DOI: 10.37156/RELEA/2020.29.087

COMPARISON OF ASTRONOMY SCHOOL EDUCATION CURRICULA BETWEEN PHILIPPINES AND JAPAN

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Abstract: As a case study for developing countries aiming at improving science and Astronomy school education, we compare the Philippine and Japanese school science curricula. The Philippines recently changed its national curriculum with a view of strengthening science education. Japan, on the other hand, already has a reputable national curriculum and continues to be one of the outstanding countries in science education. Likewise, higher education and informal Astronomy education of the two countries were reviewed for similarities and differences. The Philippine and Japanese National Curriculum Standards and government approved science books were used in the analysis of their respective Astronomy learning competencies. The findings show that the Astronomy-related topics in both countries are almost the same, but Filipino students have more time and exposure to Astronomy concepts compared to Japanese students. On the other hand, Japan is rich in student research presentation in high school. Japan offers more opportunities and facilities to students who would like to pursue both Astronomy education and research. It seems that these backgrounds are the basis for richer Astronomy research environment in Japan.

Keywords: School curricula; Comparison of curricula Philippines-Japan.

COMPARAÇÃO DE CURRÍCULOS DE EDUCAÇÃO ESCOLAR EM ASTRONOMIA ENTRE FILIPINAS E JAPÃO

Resumo: Como um estudo de caso para países em desenvolvimento com o objetivo de melhorar a educação escolar em ciências e Astronomia, comparamos os currículos de ciências escolares das Filipinas e do Japão. As Filipinas recentemente mudaram seu currículo nacional com o objetivo de fortalecer o ensino de ciências. O Japão, por outro lado, já possui um currículo nacional respeitável e continua sendo um dos países de destaque no ensino de ciências. Da mesma forma, o ensino superior e o ensino informal de Astronomia dos dois países foram revisados quanto a semelhanças e diferenças. Os *Standards* Curriculares Nacionais das Filipinas e do Japão e os livros científicos aprovados pelos governos foram usados na análise de suas respectivas competências em aprendizado de Astronomia. Os resultados mostram que os tópicos relacionados à Astronomia nos dois países são quase os mesmos, mas os estudantes filipinos têm mais tempo e exposição aos conceitos de Astronomia em comparação aos estudantes japoneses. Por outro lado, o Japão é rico em apresentações de pesquisas por parte de alunos no Ensino Médio. O Japão oferece mais oportunidades e facilidades aos estudantes que desejam seguir o ensino e a pesquisa em Astronomia. Parece que esses antecedentes são a base para um ambiente de pesquisa em Astronomia mais rico no Japão.

Palavras-chave: Currículo escolar; Comparação de currículo Filipinas - Japão.

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COMPARACIÓN DE CURRICULA DE EDUCACIÓN ESCOLAR EN ASTRONOMÍA ENTRE FILIPINAS Y JAPÓN

Resumen: Como un estudio de caso para países en desarrollo con el objetivo de mejorar la educación escolar en ciencias y Astronomía, comparamos los planes de estudios escolares de Filipinas y Japón. Filipinas cambió recientemente su plan nacional de estudios con el objetivo de fortalecer la educación científica. Japón, por otro lado, ya tiene un currículum nacional de buena reputación y continúa siendo uno de los países más destacados en educación científica. Del mismo modo, se revisó la educación superior y la educación informal en Astronomía de los dos países en busca de similitudes y diferencias. Los Estándares Curriculares Nacionales de Filipinas y Japón y los libros de ciencias aprobados por los gobiernos se utilizaron en el análisis de sus respectivas competencias de aprendizaje de Astronomía. Los resultados muestran que los temas relacionados con la Astronomía en ambos países son casi iguales, pero los estudiantes filipinos tienen más tiempo y exposición a los conceptos de Astronomía en comparación con los estudiantes japoneses. Por otro lado, Japón es rico en presentaciones de investigación de los estudiantes en la escuela secundaria. Japón ofrece más oportunidades e instalaciones a los estudiantes que deseen seguir en la educación o la investigación en Astronomía. Parece que estas condiciones son la base para un entorno de investigación de Astronomía más rico en Japón.

Palabras clave: Curricula escolar; Comparación de curricula Filipinas - Japón.

1 Introduction

The study of the sky and celestial objects is, in fact, one of the oldest fields of science (e.g., IAU, 2019a). Astronomy has been known since the time of the ancient civilizations. It is also embedded in culture and plays a significant role in the lives of the people. Thus, people still want to discover and understand our universe. Many countries worldwide include Astronomy in their curricula.

Japan continues to be one of the top-performing countries in the world and Japanese students achieve high scores in international academic surveys such as PISA and TIMSS (e.g., KNIPPRATH, 2005). Though Japan still has a serious problem that many students do not have positive attitude and interest in science, Japan is also one of the countries with many professional astronomers affiliated with the International Astronomical Union (e.g., IAU, 2019b). Furthermore, universities in all areas in Japan offer Astronomy courses to students. On the other hand, the Philippines has struggled with Astronomy education program (e.g., SESE; KOUWENHOVEN, 2012). Astronomy topics used to be taught only in elementary school and 1st year of high school. In addition, few universities offered Astronomy courses. Thus, government decided to change the national curriculum in 2011. One of the significant changes in the science curriculum is the distribution and spiraling of Astronomy topics from elementary school to senior high school.

This paper compares the science curriculum of the Philippines and with that of Japan to present the discussion points for development of science education in the Philippines. The curriculum comparison study is growing globally (e.g., SALIMPOUR *et al*., 2020). This case study can be useful to other developing countries aiming at improving science and Astronomy school education. This paper is organized as follows. In section 2, we briefly present the new Philippine education system and Japanese one. In section 3, we compare the Astronomy-related contents in the curricula. In section 4, we present comparison of Astronomy education in higher education. In section 5, we present out-of-school Astronomy education which is also an important side of Astronomy education environment. Conclusions are given in section 6.

2 Brief Description of the Educational System in the Philippines and Japan

2.1 Philippine Educational System

The Philippine educational system from elementary to high school is supervised by the Department of Education (DepEd). The central office of the DepEd sets the policies and curriculum standards for public and private schools. For the tertiary level and non-degree vocational courses, the office of the Commission on Higher Education (CHED) and Technical Education and Skills Development Authority (TESDA) determines the policies for public and private universities (PHILIPPINE, 2015). Table 1 shows the Philippine Educational System from 1945 to June 5, 2011, was composed of six years of elementary school and 4 years of high school, a total of 10 years of compulsory education. It is one of the countries with the shortest basic education. With this system, Filipinos can enter university at the age of 16 or 17.

School	Grade	Other names	Age
Pre-school Optional	Nursery Kindergarten I Kindergarten II		3-5
Elementary School (Primary) Compulsory	Grade 1	Primary	6–7
	Grade 2		7–8
	Grade 3		8–9
	Grade 4	Intermediate	9–10
	Grade 5		10–11
	Grade 6		11–12
High School (Secondary) Compulsory	First Year	Freshman	12–13
	Second Year	Sophomore	13–14
	Third Year	Junior	14–15
	Fourth Year	Senior	15–16
University	4-5 Years		17–21

Table 1 - Philippine Old Curriculum (1945 to June 5, 2011).

However, upon assuming office in 2010, the former President Benigno Aquino III promised to make education as an investment for Filipinos by improving the education system of the Philippines[5]. The Republic Act No. 10157 also known as "Kindergarten Education Act of 2012" and the Republic Act No. 10533 also known as "Enhanced Basic Education Act of 2013" was passed to ensure all Filipinos will have

[5] Press release of Aquino's Platform during presidential race, November 28, 2009. https://senate.gov.ph/press_release/2009/1128_aquino1.asp

the right to quality education. The "No Filipino Left Behind Act of 2010" introduced by Senator Manuel Villar last 2010 and the commitment to achieve Education for All by 2015 are the motivations to change the national curriculum from 10 years to 13 years of compulsory basic education. It also has had a great impact on Philippine education to jump to the frontier of the modern education system.

Table 2 shows the K-12 program. A child must complete kindergarten, six years of elementary school, four years of junior high school and two years of senior high school, a total of 13 years of compulsory basic education (CIIT COLLEGE…, 2015). Thus, students have sufficient time to master the concepts and skills set by the national standards. With this system, 5-year-old children must enter kindergarten in order for them to be admitted to grade 1. Furthermore, when students finish their 4 years in junior high school, they are considered to have completed grade 10. Students must finish an additional two years of senior high school to be considered a high school graduate.

School	Grade	Age	Completion Ceremony
Kindergarten Compulsory	Kindergarten	5	Moving up
Elementary School Compulsory	Grade 1	6–7	Graduation
	Grade 2	7–8	
	Grade 3	8–9	
	Grade 4	9–10	
	Grade 5	10–11	
	Grade 6	11–12	
Junior High School Compulsory	Grade 7	12–13	Moving up
	Grade 8	13–14	
	Grade 9	14–15	
	Grade 10	15–16	
Senior High School Compulsory	Grade 11	16–17	Graduation
	Grade 12	17–18	
University	4 -5 Years	18–onwards	Graduation

Table 2 - The Philippine K-12 Curriculum (June 6, 2011, to present).

2.2 Japanese Educational System

Japan's Ministry of Education, Culture, Sports, Science, and Technology (MEXT) sets policies and curriculum standards from kindergarten to senior high school level, both private and public. The basic education, elementary to senior high school, is centralized such that even the textbooks to be used by students must be approved by MEXT for alignment with the set learning competencies. Table 3 shows the Japanese educational system. The education system has six years of elementary school, three years of junior high school and three years of senior high school. Although optional, most Japanese children enter early Kindergarten education. Only elementary school and junior high school are compulsory, but most junior high school graduates proceed to senior high school.

School	Grade	Age	Completion Ceremony
Kindergarten Optional	Kindergarten	3-5	Graduation
Elementary School Compulsory	Grade 1	6–7	Graduation
	Grade 2	7–8	
	Grade 3	8–9	
	Grade 4	9–10	
	Grade 5	10–11	
	Grade 6	11–12	
Junior High School Compulsory	First	12–13	Graduation
	Second	13–14	
	Third	14–15	
Senior High School Optional	First	15–16	Graduation
	Second	16–17	
	Third	17–18	
University	4 Years	18-onwards	Graduation

Table 3 - The Japanese Educational System.

3 The Astronomy Curriculum in the Basic Education in the Philippines and Japan

3.1 Objectives and Features of Science Curriculum

Each country has its own design of the science curriculum. It is shaped by their objectives and it depends on the expected quality of student achievement at the end of schooling. The new Philippine curriculum designed by DepEd aims to nurture the Filipinos to have scientific literacy for them to be knowledgeable and responsible citizens; to apply scientific knowledge in everyday life; to be innovative thinkers, and to be critical problem solvers. On the other hand, the new Japanese curriculum standard announced by MEXT in 2017, aims to nurture Japanese students to have a deep understanding of nature; to have scientific views and ways of thinking; to cultivate a scientific attitude and the ability to conduct scientific research. The curricula of both countries aim to make citizens not only scientifically literate but also to have the scientific attitude to be critical thinkers and creative problem solvers. Both the Japanese and Filipino science curriculum follow the spiraling curriculum concept. The spiral curriculum is a design where students revisit the topics in the duration of their school career (e.g., BRUNER, 1960). As they repeat these topics, the complexity increases. Therefore, the students can relate their new learnings from their old learnings. It also strengthens their learning each time they repeat the topic. Both the Japanese and Philippine governments want the curriculum to be relevant to the learners. In order to achieve such objectives, both curricula were designed to be student-centered to ensure meaningful learning experiences. In a student-centered classroom, the students play an active role to build knowledge and skills, in addition, to independently solving problems.

From 2000, Japan introduced "*Sogo-teki na gakushu no jikan*," the Period of Integrated Study. With this system, teachers practice the best way to integrate different subjects to their classroom. The aim is to make the class more relevant to the daily lives of the students and to encourage inquiry-based learning. It gives great emphasis on science practical skills, using the problem-based approach to enable students to respond to issues and problems (KIYOHARA, 2017). It guides the students in observing and exploring nature, and in finding solutions to problems. With this approach, students can see the connection between their learning and real-life situations, thus giving them the enthusiasm to learn science (GARDNER, 2016).

The Philippines lags behind other countries in terms of economic progress and human development (e.g., UNDP…, 2019). Before the education reform, poor quality education is evident in the country. The Philippines participated in 1999, 2003, and 2008 TIMMS and achieved the lowest scores compared to all participating countries. In addition, the scores in the National Achievement Test showed that the students' mastery in mathematics and science is also substandard (SARVI *et al.*, 2015). One of the weaknesses of the old curriculum is the congestion of topics that results in a low-level of comprehension and mastery of these core subjects (PHILIPPINE, 2011). The government decided to lengthen the years of education to give enough time for mastery and change the curriculum design and learning competencies to comply with the global standards. Improving the content of the science curriculum and promoting research and development to increase the scientific population is a step to address the issues of human development and quality education.

To improve students' mathematical, scientific and linguistic capabilities, the curriculum uses different approaches such as interdisciplinary approach, contextual learning approach, problem-based learning and inquiry-based approach to acquire the three domains of learning science – knowledge, skills, and attitude[6]. The curriculum does not limit the teacher to use only one approach; moreover, it encourages teachers to use several methods to enable more effective student learning. Most teachers use the inquiry-based approach where they allow the students to discover through asking questions, to explore and involve themselves in the process of learning. With this approach, students are motivated to learn, to enhance their creativity and to develop communication skills and eventually relate their learning to real-life situations with the help of hands-on experiences (BONDOC, 2016).

3.2 Science Curriculum Content

Science as a subject in both countries starts in grade 3 of elementary school. The science subject in both elementary and junior high school is mandatory. Table 4 shows how science content in elementary and junior high school is divided into parts. In Japan, science is a single subject in elementary school and science in junior high school is also a single subject, but the contents are divided into 2 parts – Matter/Energy and

[6] Enhanced Basic Education Act of 2013. Section 5 (c): www.officialgazette.gov.ph/2013/05/15/republic-act-no-10533/.

Implementing Rules and Regulations of The Enhanced Basic Education Act of 2013, Rule II Section 10.2 (e): https://www.officialgazette.gov.ph/2013/09/04/irr-republic-act-no-10533/.

Life/Earth. On the other hand, the Philippine science subject is divided into 4 parts: 1) Matter, 2) Living Things and Their Environment. 3) Force and Motion and 4) Earth and Space. In Japan, the Astronomy-related topics are included in the Life/the Earth part of Science while in the Philippines, it is included under Earth and Space. The references of the curricula of both countries are summarized in the note added in the end.

Japan Elementary School	**Japan Junior High School**	**Philippines Elementary and Junior High Schools**	**Corresponding Specialized Subject**
Science	Matter/ Energy	Matter	Chemistry
		Force and Motion	Physics
	Life/The Earth	Living Things and the Environment	Biology
		Earth and Space	Earth Science

Table 4 - Science Subject in Elementary and Junior High Schools in Japan and the Philippines.

Table 5 shows how the science course in senior high school is prepared. In Japan, Science in senior high school has divisions by discipline – Biology, Chemistry, Physics, and Earth Science. These divisions have basic and advanced subjects. The students have to choose among these subjects, they either choose three basic science subjects or choose Science of our Daily Life, an integrated subject, and one from the basic science subject. There is also another optional subject which is a science research task. Most students choose Basic Biology, Basic Chemistry, and Basic Physics. In 2015, 26.9% of the senior high school students chose Basic Earth Science and 0.8% chose Earth Science, in which most of the Astronomy topics are included.

The senior high school in the Philippines adopts a new system. These additional two years are the bridge between junior high school and tertiary education. The senior high school curriculum consists of three types – the core subjects, specialized and applied subjects. Students must take the core subjects that are aligned with the competencies set by the DepEd for elementary and junior high schools. In addition, some of the General education subjects in the tertiary level old curriculum are included in the senior high school curriculum. In the Philippines, science subjects are included in the core subjects of an Academic track. There are several strands in the academic track such as Science, Technology, Engineering and Mathematics (STEM) strand. If the student chooses another strand, they are referred to as Non-STEM students. Non-STEM students must take Physical Science, and Earth and Life Science; while STEM students must take Earth Science as their core subject. In addition to the core subject of the STEM students, they also have to take all specialized subjects – Biology, Chemistry, and Physics. They must also conduct a research project related to science. Most of the Astronomy topics are included in the Earth Science subjects but there are topics included in the Physics subject.

Japan	Philippines	
	STEM students	Non-STEM students
Basic Biology and Biology Basic Chemistry and Chemistry Basic Physics and Physics Basic Earth Science and Earth Science Science of Our Daily Life	General Biology 1 and 2 General Chemistry 1 and 2 General Physics 1 and 2 Earth Science (core) Disaster Readiness and Risk Reduction (core) Research	Physical Science (core) Earth and Life Science (core)

Table 5 - Science Subjects in Senior High School in Japan and the Philippines.

3.2.1 Astronomy-related topics in Elementary School

Table 6 shows the Astronomy topics learned by elementary school students in Japan and the Philippines. Most of the topics focus on the Sun, Moon, and stars. The learning competencies in the elementary level pertain to the understanding of observable heavenly objects and their movements and how their movements affect human life. The competencies establish the connections between a student's daily observations and experiences with science. Although both curricula follow the spiraling concept, there is no Astronomy topic assigned to Grade 5 Science in Japan.

Grade Level	Japan	Philippines
Grade 3	Shadow and the movement of the Sun	Natural objects in the sky affect one's daily activities
Grade 4	Motion and phases of the Moon Motion, color, and brightness of stars	Shadow and motion of the Sun Importance and effects of the Sun
Grade 5	None	Phases of the Moon Relation of Moon's motion with the length of a month Constellation (star patterns seen at particular times of the year)
Grade 6	Phases of the Moon Position of the Sun and the Moon Lunar surface	Motion of the Earth and its effects Characteristics of planets and their position from the Sun

Table 6 - Astronomy-related topics in Elementary School.

3.2.2 Astronomy-related topics in Junior High School

Table 7 shows the Astronomy topics learned by junior high school students in Japan and the Philippines. The discussion about the Sun, Moon, season, Solar System and stars use observational data to explain and fully understand the workings of these celestial bodies.

The topics of the Sun, its position and its effects on the seasons as discussed in the Philippine curriculum, is not as detailed as in the case of the Japanese system where discussions are in terms of locations in the celestial sphere. On the other hand, The Philippine curriculum includes the traditional beliefs and practices to enable students to analyze how early Filipinos interpreted astronomical phenomena and to identify their scientific basis. The 1st and 2nd-year junior high school in Japan do not have Astronomy topics in their science subjects. There is, thus, a 2-year gap between grade 6 elementary school and 3rd-year junior high school (MATSUMURA, 2008). On the other hand, Astronomy topics in the Philippines are continuous until grade 9 junior high school. The Grade 10 science subject does not include any Astronomy topics.

Grade Level	Japan	Philippines
1st year / Grade 7	None	Position of the Sun and seasons – tilt of the Earth, length of day, height of Sun in the sky and amount of energy received Seasons in the Philippines Solar and lunar eclipses
2nd year / Grade 8	None	Other members of the Solar System – asteroids, comets, and meteors
3rd year / Grade 9	Celestial sphere Diurnal motion of celestial bodies and rotation Annual motion and revolution – changes in the length of day and night due to Sun's culmination Characteristics of Sun Motion and phases of the Moon Solar and lunar eclipse Characteristics of planets Structure of the Solar System based on observation data – phases of Venus Characteristics of stars Milky Way Galaxy - as a collection of stars	Characteristics of stars based on the characteristics of the Sun Constellations and its movement in the sky Beliefs and practices about constellation and astrology
Grade 10	N/A	None

Table 7 - Astronomy-related topics in Junior High School.

3.2.3 Astronomy-related topics in Senior High School

Table 8 shows the Astronomy topics in senior high school. Astronomy contents in both countries are mainly included in the Earth Science subjects.

In Japan, students choose some from the science subjects; therefore, not all students take Earth Science. The topics included in the Earth Science subject are about the Sun, stars, Solar System, galaxies, and the universe. Some Astronomy-related topics are also included in the Physics subject such as Gravitation and Kepler's Law.

In the Philippines, all academic track students must take Earth Science for STEM strand; and Earth and Life Science and Physical Science for Non-STEM strand. Hence, most students can continue to learn more about Astronomy. The topics include models and formation of the Solar System; formation of the universe and Big Bang Theory; models of the Solar System and telescope. Some Astronomy-related topics are also included in the Physics subject such as Gravitation and Kepler's Law.

Japan		**Philippines**	
Subject	**Content**	**Subject**	**Content**
Basic Earth Science	Composition of universe Galaxies Characteristics of Sun and stars Evolution of stars Evolution of Solar System Characteristics of the earth	Earth and Life Science (Non-STEM students)	Formation of the universe and Solar System
Earth Science	Motions of the earth Characteristics of Solar System bodies Motions of the planets Sun's interior and activity Characteristics of stars Evolution of stars Structure of the Milky Way galaxy Expanding universe	Physical Science (Non-STEM students)	Elements during Big Bang and stellar evolution Diurnal motion, annual motion, and precession Models of the Solar System – Ptolemy, Tycho, and Copernicus Telescope Kepler's Laws of planetary motion
Physics	Newton's Law of Gravitation Kepler's Laws of Planetary Motion	Earth Science (STEM students)	Formation of the Solar System Origin of the universe and Big Bang theory
		Physics (STEM students)	Newton's Law of Gravitation Kepler's Law of planetary motion Telescopes

Table 8 - Astronomy-related topics in Senior High School.

3.2.4 Astronomy Research in Senior High School

Both senior high school students in Japan and the Philippines have research subject. Research is a good venue for students to apply scientific concepts and strengthen their investigative and scientific skills. Astronomy as a subject is interesting but it can be quite challenging as a research topic. Therefore, only a few numbers of students choose Astronomy as their research topic.

In Japan, some universities and the prefectural governments host research congress where senior high school students can present their research. For example, Osaka Kyoiku University, one of the core teacher-training universities in Kansai area in Japan, hosts annual presentation day for high school students. Students from Kansai area, namely region including Osaka and Kyoto, and other farther regions presented their Astronomy research at schools to fellow students, their teachers and university professors. Another example is the annual "Wakayama Prefecture High School Student Scientific Research Presentation" where the Super Science High School Students in Wakayama Prefecture present their research. This kind of presentations is held in many prefectures all around in Japan. Student research about Mathematics, Physics, Chemistry, Biology, Earth Science and Engineering were presented. This is a good venue to communicate and promote research among the students, teachers and the community. Though there are successful examples as described above, the number of schools which are proactive in research activity is still not so large. High school-university collaboration is one of the key drivers for developing the activity.

In the old curriculum of the Philippines, students conducted research focused on Mathematics, Physics, Chemistry, Biology, Engineering, and Earth Science, particularly Geology, but then, among the students under the new curriculum, there were those who did Astronomy research. The practice of holding Astronomy research events started when the first batch of students in the new curriculum were in their senior grades. One of the universities that regularly host research congresses, the Rizal Technological University (RTU), hosted its first Astronomy and Space Science Research Gala for senior high school students in 2017. Although only a few students from public and private school participated, it was seen as a good start to promote Astronomy research among high school students.

4 Astronomy Education in Higher Education

All of the 8 areas from north to south in Japan have universities that offer Astronomy course for undergraduate and graduate students in various fields[7]. They have a wide selection of departments such as space science, aerospace engineering, astrophysics, planetary science and Astronomy education. These universities have academic staff that are experts in various specific fields in Astronomy. They are also equipped with laboratories and observatories for Astronomy research. Aside from university observatories, students can also conduct their research in joint usage system with open proposal system at professional observatories such as the National Astronomical Observatory of Japan (NAOJ). In addition, research papers in Astronomy are also published in national and international journals, and conference proceedings.

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[7] Universities in all prefectures in Japan offer astronomy courses. Though the lists are written in Japanese and based on the voluntary work, there are several web sites, "List of universities where staff offers astronomy course" for high school students, based on the questionnaire to the university staff;
www.solato.net/solawomanabu/college/
https://astro-bu.com/university/

The Astronomy education institution in the Philippines is limited compared to Japan. Most of the students enroll in the Physics Department or study abroad to pursue careers in Astronomy. The first Astronomy course in the Philippines was offered by the National Institute of Physics (NIP) of University of the Philippines (UP) in 2002. Physics and Astronomy for Pedestrians for non-Physics Majors is a subject that served as an introductory course in Physics and Astronomy. As of 2014, there are two universities in the Philippines that offer Astronomy degree to undergraduate and graduate students – Rizal Technological University (RTU), a state university, and New Era University (NEU), a private university. RTU is the first university in the Philippines to offer MS Astronomy and Diploma Course in Astronomy in 2005. It was initiated by the former RTU President Dr. Jesus Rodrigo Torres. Then in 2007, RTU offered a Bachelor of Science in Astronomy for undergraduates followed by NEU in 2014. There are only a few permanent academic staff in these universities and most of them are alumni of RTU, while most of the temporary staff are visiting professors from other schools or have a degree majoring in Physics. Students conduct their research in the RTU observatory and in the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) Astronomical Observatory, a public observatory. In addition, Astronomy research in the Philippines is starting to increase and some are published in international journals. Most of the Astronomy research topics focus on light pollution, ethnoastronomy, and Astronomy education.

5 Informal Astronomy Education

Astronomy is not only learned within the formal classroom. There are other ways to study Astronomy. One way to know more about Astronomy is through informal education. Planetariums, public observatories, and Astronomy outreach programs conducted by amateur astronomers, universities, and enthusiasts help promote Astronomy to the public.

Japan has numerous planetariums and there are some observatories that are open to the public throughout the country. Children and adults can learn more about the position of stars and celestial objects by watching planetarium shows. In addition to that, educational or outreach institutions and local community associations provide seminars to people who are interested to learn more about Astronomy and to enhance their practical skills. An example of these seminars is the Star Sommelier (SHIBATA, *et al.*, 2018). The course includes the history of Astronomy, practical Astronomy and cultural Astronomy. There is also certification at the end of each lesson declaring that the participants understood and finished the lessons.

In the Philippines, there are few private and public institutions that have planetariums. Most of these planetariums are situated in Metro Manila. Some places in the country may not have planetarium, but their skies are beautiful due to the absence of light pollution. There are astronomical private organizations in the Philippines that help promote Astronomy to the public. These organizations comprise of Astronomy enthusiasts with the common goal of raising Astronomy awareness in the country. They conduct outreach such as seminars, star watching parties and other events especially during the National Astronomy Week in February.

In addition, the Philippine government, through PAGASA, issues news articles to announce and explain occurrences like solstices, equinoxes, eclipses, conjunctions and near approaches of planets. A recent example is the news feature of the longest day on June 21, 2019. Newspapers and video clips on TV are excellent means of promoting Astronomy among the populace.

6 Conclusions

The aim of the study is to compare the science curricula and the inclusion of Astronomy topics in the Philippine and Japanese education. Japan has a long history and has established its name in the world as one of the top-performing countries in science education. The Philippines changed the curriculum by adding more years of mandatory basic education, aiming to strengthen science education. As we present in section 3, both countries aim to nurture their citizens to become scientifically literate, have the scientific attitude and become critical problem solvers. While the Japanese science curriculum focuses more on the solving of real-life problems, the Philippines focuses more on developing student motivation to discover, learn and solve problems.

We also present in section 3 that the Astronomy topics in both countries, including the concept of the motions of celestial objects, motions of the Earth, stars, and the Universe, are almost the same. They both emphasize the use of observations in making Astronomy more understandable and applicable to the lives of students. In the new science curriculum of the Philippines, Astronomy topics are widely spread within basic education. Students have more time and exposure to Astronomy concepts. In Japan, however, there is a gap between the elementary and junior high school because there are no Astronomy topics in 1st and 2nd junior high schools. In addition, not all senior high schools take Earth Science subjects where Astronomy topics are studied. In terms of content, the Philippine education system is richer in Astronomy education in basic education.

Although few senior high school students in Japan take the Earth Science subject, the educational institutions promote Astronomy research by hosting research congresses. Japan has more astronomical research conducted by high school students compared to the Philippines as presented in section 3. Conferences serve as venues to learn more about innovations in Astronomy education.

As presented in section 4, in most developed countries like Japan, universities offer a lot of opportunities for high school graduates to pursue Astronomy careers. They offer a variety of Astronomy courses taught by experts in different fields of Astronomy. They are also equipped with laboratories and observatories for Astronomy research. The Philippines has limited higher educational institutions and facilities to conduct Astronomy research, but it is on its way to improve the status of Astronomy education in higher education. This should be based on the richer Astronomy research and presentation activity in high school.

Although both countries have facilities and activities to promote Astronomy to the public, Japan has a greater number of high-level facilities than the Philippines. This environment seems to contribute to richer Astronomy research and presentation activity in Japan. Offering seminars as a way to educate the public is also practiced in both countries. These help amateur enthusiasts, museum staff and in-service teachers to learn and experience Astronomy.

To summarize the comparison between Astronomy education in the Philippines and in Japan, it can be said the Astronomy contents in the Philippine curriculum are more extensive. In the case of Japan, although Astronomy education contents in elementary and high schools are not as extensive, there are many opportunities for Japanese high school students to present and exhibit their research; for amateur astronomers and school teachers to join the training activities; and for high school students to choose from among many universities and institutions to pursue their Astronomy research. It is not just the obvious formal curriculum that creates an enriching background environment described above as an important factor for maintaining the high-level science education throughout the country. Obtaining such rich background environment needs both long-term formal and informal education.

Acknowledgments

We would like to express our sincere gratitude to Ms. Pamela Luz C. Labios of Dalandanan High School and Ms. Rose Ann B. Bautista of Rizal Technological University for sharing their expertise and insights that greatly assisted this research. We would also like to thank Mr. Delfin C. Angeles of Philippine Science for his help in preparing the final manuscript. Finally, we would like to thank anonymous referees for their valuable comments.

Note

Philippine standards:

1. Science for Elementary and Junior High School
   www.deped.gov.ph/wp-content/uploads/2019/01/Science-CG_with-tagged-sci-equipment_revised.pdf

2. Senior High School
   a. Earth and Life Science
      www.deped.gov.ph/wp-content/uploads/2019/01/SHS-Core_Earth-and-Life-Science-CG_with-tagged-sci-equipment.pdf

   b. Physical Science
      www.deped.gov.ph/wp-content/uploads/2019/01/SHS-Core_Physical-Science-CG_with-tagged-sci-equipment.pdf

   c. Earth Science
      www.deped.gov.ph/wp-content/uploads/2019/01/SHS-Core_Earth-Science-CG.pdf

   d. General Physics 1
      www.deped.gov.ph/wp-content/uploads/2019/01/General-Physics-1-1.pdf

e. General Physics 2
www.deped.gov.ph/wp-content/uploads/2019/01/General-Physics-2.pdf

Japanese standards:

Science for Elementary, Junior and Senior High School
www.mext.go.jp/a_menu/shotou/new-cs/1384661.htm
Announced officially and shown on the official web site in 2017 and 2018 by Ministry of Education, Culture, Sports, Science and Technology, Japan.

The standards are not translated into English so far, therefore, one of the authors (AT) translated the contents into English for the paper.

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Artigo recebido em 12/01/2020.

Aceito em 04/06/2020.