilities.

Soon after the end of World War II, we had nothing but burned houses in Japan, but teachers were very aggressive on how to reestablish school activities. Teachers had no apparatus nor equipment, but they tried to make "home-made" apparatus. Pupils very much appreciated the teachers' attitude toward "Scientific" affords, and looked after teachers' approaches.

This kind of performance by teachers is really important to give stimulation to the pupils in the study of science.

III. Aims of the Establishment of a Growth Center.

We are planning to establish a "Growth Center for the improvement of Science and Mathematics Education in Primary and Secondary Levels". Let me first explain the ways this may improve your Science/Math Education.

1. To revise your National Curriculum, for example :
   (1) decrease the amount of course contents,
   (2) establish look at the continuity of course contents required in primary and lower secondary levels.
2. To facilitate a minimum amount of experimental equipment after rearranging your own ideas. Do not ask to purchase every apparatus listed in the textbooks published overseas.
3. To give students in the "Pre-Service Courses" in the IKIPs the concept of "Information Science", Which will be more and more important factors in the Information Area.
4. Consider how to change the way of teaching of Math/Science in Schools so as to stop forcing pupils to memorize the results, but to give them chances think and consider by themselves.

We from Japan are going to support the establishment of the growth center for the improvement of Science and Mathematics Education.

According to our proposal, the aims of the Growth Center are as follows.

1. Revise the Course Contents at IKIP
2. List Experiments which should be required at IKIP
3. Make Programs for In-Service Training at PPPG/IKIP

4. Start adequate research works for Science/Math Education, with the cooperation of University people.

In order to accomplish these aims we are proposing to be supported by JICA in the following ways.

1. Invite several Experts from Japan,
2. Send young people to Japan to study in Science/Math Education,
3. Build "Growth Centers" at three IKIPs ; 1. Bandung, 2. Yogyakarta, and 3. Malang.
4. Equipment needed for Pre-Service and In-Service Training will be provided at each Growth Center.
5. Provide some more expensive Equipment to each Growth Center, after the judgment of the staff of the possibility of the Research.

The proposal has not been accepted, but I hope this final decision will be made next fiscal year by JICA. And, finally, we are hoping that the good relationships between Indonesian and Japanese Educators will be accomplished through the establishment of the Growth Centers, and both of us will be able to cultivate good human beings with Science Literacy, and also the Growth Centers will be milestones for the Improvement of Science and Mathematics Education for all Asian Countries.

Thank you all very much for your cooperation.