Correlation Between Science Curriculum and Cognitive Level in Earth Science of Secondary School Students in the Philippines and Japan

DIGNA CABARDO PANINGBATAN*, TAKESHI KOZAI*, HIROAKI OZAWA*,
MAMORU MURATA* and HIROSHI NISHIMURA*
*Natural Science Education (Science), Naruto University of Education, Japan

ABSTRACT

Key Words: Science curriculum, Cognitive level, Earth Science, Secondary school students, Philippines, Japan

Imperative to economic development is quality education. With the belief that science and technology is a twin vehicle towards the attainment of a country's economic development, science education has always been the object of reform.

The Philippines in its quest to alleviate the quality of life of its people, has done much effort to improve Science instruction and learning in the country. The Presidential Commission on Education Reform Report (April 2000) that focused on Philippine agenda for educational reform identified science and mathematics as one of the major areas of concern.

Since the center of every learning activity is the student, this paper looks at him in one of the components of science education, that is, Earth Science, specifically at the secondary level which is a critical point of entry into tertiary level of education. Furthermore, the existence of different Science curricula implemented in the Philippines, namely; Basic Education Curriculum (BEC) and enriched curricula in Science High Schools, provides the opportunity for assessing significant differences on the students' performances.

Generally, this paper tries to correlate the science curriculum to the cognitive level in Earth Science of secondary school students in the Philippines and in Japan. Specifically, its aim is to help determine the cognitive level in Earth Science of secondary school students in the two countries. It also seeks to compare the types of secondary schools based on the implemented Science curricula. With the desire to strengthen the correlation of the two variables, the same study is conducted among the Filipino students' counterparts in Japan.

I. INTRODUCTION

The significant role which science education plays in the progress and development of a nation is stressed out in the Philippine Constitution Article XIV Section 3 entitled: Education, Science and Technology, which states that: "All educational institutions shall … encourage critical and creative thinking; broaden scientific and technological knowledge and promote vocational efficiency."

The science program for basic education (elementary and secondary levels) in the country primarily aims to develop science literate citizens who are equipped with a working knowledge about his environment; science skills for creativity and critical thinking; desirable attitudes in life and an understanding of the relationship of science to everyday life.

Attainment of this objective calls for some reforms in education. This, though at large, is not an easy task. Some developed countries like Japan identified three areas of high commonality with regard to the problems that it had faced at the time when a modern educational system was introduced, namely: (1) problems inherent in the relationship linking the community, family and children; (2) problems related to educational infrastructure such as the inadequacy of school building or educational equipment; and (3) problems in line with the content and quality of education (JICA, 2004).

The Presidential Commission on Education Reform Report (April 2000) that focused on Philippine agenda for educational reform identified science and mathematics as one of the major areas of concern.

Furthermore, based on the assessment made by the Department of Science and Technology (DOST) on its past Science and Technology (S & T) plans specifically the Science and Technology Master Plan (STMP), a 10-year (1991-2000) plan formulated as comprehensive and long-term planning in S & T, one of the problems that plague the Philippines is poor S & T education.

Learning from the history of other countries like Japan and based on the assessments done, change in the curriculum has been introduced to attain the primary aim or objective of Science Education in the Philippines. This reform emphasizes the following thrusts: integration of science and health in the elementary level; and integration of science and technology in the high school level; focus on science process skills; integration of values education and use of community resources for instruction.

This restructuring led to the existence of different science curricula, namely, the Basic Education Curriculum (BEC) and the enriched curricula of Science High Schools. This is a good point to consider whether there is an effect on students' performance in one of the components of Science that is, Earth Science.

II. RESEARCH QUESTIONS

Based on the pressing problem to improve the quality of Earth Science education at the secondary school level in the Philippines, this paper tries to answer the following central question:

1. Is there a correlation between science curriculum and cognitive level in Earth Science of students in the Philippines and Japan?

More specifically, the questions that we have addressed in this study are:

1. Is there a significant difference in the cognitive level in Earth Science of Filipino students attending different types of secondary schools, in which varied science curricula are implemented?
2. What are the strengths and weaknesses of the different Science curricula implemented in various secondary schools in the Philippines?
3. Is there a significant difference between Filipino and Japanese secondary school students in terms of their cognitive level in Earth Science?

III. BACKGROUND OF THE STUDY

1. Educational System

A. Japan

The Japanese Constitution sets forth the basic national educational policy, as follows: "All people shall have the right to receive an equal education corresponding to their ability, as provided by law. The people shall be obligated to have all boys and girls under their protection receive ordinary education as provided for by law. Such compulsory education shall be free." (Article 26)

The public Japanese educational system is centrally governed by the Ministry of Education, Science, Sports and Culture (Monbukagakusho or Monbusho). The system was established in 1871, and has since undergone several reforms and changes. The organization of the present school system is divided into five basic divisions defined by age and grade.

The hierarchy of governance flows from the national prime minister to the members of Monbusho, into prefectural boards (overseeing upper secondary and higher education), municipal boards (overseeing kindergarten, elementary and lower secondary) and finally individual schools. Prefectural board members are responsible for the hiring and payment of all teachers. Teacher salaries are substantial, even higher than pharmacists or engineers (Kristof, 1997, p. 44). Municipal board members are accountable to the prefectural board members for various reports on progress and curriculum. Principals are hired by their respective boards to administer individual schools.

Shown in table 1 is the structural organization of the present system of school education in Japan and the normal age for admission or promotion to each grade of the educational system.

Kindergarten admits children aged 3, 4 or 5 and provide them with one-to-three-year courses.

Children must attend 9 years of compulsory education from age 6 to age 15. Attendance is mandatory for elementary and lower secondary school (or the lower division of secondary education school) and in the case of special education, for the elementary and lower secondary departments. In principle, to enter any school beyond the compulsory school level, one is required to pass an entrance examination.

In terms of content of teaching provided, upper secondary schools may also be classified into two categories: general and specialized courses. General courses provide general education suited to the needs of both those who wish to advance to higher education and those who intend to gain employment but have chosen no specific vocational area. About 74 percent of all the students in upper secondary schools were enrolled in these courses in 1997.

Specialized courses are mainly to provide vocational or other specialized education for those students who have chosen a particular area as their future career. These courses are further classified into: agriculture, industry, commerce, fishery, home economics, nursing, science-mathematics, physical education, music, art, English language and other courses.

In addition to these courses, a comprehensive course was introduced in 1994, where both general and specialized education are comprehensively conducted by providing a variety of elective subjects. The distinctive feature of this course is that students can independently select subjects from among a variety of classes covering general and specialized subjects in order to adequately satisfy their diverse interests, abilities and aptitudes, future career plans, etc.

Special education schools (schools for the deaf, schools for the blind, schools for the other disabled) provide physically or mentally disabled children with thorough and meticulous education, taking into consideration the type and degree of each child's disability. The educational programme are at a level equivalent to standard kindergartens, elementary schools, lower secondary schools and upper secondary schools and aim at equipping the children with the knowledge and skills necessary to overcome the difficulties caused by their disabilities.

Universities require the completion of upper secondary schooling or its equivalent for admission, and offer four-year courses (six-year courses for medicine, dentistry and veterinary medicine) leading to a bachelor's degree.

A university may set up a graduate school offering advanced study in a variety of fields leading to masters and doctorate degrees. More than half of the universities have set up graduate schools. The standard duration of a master course is two years and that of a doctorate course is five years (four years for medicine, dentistry and veterinary medicine). Some doctoral courses are divided into two stages: the first stage of two years can be treated equal to a master course; and the second stage of three years can be treated as a doctoral course. (Ministry of Education, Science, Sports and Culture – Japan, 2000).

The Japanese school year begins on April 1st and ends on March 31st of the following year with summer vacation in August.

Kindergartens, elementary, lower secondary schools and upper secondary schools adopt a three-term school year; from April to July, September to December, and January to March. Most universities employ the semester system.

Table 1. Current Japanese School System

LEVEL		DURATION	AVERAGE ENTRANCE AGE
Pre-school (optional)		3	3
Elementary		6	6
Secondary	Lower (Junior)	3	12
	Upper (Senior)	3	15
University	Bachelor	4	18
	Masters	2	22
	Doctoral	3	24

Table2. Educational System in the Philippines

LEVEL		DURATION	AVERAGE ENTRANCE AGE
Pre-school (optional)		3	3
Elementary		6	6
Secondary		4	12
Tertiary	C	4	16
	M	2	Above 20
	D	3 or more	Above 22

Legend: C= Collegiate; M = Masters; D = Doctorate

B. Philippines

Illustrated in table 2 is the 6-4-4 structure of educational ladder in the Philippines, that is, six years of elementary or primary education (some private schools require seven years), four years of high school or secondary education, and another four years of higher education for a degree program (except for some courses like Engineering, Law and Medical Sciences which require five or more years of schooling).

The 1987 Philippine Constitution mandates the establishment of a system of free public education in the elementary and high school levels. The entry age for elementary education is 6 years effective School Year 1995-96; for secondary education, it is 12-15 years; and for higher education, it is 16-19 years. Pre-school education is optional. Some private schools offer seven years of primary education.

In line with this, education in the Philippines is free and compulsory for children ages 6 through 12 while secondary education is free but not compulsory for ages 13 to 16.

Secondary education in the Philippines is a stage of free formal education following the elementary level below college level corresponding to four (4) years of high school. It can be also attained through alternative learning system such as the home study program.

There are two types of secondary schools according to curricular offerings: the general high school and the vocational high school. General high schools offer the four-year general academic secondary curriculum while vocational high schools offer the same secondary curriculum with additional vocational courses. Science high schools offer an enriched Science, Mathematics and English curriculum in addition to the requirements of the secondary education curriculum.

Higher education is divided into collegiate, masters and doctorate levels in various programme or disciplines. Foreign students are allowed to pursue higher education in some 150 colleges and universities in the Philippines.

The responsibility of administering, supervising and regulating basic education (elementary and secondary education) is vested in the Department of Education (DepEd) while that of higher education is with the Commission on Higher Education (CHED). The post-secondary technical-vocational education is under the

Technical Education and Skills Development Authority (TESDA) which is also in charge of skills orientation, training and development of out-of-school youth and unemployed community adults.

Schools open in June and close in April. There is a two-week Christmas break before classes resume in January. The Philippines uses a bilingual medium of instruction. Certain subjects are taught in English and the rest in the national language which is Filipino.

2. Secondary Science Curriculum in the Philippines

Alongside with the creation of the different types of secondary school in the Philippines, is the existence of different curricula.

General public high schools (GPHS) implement the Basic Education Curriculum (BEC) since 2002; the Philippine Science High School (PSHS) follows its own curriculum, and so does the Regional Science High School (RSHS).

A. The Basic Education Curriculum (BEC)

The 2002 BEC is a restructuring of the 1983 Elementary Education Curriculum and the 1989 Secondary Education Curriculum which aims at raising the quality of the Filipino learners and graduates while empowering them for lifelong learning, which requires the attainment of functional literacy.

Under the BEC, there are five (5) learning areas; four of which are the “tool” subjects namely: Filipino, English, Science and Technology, Mathematics; and a fifth one, which is a cluster of subject areas, called *Makabayan*. This experiential area constitutes a “Laboratory of Life”.

The science subjects are different in each year level, comprising Integrated Science for the First Year; Biology for the Second year; Chemistry for the Third year and for the Fourth year, the choice between Advanced Chemistry (track A) and Physics (track B).

B. The Philippine Science High School (PSHS) Curriculum

The PSHS System is an attached agency of the Department of Science and Technology (DOST).

Created to develop a “pool of feeders” in Science and Technology professions, the PSHS has a core curriculum which aims to develop the scholar in all discipline. Students experience a common first year, with a demanding Mathematics and English curriculum, and exposure to Earth Science and Technology Preparation. Then students go through a process that allows them to follow either a science stream or a technology stream.

Besides a number of core courses that are taken by all students of both streams, each stream offers a choice of elective courses from the second through fourth years.

The core curriculum of the First Year is packed with science and mathematics courses, allowing the student to maximize the realization of his potential intellectual skills. This is balanced by a rich humanities course which fosters full growth of each individual personality, as a responsible member of the national and global society.

In their Second Year, students proceed to either the Science or the Technology stream.

Admission to the PSHS is through the PSHS National Competitive Examinations. Carefully selected among the upper 10% of the country’s elementary school students, applicants take the two-step screening process namely, Scholastic Aptitude Test (SAT) consisting of tests in Verbal, Abstract Reasoning and Mathematics, and the Science and Math Aptitude Test (SMAT) consisting of tests in Science and Mathematics. Then their examination scores are ranked from highest to lowest. In the second year, transfer students may be admitted to fill in vacated slots after passing an accreditation test.

C. Regional Science High School (RSHS) Curriculum

In line with the provisions of Article XIV Section 10 of the 1986 Philippine Constitution, that, Science and Technology should be given priority in education as an important tool in shaping the country’s development and progress, and in consonance with R.A. 8496 (An Act to Establish the Philippine Science High School System and Providing Funds Thereof), the Regional Science High School (RSHS) was created.

Like the PSHS, curriculum of the RSHS has enhanced Science, Mathematics and English subjects.

To meet the demand, selection of the RSHS students is also rigid. Admission to the RSHS consists of three (3) phases, namely: Mental Ability Test, Proficiency Test in Science, Mathematics, English and Filipino, and finally, an interview after passing the second phase.

Furthermore, a student may qualify for the entrance examination if he belongs to the upper 10% of the graduating class and have at least a grade of 85 in Science, Mathematics and English and 83 in all other subjects during the second grading period.

3. Earth and Environmental Science Education

A. Japan

Earth Science (ES) is treated as a unit along with other sciences in the compulsory education starting from grade 3.

Science in elementary school and lower secondary school encompasses Physics, Chemistry, Biology and Earth Science. There is no subdivision between sciences in the elementary school. It is only “science”.

Science is divided into two parts in the lower secondary school; the first includes Physics and Chemistry while the second consists of Biology and Earth Science.

Topics in ES at the lower secondary level are divided as follows: 7th grade – Geology; 8th grade – Meteorology and 9th grade – Astronomy.

It is taken as a separate subject in the senior high school along with Biology, Chemistry and Physics.

Science is a yearly 70-95 hours subject at elementary school level, 85-105 hours at lower secondary school level.

Earth science, on the other hand, is taught 23 hours a year each for 7th and 8th grade and 18 hours a year for 9th grade.

B. Philippines

For many years, the call for study of the Earth Science has drawn the attention of the curriculum planners. Subsequently, the mandates of the 2002 Basic Education Curriculum that is attainment of quality education especially in Science Education was mulled over. Through their concerted efforts, the Earth Science was clearly realized as a vital subject. This is taken up as part of the Science lessons from grades 3 to 6.

Reached by the wave of dynamism, the Earth Science education has been modified recently. The inclusion of the Environmental Education that plays an integral part in man's awareness of his environment has been integrated into the subject.

The Earth and Environmental Science as a subject in secondary school, particularly of the first year, deals with the study of the Earth, its origin, features and the components of its environment. Environmental Science is integral to the study of the Earth as it focuses on the environment, resources, problems and issues, addressed in an interdisciplinary manner.

The inclusion of Earth and Environmental Science in the secondary education curriculum is the answer of the Department of Education to the pressing problem on continuous human activities altering the surface of the planet that results to diverse environmental changes.

Earth Science is a separate subject in the science high school curriculum but incorporated in the Integrated Science subject of the first year in general public high schools. This indicates the varying number of class hours a year spent for studying ES in different schools. To cite, PSHS is 120 hours; QCSHS is 200 hours while it is about 60 hours in GPHS.

The course is divided into three major topics: the Earth, the Stars and the Galaxy and the Environment. Each major topic is composed of subtopics which present the interconnectedness between and among concepts related to economic, social and moral issues.

IV. DATA MANAGEMENT AND ANALYSIS

The Questionnaire

With the desire to find the answers to our research questions, we used a questionnaire (Amponsah-baa, 2004) to find out the cognitive level of high school students in Earth Science. The test consisted of 30-item multiple choice questions that covered the three main areas of Earth Science namely: Geology, Astronomy and Meteorology.

Since some of the questions were taken from the TIMSS item pool (TIMSS, 2003), classification based on the cognitive domain was made as indicated in table 3.

Table 3. Classification of Questions by Cognitive Domain

Item Number	Cognitive Domain	Item Number	Cognitive Domain	Item Number	Cognitive Domain
1	USI	11	USI	21	T, A, SP
2	USI	12	USI	22	UT, RP, SP
3	USI	13	T, A, SP	23	UCI*
4	USI	14	UCI	24	USI*
5	UCI	15	USI	25	UCI*
6	USI	16	USI	26	USI*
7	UCI	17	USI	27	USI*
8	UCI	18	USI	28	UCI*
9	T, A, SP	19	USI	29	UCI*
10	USI	20	UCI	30	UT, RP, SP*

Legend:
* = TIMSS questions
USI = Understanding Simple Information
UCI = Understanding Complex Information
UT, RP, SP = Using Tools, Routine Procedures and Science Processes
T, A, SP = Theorizing, Analyzing and Solving Problems

The Participants

In the Philippines, the participants for the study were students from three secondary schools in the National Capital Region (NCR) namely: Ramon Magsaysay (Cubao) High School (RMCHS, a General Public High School-GPHS), Quezon City Science High School (QCSHS, a Regional Science High School) and Philippine Science High School (PSHS). These schools differ in terms of the Science curricula they implement. RMCHS is a general public high school hence the BEC is implemented; QCSHS and PSHS on the other hand, follow the enriched Science curriculum with slight varying degree. Eighty (80) participants were chosen randomly from among the second year high school students in each school, since Earth Science was taught in their first year level, adding up to a total of 240 participants.

As a counterpart, the same study was also conducted in Japan, where the test was administered to 191 8th graders in Junior High School (JJHS) in the Chiba (Tokyo area) and Kumamoto (semi-rural Southern Kyushu) prefectures

All participants in this study were of ages 13-14 years.

Data Analysis

Participants' responses were encoded and then analyzed through the Statistical Package for Social Sciences (SPSS) data file. In SPSS, the percentage validity of the students' response for each question was determined.

To find out if there is a significant difference between the two variables, the data were further analyzed using the chi-test. Data collected were cross tabbed to find if there is a significant difference in the performance of students from different schools.

Rationale of the Methodology

The Science curriculum has always been the object of reform in education. It is constantly improved to meet the needs of the times. However, the starting point for change is always a vital step for curriculum planners and educators. Thus, the result of this study can be used as a reference as it gives a concrete current cognitive level of Filipino and Japanese students in the study of Earth Science.

Furthermore, the current disasters that devastated South Asia and even affected some countries in East Africa, revealed a low level of awareness to natural calamities among the populations. Knowledge about natural phenomena is not only for the sake of learning but also essential for survival. The Philippines and Japan are both located in seismically-active zones of the world. As such, the need for measuring the extent of people's environmental and geographical awareness is a must.

V. RESULTS AND DISCUSSIONS

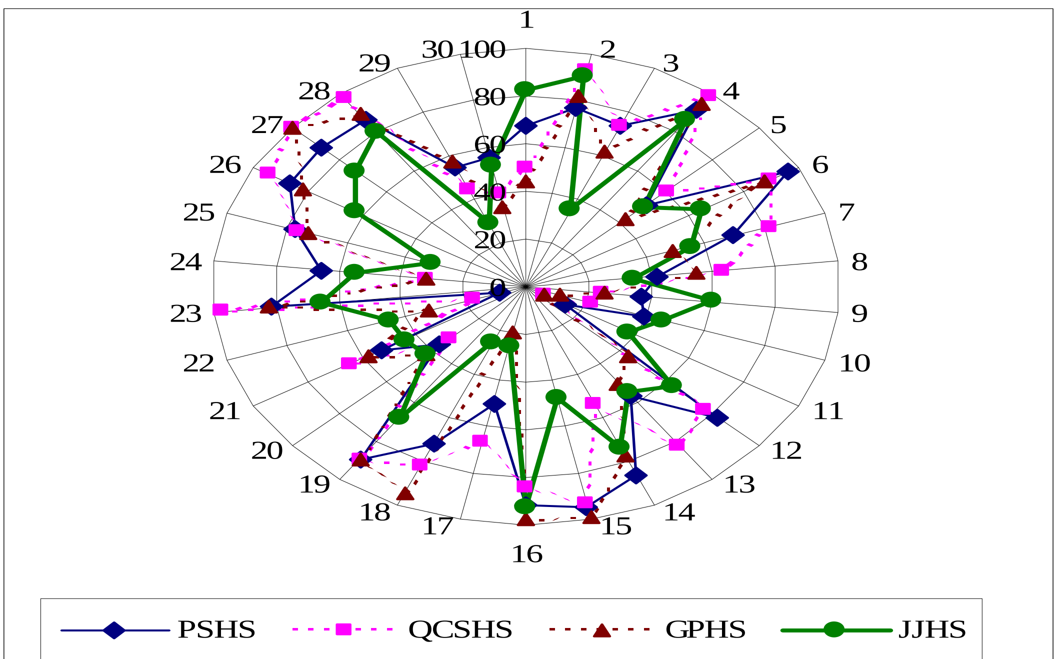


Fig.1 Filipino and Japanese Students' Frequency of Correct Responses (%)

Analysis of data revealed the following results as shown in figure 1.

From the given figure, we can see that Filipino students from all types of secondary schools performed well in item numbers 2 (atmosphere), 4 (fossils), 6 (sunrise and sunset direction), 15 (satellite), 16 (astronomy), 18 (earthquake), 19 (planets), 23 (erosion), 25 (occurrence of Earth's seasons), 26 (tectonics), 27 (moon) and 28 (atmosphere). The average frequencies of correct responses in these items were from 75 to 100%. Most of these items were included in the content of the Earth Science subject as seen in table 4.

For other items in the Earth Science test, the frequencies of correct responses were either very low or well-dispersed in the graph based on the same figure. To cite, Filipino students showed very low performance for items 10 (fossils), 20 (length of daytime and nighttime), 22 (measuring air temperature), 29 (soil profile) and 30 (interpreting diagram) despite the fact that these topics were taught at different year levels. The average frequencies of correct responses were 55% and below. Among these, even students from science high schools gave incorrect responses in questions 10 and 22.

Comparing the Filipino and Japanese students, the JJHS students did better than their Filipino counterparts in some items such as 1, 9, 10, 11 and 22. These questions were on erosion, calculation of velocity of stars, fossils, minerals in rocks and measuring air temperature. These concepts were learned at different year levels in both countries. However, Filipinos did better than the Japanese students in most items, to enumerate 3, 6, 8, 15, 17, 18, 19, 23, 25, 26, 27 and 29. An explanation for this is that most of these topics were not covered in the curriculum for 8th graders in Japan as seen in table 4 below. Based on the textbooks used in schools in Japan, rock samples were discussed (items 3 and 17) in a limited way only. Similarly, some topics in astronomy (items 15 and 19) were not tackled at all within this grade level. However, for the other items that have been discussed, this clearly indicates that students did not remember them. It is notable that Japanese students perform poorly in questions related to orientation and wind-directions (items 6, 8 and 21).

In the case of the Filipino students, however, it is interesting to note that most of the topics were taken up in elementary and high school except for questions on velocity of stars and use of geological terms in describing the color of rock mineral.

Table 4. Comparison of Earth Science Curriculum Content

Item No.	JJHS (8th Grade)	Philippine Schools (2nd year HS)	Item No.	JJHS (8th Grade)	Philippine Schools (2nd year HS)
1	L (7th)	L (E)	16	UL (HS)	L (E)
2	L (E & 7th)	L (HS)	17	UL (HS)	L (E)
3	L (7th)	L (E)	18	UL	L (HS)
4	L (6th)	L (HS)	19	UL (9th)	L (E)
5	UL (HS)	L (HS)	20	UL (9th)	L (HS)
6	L (4th)	L (E)	21	UL (9th)	L (HS)
7	L (7th - Chem)	L (HS)	22	L (4th)	L (E)
8	L (5th)	L (HS)	23	UL	L (E)
9	UL (9th)	UL	24	UL	L (HS)
10	L (7th)	UL	25	UL (9th)	L (E)
11	L (7th)	UL	26	L (7th)	L (HS)
12	L (7th)	L (HS)	27	UL	L (E)
13	L (5th – Math)	L (HS)	28	UL	UL (4th yr HS)
14	UL (8th)	L (HS)	29	UL (9th)	L (E)
15	UL (9th)	L (E)	30	UL (HS-Social Studies)	UL

Legend: L = Learned; UL = Unlearned; E = Elementary; HS = High School

As reflected in fig. 2, among the Philippine schools, mean frequency of correct responses by students from QCSHS and PSHS are both high (64-65%), while that of the GPHS is the lowest (about 60 %).

From the same figure, we can also say that Filipino high school students performed slightly better than their Japanese counterparts (JJHS) (nearly 56%) in the Earth Science test.

To further analyze the results of the study, a chi-test was done by cross tabulation of the different schools in Philippines and in Japan.

The cross tabulation between GPHS and SHS using Chi-square test (Continuity correction), for 2 x 2 table with one (1) as a degree of freedom, showed that there is a significant difference in the percentage of correct responses in 10 items. Among these items, six (6) have a very high level of significance, that is, at 1%, while the rest are significant at 5%. In most items, the GPHS has lower frequency of correct responses in percent. This strongly proves then that in the Philippines, students from Science High School perform better than those of General Public High School.

However, it is important to note that there were three (3) items where students from GPHS significantly did better than those of SHS. This suggests that these topics were not well-explained hence, a need for clarification in the class.

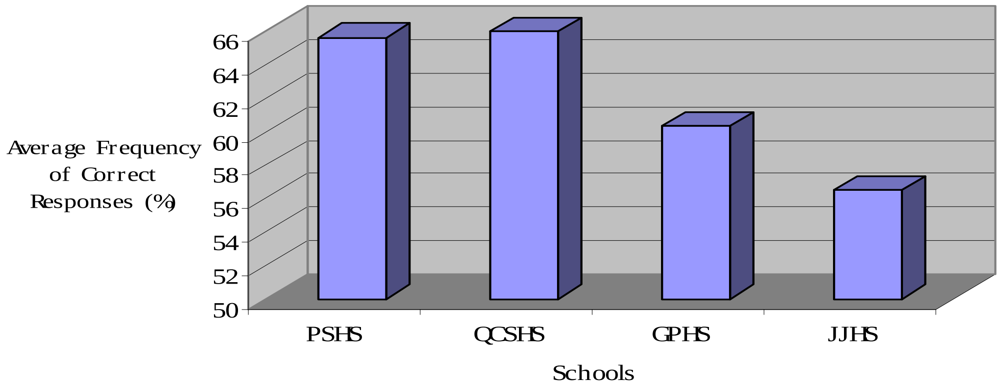


Fig. 2 Philippines and Japan Secondary Schools' Average Frequencies of Correct Responses in Earth Science Test

Table 5. Cross tabulation of Items for Philippine Schools

Items with Significant Differences	School with Lower Percentage of Frequency
1	GPHS
7*	GPHS
10	GPHS
12*	GPHS
13*	GPHS
16	SHS
17*	GPHS
18*	SHS
22*	SHS
24	GPHS

Legend:
* = 1% significance level
unmarked = 5% significance level
GPHS = General Public High School
SHS = Science High School
P = Philippines
J = Japan

Table 6. Crosstab of Items Between Japan and Philippine Public School

Items With Significant Differences	Country With Lower Frequency
1*	P
3*	J
6*	J
8*	J
9*	P
10*	P
11*	P
12*	P
15*	J
18*	J
19*	J
21*	J
23*	J
24*	P
25*	J
26*	J
27*	J
29*	J
30	P

Table 7 summarized the cross tabulation of the students responses in two countries using Chi-square test (Continuity Correction) for a 2 x 2 table with 1 as a degree of freedom. This gave us an idea about the significant differences on the performance of the Science High Schools in the Philippines i.e. QCSHS and PSHS, and JJHS. As reflected, there were 23 items in which the percentages of correct responses have significant differences at 1% level except for item number four (4) at 5%. Again in most items, students from SHS in the Philippines did better than their Japanese counterparts. A possible explanation for this is that the Earth Science curriculum of the two countries differs, as mentioned in the previous discussions.

However, in the recently released TIMSS 2003 results, 8^{th} graders in Japan ranked 5^{th}, along with Estonia, in Science while Philippine 8^{th} graders ranked 42^{nd} among the 46 participating countries. This trend had also been observed in the questions lifted from the TIMSS test item pool.

The discrepancies between the results of the present study and that of TIMSS could have been possibly due to differences in the content domains of TIMSS and the questionnaire used in this study, as only about 15% and 9% of the TIMSS items were related to Earth and Environmental Sciences, respectively; compared to the pure and comprehensive Earth Science test used in this study. Another reason for the differences in results may be the homogeneity of Japanese participants in the TIMSS, in contrast to the Philippines, where TIMSS encompasses a large population from both city and remote rural areas, while the present study has been so far only made on a small population within the capital area.

Table 7. Crosstab of Items Between Japan Junior High School and Science High Schools in the Philippines

Item Numbers With Significant Differences	Country With Lower Frequency	Item Numbers With Significant Differences	Country With Lower Frequency
1*	P	17*	J
3*	J	18*	J
4	J	19*	J
6*	J	21*	J
7*	J	22*	P
8*	J	23*	J
9*	P	25*	J
10*	P	26*	J
11*	P	27*	J
12*	J	28*	J
13*	J	29*	J
15*	J		

VI. CONCLUSION

Based on the above results and discussions, we may conclude that there is a correlation between science curriculum and cognitive level in Earth Science of secondary school students in the Philippines and Japan. Hence, in the Philippines, students from science high schools performed better than students from general public high schools. Filipino students in secondary schools, as a whole, did slightly better than their Japanese counterparts in Earth Science. Their slightly above average cognitive level is primarily due to several factors, among which are content and time allotment. In the Philippines, Earth Science was allotted more time; consequently, more topics are dealt with as compared to Japan.

The comparison between the students of the two countries of our study shows the value of the enriched Earth Science curriculum in the Philippines in terms of content. However, as suggested by the TIMSS results, our study should be broadened to a larger and more diverse population in order to meet the needs of further development of scientific skills and improvement of teaching methods to a larger area of the archipelago.

REFERENCES

Amponsah-baa, S. (2004). *Basic Education Science Curriculum in Ghana: A Proposal on Enhancing Its Earth Science Content Level.* Master Thesis in Naruto University of Education, pp. 112.

Bureau of Secondary Education (BSE) Primer (2002). Retrieved December 20, 2004 from http://www.deped.gov.ph.

Bureau of Secondary Education (2002). *Operations Handbook in Science: 2002 Basic Education Curriculum Secondary Level*. Pasig City: Department of Education.

Comparing NAEP, TIMSS and PISA in Mathematics and Science. Retrieved January 25, 2005 from http://www.nces.ed.gov/timss/pdf/naep_timss_pisa_comp.pdf.

Education in Japan: A Graphic Presentation (13th ed.) (1999). Ministry of Education, Science, Sports and Culture of Japan. Tokyo: Gyosei Corporation.

Ibe, M. D. and Ogena, E. B. (1990). Science Education in the Philippines: An Overview. *National Science Education Congress*, pp.27-28.

Ishikawa, Sei (2004). Geological Education of Elementary School and Lower Secondary School in Japan. *The Sixth Symposium of IGCP 434*, pp. 31-32.

National Science and Technology Plan 2002-2020 (2004). Manila: Department of Science and Technology.

Pallant, J. (2001). *SPSS Survival Manual*. New York: Open University Press.

Philippine Science High School (PSHS) System Home. Retrieved December 16, 2004 from http://www.pshs.edu.ph.

Takahura, S. and Murata, Y. (eds.) (1997). *Education in Japan, A Bilingual text: present System and Task/ Curriculum and Instruction.* Tsukuba: The Tsukuba Association for International Education Studies.

The History of Japan's Educational Development (2004). Tokyo: Institute for International Cooperation – Japan International Cooperation Agency.

The 2002 Basic Education Curriculum (2002). Pasig City, Metro Manila: Department of Education.

Trends in International Mathematics and Science Study (TIMSS) 2003. Retrieved January 25, 2005 from http://www.isc.bc.edu.

APPENDIX: QUESTIONNAIRE ON KNOWLEDGE IN EARTH SCIENCE

1. What is the name given to the function of a river that deposits transporting sand and gravels at the river mouth?
   A. Transportation B. Erosion C. Sedimentation D. Weathering
2. What do you call the state that air cannot contain any more water vapor at a given temperature?
   A. Saturation B. Vaporization C. Sublimation D. Crystallization
3. Which one of the following is a sedimentary rock?
   A. Gabbro B. Granite C. Limestone D. Dike
4. In strata, we can find evidence of the past life including remains and traces. What do you call this?
   A. Fossil B. Ruins C. Volcanic ash D. A shell mound
5. What do you call the breeze that is caused by the temperature difference when the sea surface is warmer than the adjacent land at nighttime?
   A. Sea breeze B. Land breeze C. Night breeze D. Solar wind
6. From which direction does the sunrise and set?
   A. West to East B. East to West C. North to South D. South to North
7. An important, soluble product of the weathering of limestone is
   A. Clay B. Calcium bicarbonate C. Gypsum D. Quartz
8. Which direction can you find the crescent in the evening?
   A. East B. South C. West D. North
9. How many degrees per hour is the velocity of the star in appearance?
   A. 15 degrees B. 25 degrees C. 30 degrees D. 45 degrees
10. What name is given to the fossil, which gives us the formation age of the strata?
    A. Index rock B. Facies fossil C. Mega fossil D. Strata fossil
11. Which one is a common mafic mineral in granite?
    A. Quartz B. Feldspar C. Olivine D. Biotite

12. Once an earthquake occurs, the shocks propagate. What do you call the first relatively small shocks?
    A. P-wave B. S-wave C. L-wave D. B-wave
13. If the Earth turns 15° every hour, what time will it be in Japan, which is 135° east when it is 4 am in Ghana which is on latitude 0°?
    A. 1:00 am B. 2:00 pm C. 1:00 pm D. 2:00 am

14. What do you call a measure of atmospheric moisture, the temperature to which air must be cooled for saturation to occur?
    A. Boiling point B. Freezing point C. Dew point D. Melting point
15. What do you call an object orbiting a planet?
    A. Star B. Satellite C. Meteorite D. Comet
16. The study of the universe and the behavior and relationship existing between the heavenly bodies is called
    A. Astronomy B. Astrology C. Geology D. Horoscope
17. Which of the following is an example of a metamorphic rock?
    A. Shale B. Basalt C. Gypsum D. Slate
18. The scale used in measuring the magnitude of an earthquake is called___
    A. Mercalli scale B. Richter scale C. Morgan Scale D. Richard scale

19. Which planet has the most extensive ring structure?
    A. Jupiter B. Neptune C. Saturn D. Uranus
20. During which period of the year are the days longer than the nights in the northern hemisphere?
    A. From March 21 to September 23 C. From December 20 to June 21
    B. From September 23 to March 21 D. From June 20 to December 21
21. The earth rotates on its axis once a day. What is the rotation direction?
    A. From North to South B. From South to North C. From East to West D. From West to East
22. Where can we measure the air temperature correctly?
    A. In the shade without wind. C. In the sun without wind.
    B. In the shade with wind. D. In the sun with wind.
23. Rain and running water can wash away soil. From which area is soil most likely to be washed away?
    A. A sloping area with bushes C. A flat area that is barren
    B. A flat area with grasses D. A sloping area that is barren
24. What is predicted to be a result of global warming?
    A. Rising Ocean level. C. Larger volcanic eruptions.
    B. More severe earthquakes. D. Thinning ozone layer.

25. Which of the following is an important factor in explaining why seasons occur on Earth?

A. Earth rotates on its axis. C. Earth's axis is tilted.

B. The sun rotates on its axis. D. The Sun's axis is tilted.

26. Which BEST describes the movement of the plates that makes up the Earth's surface over millions of years?

A. They moved for millions of years but have now stopped. C. They have been continually moving.

B. They stayed the same for millions of years but are now moving. D. They have never moved.

27. The moon produces no light, and yet it shines at night. Why is this so?

A. The Moon reflects the light from the Sun. C. The Moon is covered with a thin layer of ice.

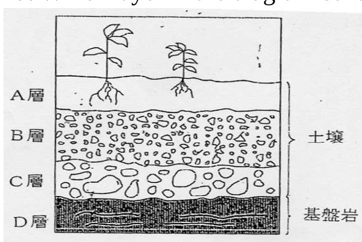
B. The Moon rotates at a very high speed. D. The Moon has many craters.

28. Why do mountain climbers use oxygen equipment at the top of the world's highest mountain?

A. There is less oxygen in the air at great heights. C. There is a hole in the ozone layer.

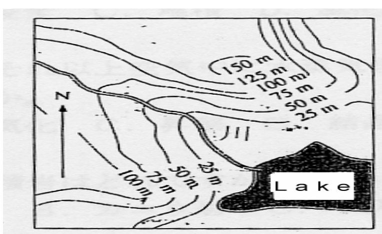
B. There is little nitrogen in the air at great heights. D. There is no air at the top of very high mountains.

29. Which layer in the diagram contains the most organic materials?



A. Layer A B. Layer B C. Layer C D. Layer D

30. On the diagram, hills and valley are shown by means of contour lines. Each contour line indicates that all points on the line have the same elevation above the sea level.



In which direction does the river flow?

A. Northeast B. Southeast C. Northwest D. Southwest