



Through the teacher's lens: Evaluation of the project-based curricula of Philippine and Japanese science high schools

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Abstract

Specialized science, technology, engineering, and mathematics (STEM) high schools provide intensive learning experiences for advanced learners. At the core of these STEM, schools are a project-based (research) curriculum that aims to foster research culture among learners, creating critical thinkers and problem-solvers, preparing them to be globally competitive STEM professionals in the future. The Philippine STEM junior high school's system and Japan's Super Science High (SSH) are amongst implementers of the project-based (research) curricula. Hence, this paper sought to conduct a critical review of these project-based curricula through quantitative analysis of Filipino and Japanese teachers' perceptions of its effectiveness along the four dimensions of Tyler's Objective-centred Model for curricular evaluation. Findings show similarities and significant differences in the perception of the project-based curricula' effectiveness between Filipino and Japanese teachers along the four dimensions of Tyler's Objective-centred Model: (1) learning objectives; (2) learning experiences; (3) organization of learning experiences; and (4) evaluation methods.

Keywords: Project-based Curriculum, Research, STEM, SSH.

Introduction

While STEM-focused specialized schools are of today's research interest, the existence of such schools has been recorded for over 100 years. Specialized secondary schools were established in response to economic, political, and educational currents (Thomas & Williams, 2010). Most particularly after World War II, the United States began instituting specialized science high schools to foster future scientists' and engineers' development. Specialized science, mathematics, and technology-focused high schools offer intensive education for developing science talent at the secondary level (Kettler & Puryear, 2018). These schools provide advanced learning experiences for gifted and advanced students by offering advanced curricula that

emphasize a higher understanding of the sciences and mathematics. Kettler and Puryear (2018) further claimed that specialized schools for science and mathematics include students' engagement in research or project-based studies who are guided by "faculty members who are experts in content and research methodologies". Engagement in project-based studies or research of students and mentorship of faculty are "two of the most distinctive features that separate specialized high schools from tradition high school programs for gifted and talented science and mathematics students".

Japan's Ministry of Education, Culture, Sports, Science, and Technology (MEXT) adopted the "Science Literacy Enhancement Initiatives" in 2002 to implement

comprehensive policies to support and promote science and technology education with a focus on project-based study activities. One of the main contents of this plan is to designate schools that prioritize science, technology, and mathematics education as "Super Science High (SSH) Schools," and research and develop policies for education courses placing importance on science and mathematics and for active cooperation with universities and research institutions.

In 2002, the first year of its operation, 26 schools were awarded the SSH status. In 2007, 101 schools were designated. As of 2020, 178 schools were awarded such designation, committed to being involved in developing science and technology education, including research and development amongst students in Japan (Japan Science and Technology Agency, 2017). These schools received governmental subsidies to prepare equipment, materials, and consumables required for students to conduct experiments in pursuit of research and development. Furthermore, designated super science high school programs can conduct their original experimental curriculum without being bound by national curricula (Science and Technology System Reform, 2008). Hence, various schools in Japan with SSH designations are free to make their unique curricula, particularly in the implementation of research classes.

On the other hand, cognizant of the need to also strengthen science and mathematics education in the country, the Philippine government has started several programs in basic education, particularly at the secondary level. Thus, the creation of the Science, Technology, Engineering, and Mathematics Education Program (STEM, formerly Engineering and Science Education Program or ESEP). The STEM program is a science and mathematics-oriented curriculum devised for high schools in the Philippines. Supervised by the Department of Education, specialized high schools offer the STEM program. Currently, more than 150 high schools are offering the STEM program, the

majority being public. It was piloted in 1994 by the Department of Education, Culture and Sports (now DepEd) in collaboration with the Department of Science & Technology (DOST).

Currently, the Philippines STEM high school system is generally categorized into STEM high schools, Regional Science High Schools, and Philippine Science High Schools (PSHS) which offer curricula placing importance in mathematics, sciences, and research (project-based study). STEM high schools and regional science high schools are operated by DepEd, while the DOST operates the PSHS system. Collectively, these schools are formulated with the aim of not only putting importance on science and mathematics curricula but also improving science and mathematics research amongst students in basic education. The governmental subsidy was allotted for student science project-based studies, specifically in the form of support to the conduct of science and mathematics investigatory projects such as payment for laboratory analysis, supplies, rentals of equipment, spaces, and transport (DepEd Order No. 55 s. 2010 & DepEd Order No. 15 s. 2014).

Country-wide implemented curriculum in STEM high schools in the Philippines started with enriched science, mathematics, and English curriculum in addition to the standard requirements of the new secondary education curriculum (DECS Order No. 69 s. 1993). However, research opportunities were then limited to the third year (Research in Biology) and fourth year (Research in Physics) putting lesser emphasis on other scientific and mathematical fields. The program failed to provide novice student researchers enough time to follow the rigour of research writing having only two years to finish biology and physics research, respectively.

A revision was made with the release of DepEd Order No. 41, s. 2004, in which Research 1 (Basic Statistics in Research) is offered to second-year students and Research

2 (Research in Science) which tried to shift the former biology-physics dichotomy of research in high school to a more science-inclusive research course. Again, with this revision, another problem arose, that is, while statistics have been an essential concept in doing research, researching proper was limited to one academic year for students who are beginners in conducting research. Having limited time allotment for research conceptualization, research plan presentation, partnership with external institutions and laboratory, experimentation, and final research presentation, had become a struggle not only for inexperienced students but also for the facilitation of the teachers.

The two earlier project-based (research) curricula failed to provide the students enough time to follow the rigorous processes of doing research. Hence, in 2014, a significant facelift of research curriculum was proposed alongside the adoption of the current K to 12 basic education programmes of the Department of Education, which increase the number of years for basic education, i.e. addition of two years in high school which was separately called as Senior High School. The proposed science and technology-oriented high schools (STEM high schools) academic program this time includes research courses I to IV distributed across the four-year levels of the junior high schools (K to 12 special science program project-based (research) curriculum guide, 2014): Research I (Scientific Attitudes, Science Process Skills, and Basics of Scientific Method) for grade 7, Research II (Research Plan preparation) for grade 8, Research III (Experimentation and Data Collection) for grade 9, and Research IV (Improvement and Development of New Research and Research Presentation) for grade 10.

Curriculum evaluation is a vital aspect of any education system. This process provides a basis for curriculum policymaking and feedback for curriculum modifications and implementation (Wang, Wang & Meng, 2016). Guba and Lincoln (1981) suggested

putting importance on the aspects of merit (intrinsic value of the curriculum), and worth ("payoff" value of the curriculum) when evaluating curriculum. In other words, merit is an assessment of the content, programs, activities, and learning opportunities provided by the curriculum while worth assessment is its value in a specific application (Curriculum Evaluation, n.d.).

Now, this leads to the question, how can the merit and worth of such aspects of the curriculum be determined? One of the most popular models for curriculum evaluation is that of Ralph Tyler's (1950) Objectives-centred Model. Tyler's model evaluates the degree to which curriculum goals or objectives were achieved. Anh (2018) citing Popham (1995) discusses that the model mainly involves the "careful formulation according to three educational goals (the student, the society, and the subject matter) and two-goal screen (a psychology of learning and a philosophy of education)" (p.25).

Tyler (1976) discusses the four major dimensions or steps of curriculum evaluation: 1. Selecting educational purposes; 2. Selecting learning experiences; 3. Organizing learning experiences; and 4. Evaluation. These four dimensions should answer the following questions: *"What should the educational objectives of the curriculum be? What learning experiences should be developed to enable students to achieve the objectives? How should the learning experiences be organized to increase their cumulative effect? How should the effectiveness of the curriculum be evaluated?"*(p.42).

In the context of the current study, curriculum evaluation using the Tylerian Objective-centred model was used to compare the implementations of the project-based (research) curricula of Japan's Amaki Senior High School (Super Science High School) and Philippines Department of Education's Science, Technology, and Engineering (STEM) Program along four dimensions enumerated by Tyler.

This study aimed to compare the curriculum implementation of Japan's Super Science High School (SSH) and Philippines' Science, Technology, Engineering, and Mathematics (STEM) Program against the four dimensions of Tyler's Objective-centred model. Specifically, this study sought to answer the following question: What is the extent of effectiveness of the project-based (research) curriculum along the following dimensions as perceived by the teachers?

- a. formulated learning objectives of the project-based (research) curriculum;
- b. identified learning experiences in the curriculum to enable achievement of objectives;
- c. organization approaches of learning experiences; and

evaluation methods of the project-based (research) curriculum

Methods: Research Design

This research utilized a descriptive comparative research design.

The quantitative approach involved the use of a survey questionnaire measuring the

Table 1.0 Distribution of teachers from select science junior high schools and super high schools in the Philippines and Japan

Country	School	Number of Participants
Japan (23)	Tsuyama High School 岡山県立津山高等学校	5
	Ichinomiya High School 岡山県立岡山一宮高等学校	5
	Kurashiki Amaki High School 岡山県立倉敷天城高等学校	13
Philippines (35)	Baguio City National Science High School	5
	Bautista National High School	1
	Benigno V. Aldana National High School	2
	Bukidnon National High School	1
	Canan National High School	1
	Candaping National High School	1
	Don Ramon E. Costales Memorial National High School	3
	Guihulngan National High School-Poblacion	1
	Juan G. Macaraeg National High School	1
	Luna National High School	1
	Manoag National High School	1
	Mataas na Paaralang Neptali A. Gonzales	1
Marcelo H. del Pilar National High School	1	

extent of effectiveness of the identified curricular learning objectives, learning experiences, organization approaches, and evaluation methods of the project-based (research) curricula of the two STEM high school systems. These were assessed by teachers from both systems who are involved in the implementation of the project-based (research) curriculum.

Participants and Documents

Select teachers from Super Science High Schools in Okayama, Japan (n=23) and DepEd's STEM High Schools (n=35), who are involved in the implementation of the project-based (research) curriculum, answered a survey questionnaire measuring the extent of effectiveness along the following dimensions based on Tyler's Objective-centred model: *identified curricular learning objectives, learning experiences, organization approaches, and evaluation methods* of the research curricula of the two STEM high school systems. The profile of teachers are as follows:

Ozamiz City National High School	1
Puerto Princesa National Science High School	1
Quezon City Science High School	3
Sablayan National Comprehensive High School	1
San Fabian National High School	1
San Jacinto National High School	1
Manila Science High School	1
Tagbina National High School	1
Tarlac Montessori School	1
Tayug National High School	3
Valenzuela City School of Mathematics and Science	1

Data Gathering Instrument and Procedure

Teachers were asked to answer a 21-item questionnaire. The questionnaire used in this research consisted of carefully written subdimensions providing a comprehensive description of the four dimensions of Tyler's Objective-centred model. The subdimensions included are as follows: *self-sufficiency, comprehensiveness, validity, interest, significance, utility, learnability, and feasibility* for the identified curricular learning objectives; *validity, comprehensiveness, variety, interest, relevance to life, and suitability* for the learning experiences; *continuity, sequence, and integration* for organization approaches; and *variety, effectiveness, validity, and comprehensiveness* for evaluation methods. The domains, subdimensions, and their descriptors were written in both English and Japanese for the Filipino and Japanese teachers, respectively. Each subdimension is rated according to the extent of its effectiveness in the context of the project-based (research) curriculum among the following options: 4-strongly agree, 3-agree, 2-disagree, and 1-strongly disagree.

To ensure content validity of the crafted questionnaire, six curriculum developers and teachers from the Philippines and Japan were asked to rate it using a 4-level rating scale: 4-very valid, 3-valid, 2-somewhat valid, and 1, not valid. Collated ratings from the six curriculum developers and teachers were computed using Aiken's V validity estimation. An overall validity coefficient of

0.94 was computed which means that the crafted questionnaire is valid.

For the reliability or internal consistency of the questionnaire, 15 teachers from the Philippine Science High School campuses answered the survey. Gathered data were computed using Cronbach's alpha and showed excellent reliability with a coefficient of 0.98.

The validated and reliability-tested questionnaire was transformed in a Google Form® for easy administration and retrieval of data. This was also initiated due to travel restrictions and limited school access due to the ongoing Corona Virus pandemic. A survey questionnaire was administered to teachers from both STEM systems, i.e., Japan's SHS and Philippines' STEM HS, involved with the implementation of the project-based (research) curriculum. Overall, the questionnaire measures the extent of effectiveness of the project-based (research) curriculum according to the perspective of the teachers.

Data Analysis

Descriptive and inferential statistics were utilized to process the data that will be gathered from the survey on the extent of effectiveness of the research curriculum against the four dimensions of the Tylerian Model. Specifically, Mann-Whitney U-test was used to compare the difference between the perspectives of the teachers as to the extent of effectiveness of the project-based (research) curriculum along the four

dimensions. Interpretation of the gathered data is detailed in table 2.0

Table 2.0 Transformed scale of interpretation for the teachers' perceived level of effectiveness of the project-based (research) curriculum

Statistical Range		Level of Agreement	Interpretation: Teachers Perceived Level of Effectiveness of the Project-based (research) Curriculum
3.50	4.00	Strongly Agree	Extremely Effective
3.00	3.49	Agree	Effective
2.50	2.99	Somewhat Agree	Moderately Effective
2.00	2.49	Somewhat Disagree	Slightly Effective
1.50	1.99	Disagree	Least Effective
1.00	1.49	Strongly Disagree	Not Effective at all

Results, Findings, and Discussions: Perceived Extent of Effectiveness of the Project-based (research) Curriculum

The succeeding sections present the extent of effectiveness of the project-based (research) curriculum as perceived by teachers from the Philippines and Japan. The prepared survey questions focused on four (4) main dimensions, including the formulated learning objectives of the project-based (research) curriculum; identified learning experiences in the curriculum to enable achievement of objectives; organization approaches of learning experiences; and evaluation methods of the project-based (research) curriculum. A comparative teachers' perception from the Philippines and Japan on the four dimensions are shown in table 3.0 on formulated learning objectives, table 4.0 on learning experiences, table 5.0 on organization approaches of learning experiences, and table 6.0 on evaluation methods.

Formulated learning objectives of the project-based (research) curriculum

Concerning the learning objectives of the project-based curriculum, teachers from the Philippines and Japan answered the question, *“What is the extent of effectiveness of the formulated learning objectives of the project-based (research) curriculum?”* along seven sub-dimensions: self-sufficiency, comprehensiveness, validity, interest, significance, utility, learnability, and

feasibility. The evaluation questionnaire (see appendix A) details each subdimension.

Overall, Filipino and Japanese teachers pointed out that the overall effectiveness (Table 2.0) of the project-based (research) curriculum across the seven dimensions is “extremely effective”, with the latter slightly rating their curriculum higher. This means that the teachers from both countries perceived that learning objectives set in the project-based (research) curriculum are exceptionally laid to suit the needs of the STEM students who will be pursuing scientific and mathematical research projects. Specifically, these teachers rated “self-sufficiency”, “comprehensiveness”, and “validity” of the curriculum as “extremely effective”. This implies that the learning objectives embedded in the curriculum include contents or subject matter that can achieve the overall aim of the curriculum; that these objectives allow them to experiment, observe, and conduct field study; and that these objectives cover the three important domains of learning, that is, cognitive, affective, and psychomotor to allow holistic learning experience of the learners. Anderson et al. (2001) discussed that the diversity of learning tasks with the presence of these three domains creates a “comparatively well-rounded learning experience” for the students. In the context of the present research, the inclusion of these domains will target the significant points in

learning the basics and complexities of research-making.

Table 3.0 Perceived effectiveness of the formulated learning objectives project-based research curriculum along the following subdimensions between Filipino teachers and Japanese teachers and their associated *p*-values

Subdimensions	Filipino Teachers X_{PH}	Japanese Teachers X_{JP}	<i>p</i> -values
Self-sufficiency	3.83 - EE	3.87 - EE	0.69
Comprehensiveness	3.77 - EE	3.87 - EE	0.36
Validity	3.74 - EE	3.83 - EE	0.14
Interest	3.83 - EE	3.91 - EE	0.52
Significance	3.83 - EE	3.87 - EE	0.69
Utility	3.83 - EE	3.74 - EE	0.47
Learnability	3.77 - EE	3.91 - EE	0.11
Feasibility	2.60 - ME	3.78 - EE	<0.001**
Overall	3.65 - EE	3.85 - EE	0.08

Legend: EE-Extremely Effective; E-Effective; ME-Moderately Effective; SE-Slightly Effective; LE-Least Effective; NE-Not Effective at all

** significant at 0.01 level of significance

Furthermore, Filipino and Japanese teachers also rated the following learner-centred subdomains, “interest”, “utility”, and “learnability” of the project-based (research) curriculum as “extremely effective”. Teachers find that the objectives set in the program are formulated according to the interests of the learners, that these are according to the usefulness of the content and subject matter to the learners, and that these objectives are aimed to maximize the learning capacity and experiences of the learners. This concurs with the study conducted by the Japanese Science and Technology (JST) agency which reported that students who like science and mathematics subjects responded that the whole SSH program helped them to have more interest in the scientific fields (Wada, n.d.). It is extremely important that learners are at the central point of an effective curriculum as underscored by Jagersma (2010). Jagersma stated that curriculum is constructed with the learner as its central focus as it enables teachers to devise experiences to develop lifelong learners and responsible citizens. When learners are put at the forefront of effective research curriculum planning, learners will be capable of crafting

research that will be significant to them and the society beyond the walls of their classroom.

Lastly, in terms of the “feasibility” of the curriculum, Filipino teachers rated their curriculum significantly lower than how Japanese teachers rated theirs. Filipino teachers find that while objectives of the research curriculum are theoretically effective in the achievement of the overall aim of the research curriculum, that is, to develop an inquiry-based research project, available resources and allowable time to implement research topics are amongst pressing problems facing the research and development program of the Filipino teachers. In an in-depth interview with a Filipino research teacher, he said that learning resources including equipment to conduct scientific research proposals of the learners in science high schools are still scarce. While the curriculum’s learning objectives are smartly crafted, the feasibility to implement such objectives is still a problem to many Philippine government schools implementing STEM programmes.

On the other hand, Japan’s Super Science High Schools (SSH) are afforded with

progressing budget to orchestrate the very goal of instituting the program set by MEXT, that is, to provide hands-on and problem-solving learning in the students' project-based study through observations and experiments, conducting the project-based study by individual student or groups (Hasegawa, 2010). In fact, according to the report by Hasegawa (2010), from 2010 to 2014, the total budget downloaded for the super-science high program has doubled from 2010 to 2014, proving the dedication of the Japanese education ministry to develop human resources in the scientific and technological field. Furthermore, to meet these goals, the JST pays all expenses of SSH's activities instead of SSHs themselves, hence, Japanese students are fully provided with both opportunities and resources to further their skills in developing scientific and mathematical research. This, therefore, confirms the high rating of Japanese teachers of the "feasibility" of the SSH project-based curriculum.

Identified learning experiences of the project-based (research) curriculum

For the second dimension of Tyler's object-centred model, teachers from the Philippines and Japan answered the question, "What is the extent of effectiveness of the identified learning experiences in the curriculum to enable achievement of objectives?". The teachers rated the second dimensions among the following subdomains: validity, comprehensiveness, variety, interest, relevance to life, and suitability. According to Okunloye (2014), these criteria are non-negotiable in the selection of learning experiences and must be consistent with the rest of the stages of curriculum development.

Table 4.0 Perceived effectiveness of the identified learning experiences of the project-based research curriculum along the following subdimensions between Filipino teachers and Japanese teachers and its associated *p*- values

Subdimensions	Filipino Teachers X_{PH}	Japanese Teachers X_{JP}	<i>p</i> -values
Validity	2.74 - ME	3.70 - EE	<0.001**
Comprehensiveness	2.86 - ME	3.52 - EE	0.003**
Variety	1.77 - LE	3.57 - EE	<0.001**
Interest	2.74 - ME	3.09 - E	0.11
Relevance to Life	3.94 - EE	3.96 - EE	0.83
Suitability	3.83 - EE	3.91 - EE	0.37
Overall	2.98 - E	3.62 - EE	<0.001**

Legend: EE-Extremely Effective; E-Effective; ME-Moderately Effective; SE-Slightly Effective; LE-Least Effective; NE-Not Effective at all
** significant at 0.01 level of significance

From table 4 we know that overall, Filipino teachers in select STEM schools in the Philippines rated the Department of Education's project-based (research) curriculum, "effective" while Japanese teachers from SSH rated their curriculum "extremely effective". This means that overall, Japanese teachers find their project-

based curriculum filled with opportunities for students to interact with content toward its achievement, which includes experimenting and explorations. Filipino teachers, on the other hand, have significantly lower ratings than their Japanese counterparts along this dimension. These teachers feel that the learning experiences of the students

including the learning opportunities, activities, teaching-learning strategies, and methods need to be enhanced to meet the overall aim of the project-based curriculum.

In terms of the individual subdimensions, Japanese teachers rated the following significantly higher than the overall response of the Filipino teachers: validity, comprehensiveness, and variety. This means, for the SSH's project-based curriculum, learning experiences set in it cover all the stated objectives of the research course and are holistic. This implies that according to Japanese teachers, research learning experiences in their respective project-based are set according to cognitive (e.g., development of a research topic, analysis of data, etc.), affective (e.g., research procedures are bound by ethical considerations, etc.), and psychomotor objectives (e.g., research experimenting, etc.). Furthermore, the learning experiences in the SSH's project-based curriculum are perceived to be varied and differentiated. This includes the use of different modalities such as attendance at research conferences with invited research speakers, exposure to research laboratories, among others. True enough, with Japan's Ministry of Education, Culture, Sports, Science, and Technology (MEXT) adopting the "Science Literacy Enhancement Initiatives" in 2002, SSH students are provided with comprehensive and varied learning opportunities for budding researchers in the senior high school. Students are provided with many opportunities to further their understanding of conducting research such as in fieldwork, laboratory and museum visits, and research conferences. The whole agency strongly supports "research invitation lectures" which invite researchers and technicians to conduct lectures at SSHs through cooperation between education units and universities, allowing the students to experience and learn cutting-edge technology (MEXT, n.d.). A large number of SSHs cooperate with their neighbouring university on project-based studies, such as Okayama University, Hiroshima University, Mie University,

Osaka University, University of Tsukuba, among others (Hasegawa, 2010). By providing students with these learning opportunities, students are afforded practical and work-ready skills that apply to a real-life scenario and conceptualize and conduct research that can be utilized by their respective communities.

According to Kolb and Kolb (2005, p. 199), "true experiential learning can be labelled as an atmosphere created by the teacher to enhance the learning capacity of a learner". Accordingly, students who learn through project-based, experiential methodology can more readily grasp the first-hand intricacies of day-to-day life in real-world situations. Thompson and Edwards (2009) argued that learners who are engaged in projects related to real-world situations have proven to be a boon for not only the students but for the outside clients.

On the other hand, Philippines STEM schools, whilst seeing the importance of comprehensive and varied learning experiences for the students, are prevalently traditional (de Mesa & de Guzman, 2006), that is, learning concepts of the research course is still often limited to classroom teaching. This may be due to the following reasons: congested curriculum and lack of outside the school learning opportunity. In a report by Sunio (2018), the Philippines K to 12 curricula is cramped as compared to the other southeast Asian countries and claimed that students are confined inside the classroom for almost the whole year learning hundreds if not thousands of learning competencies stipulated in the curriculum with little to no exposure outside the school for fieldwork. The research curriculum for Grade 7 and Grade 8 alone are congested with competencies that are purely on knowledge learning rather than skill development. While some competencies require exposure to research laboratory techniques and attendance at research conferences, problem on the budgetary allotment to provide materials, learning resources, and attending symposia and conferences is still prevalent.

Secondly, on lack of outside the school learning activities, opportunities to tie up with neighbouring universities and laboratories are still a struggle for many schools, for lack of support by the school administration, unavailability of official guidelines by the Department of Education in partnering with institutions for laboratory use and lectures, and non-reception of students by some research institutions. Teachers' initiatives, with little to no budgetary support, to seek agreement with outside institutions are often the cases happening in the country.

However, in terms of interest, relevance to life, and suitability, both Filipino and

Organization approaches of learning experiences of the project-based (research) curriculum

The succeeding discussions deals with the third dimension of Tyler's objective-centred model deal centred on the organizational approaches of learning experiences of the project-based (research) curriculum (Tyler, 1976). In this part, Filipino and Japanese teachers answered the question, "*What is the extent of effectiveness of the organization approaches of learning experiences set in the project-based (research) curriculum?*". This Tylerian dimension is measured according to the following subdimensions: continuity, sequence, and integration.

Overall, both Filipino and Japanese teachers find that their respective project-based (research) curriculum "effective" in terms of the organization of learning experiences across the three subdimensions. This means both set of teachers perceive that learning experiences set in the project-based curriculum have continuity. This implies that

Japanese teachers rated highly. This means that learning experiences that are set in the project-based curriculum are of great interest to learners. Additionally, these learning experiences are perceived to be relevant to real-life situations, which implies that these experiences help learners understand their society and offer solutions to some problems through their project-based study. Lastly, both sets of teachers find that the learning experiences are suitable for the age or level of the learners and for the content for which it is meant. Research topics and procedures to be undertaken by the students are within their physical and mental capacity.

learners acquire new knowledge and, with mastery, develop progressively, systematically, and naturally with new knowledge building on earlier acquired knowledge. For example, learners conceptualize a research topic based on their research interest and later develop this topic through experimentation and data collection, to arrive at new knowledge. Furthermore, they perceived that their curriculum has a "sequence" which implies that learning experiences set in the project-based curriculum progress from lower to a higher level of knowledge, and from simple to complex. For example, learners transition from understanding basic and integrated science process skills to utilizing the scientific method, from formulating research objectives to designing the experiment, etc. Lastly, these teachers pointed that there is "integration" of learning experiences. This means that learning experiences set in the project-based curriculum integrate several subjects and areas. Knowledge and skills in sciences, mathematics, and other related fields are used in doing the research process.

Table 5.0 Perceived effectiveness of the organization approaches of learning experiences along the following subdimensions between Filipino teacher and Japanese teachers and its associated *p*-values

Subdimensions	Filipino Teachers X_{PH}	Japanese Teachers X_{JP}	<i>p</i> -values
Continuity	3.46 – E	3.48 - E	0.90
Sequence	3.49 – E	3.26 - E	0.19
Integration	3.49 – E	3.35 - E	0.46
Overall	3.48 – E	3.36 - E	0.36

Legend: EE-Extremely Effective; E-Effective; ME-Moderately Effective; SE-Slightly Effective; LE-Least Effective; NE-Not Effective at all

For the Philippines STEM research curriculum, from table 5 we know that curriculum is anchored on the general approach of the K to 12 curriculums, which aims to ensure continued learning through spiral progression, and that the curriculum shall use pedagogical approaches that are constructivist, inquiry-based, reflective, collaborative and integrative (Republic act no. 10533). Perez, Bongcales, and Bellen (2020) discussed that the move of the Philippines to adopt the spiral progression approach of the recently implemented curriculum is a means to be at par with the curriculum of high-performing countries such as Japan. In the context of the project-based curriculum in the Philippines, there is an evident continuity, sequence, and integration of the curriculum which realizes the aimed salient features of the K to 12 curriculums. The findings of Perez et al corroborate with the finding of the current research in terms of the positive reception of the organization of the learning experiences set in the project-based curriculum. For the earlier study, teachers regard positively on the curriculum organization, “viewing it as a learner-centred, advanced, and sophisticated way of organizing the contents of a curriculum” (p.10). However, from personal correspondence with some implementers of the research curriculum, they pointed topics set for grades 9 and 10 are less organized as compared to the grades 7 to 8 learning experiences, including the absence of the third quarter topics. Hence, teachers for the fourth research class find difficulty in distributing the topics for the whole academic

year especially in the said course which is implemented 4-days a week. Furthermore, the competencies for the fourth research course are found to be impossible to be implemented within classroom hours and within the school due to its time-demanding and laboratory-usage nature, when each class is only an hour-long, and laboratories are unequipped.

On the other hand, Japan’s curriculum has demonstrated coherence as evident in their performance in international assessments such as Trends in Mathematics and Science Studies (TIMMS) and Programme for International Student Assessment (PISA). According to Tan (2012), Japan amongst others follows a spiral progression and integrated approach to coherently implement science and mathematics topics, allowing them to perform highly in international assessments. Tan further discussed that international assessment studies have integrated questions and are based on a spiral progression of concepts; hence, the result of these assessments reflects the success of the organization of learning experiences illustrated in the curriculum. While implementation of the project-based curriculum varies amongst super science high-designated high schools in Japan, the general approach of each curriculum is bounded by a coherent and integrated national curriculum.

Indeed, the organization of learning experiences is vital in the success of the curriculum. Furst (1950) argued that

organization is important from the standpoint of the individual learner. First claimed that the extent to which various outcomes are organized may affect the individual's ability to generalize his learning from one content field to another and broader areas of everyday life. Without such organization, the possibilities of transfer and generalization are greatly limited and the individual's behaviour patterns may remain relatively compartmentalized. Thus, he may be effective in solving problems in one kind of situation but not in another. And even in a problem situation of a similar kind, he may not be able to interrelate effectively the kinds of reaction required for a satisfactory adjustment or solution.

Evaluation methods of the project-based (research) curriculum

The discussion that follows covers the perceived effectiveness of the evaluation methods of the project-based (research) curriculum. Filipino and Japanese teachers involved in the implementation of the research curriculum answered the question, "What is the perceived effectiveness of the evaluation methods of the project-based (research) curriculum along specific dimensions?".

Teachers rated their respective curriculum among the following domains: variety, effectiveness, validity, and comprehensiveness.

Generally, the teachers from the Philippines and Japan who are involved in the implementation of the project-based curriculum in their respective special science high school programmes perceived that evaluation methods incorporated in their project-based curriculum are effective. Firstly, there is a variety of methods used to assess and evaluate the attainment of goals of the project-based (research) curriculum other than written tests. Secondly, the tools of assessment employed within the assessment and evaluation process are used to effectively evaluate the attainment of the project-based (research) curriculum goals and objectives. Thirdly, in addition to assessing the cognitive development of the students, affective and psychomotor domains are included in the assessment providing a holistic assessment system of students learning. Lastly, the assessment and evaluation process is conducted in such a way as to assess comprehension, application, and evaluation of research knowledge and skill rather than mere retention of information.

Table 6.0 Perceived effectiveness of the evaluation methods of the project-based research curriculum along the following dimensions between Filipino teachers and Japanese teachers and its associated *p*-values

Subdimensions	Filipino Teachers X_{PH}	Japanese Teachers X_{JP}	<i>p</i> -values
Variety	3.46 - E	3.48 - E	0.67
Effectiveness	3.46 - E	3.43 - E	0.95
Validity	3.37 - E	3.43 - E	0.49
Comprehensiveness	3.54 - EE	3.48 - E	0.80
Overall	3.46 - E	3.46 - E	0.55

Legend: EE-Extremely Effective; E-Effective; ME-Moderately Effective; SE-Slightly Effective; LE-Least Effective; NE-Not Effective at all

From table 6, both the Philippines and Japanese curricula adhere to a variety of assessments in terms of evaluating the attainment of learning objectives set in each project-based curricula. Various forms of assessments are incorporated in these curricula including the traditional written

assessments, assignments, and progressive or alternative assessments such as collective portfolios, reflective essays, oral presentations, laboratory work, research reports (both paper output and multimedia presentation), amongst others. Rust (2005) underscored the importance of developing a

variety of assessment methods. Rust pointed out that when one varies methods in the assessment of student learning, it covers effectively the other three subdimensions of this domain, that is, variety enables assessment beyond cognitive learning which is commonly assessed in a typically written assessment.

However, one major difference between assessment practices of the two sets of teachers is that Japanese lessons promoted conceptual understanding and problem-solving in which students are freely allowed to use the class time for conceptualization, planning, experimentation, gathering of data, and presentation, with minimal supervision of the teachers (Hattori & Saba, 2008) heavier than Filipino teachers do. Accordingly, with the introduction of inquiry-based and project-based learning in Japan, “deep learning, dialogical learning, and self-directed learning” (p. 38) were highlighted to engage active learning in high school education (Shimajima & Arimoto, 2017). Shimajima and Arimoto indicated that “inquiry and project-based learning not only learning to promote both traditional competencies and new 21st century skills but also require the transformation of assessment process and strategies” (p.39). Hence, this enables Japanese teachers to accommodate assessment methods that engage Japanese students to achieve 21st-century skills. Interestingly, Japanese assessments are anchored into sociocultural contexts. These include *hansei* (reflection, a method used in Japanese schools for self-improvement, often collaborative self-improvement), *kodomo ni yorisou* (building rapport with the children), *Kodomo o mitoru* (understanding children), amongst others. Mikouchi, Akita, and Komura (2018) discussed further Japanese assessments for project-based learning are grounded on “knowledge structure and metacognitive” (p.375). Newer assessment tools besides traditional examinations are promoted. These include self-assessments, portfolio assessments, oral communication, amongst others.

Filipinos, on the other hand, still prevalently relied on traditional assessments, that is, viewing the teachers as the dispenser of knowledge. There is a significant attempt to transition to a lesser traditional approach in the Philippine classroom, especially in the context of teaching the project-based (research) curriculum such as for the oral presentation of research papers, especially that various forms of formative and summative assessments (both individual and collaborative) are encouraged by the Department of Education (DepEd Order No. 8, s. 2015). However, going back to the problems of lack of resources, teachers are left with no choice but to stick to the traditional approach of implementing the curriculum. Furthermore, beyond lack of materials for holistic assessment of attained objectives, other factors also play a significant role as to why many have heavily used traditional assessment approaches. In a study by Lasaten (2016), he found out that “paper and pencil” assessment methods such as multiple-choice tests, essay tests, amongst others are still a top choice amongst Filipino teachers due to its easier facilitation, checking, and scoring. Several pieces of research (Navarro & de Guzman-Santos, 2013; Senk, Beckmann, & Thompson, 1997; Taylor, 2010) also concluded that many teachers are still confined to conventional practices of assessment, due to familiarity and easiness of its facilitation. This concurs with the personal correspondence made with some teachers in the Philippines who affirmed that many research assessment practices still relied on the use of traditional assessment particularly on periodical assessment, assignments, quizzes, amongst others.

Furthermore, many teachers teaching the course are inexperienced in doing research, let alone facilitating a class on scientific research and mathematics research (Manalo, personal communication, December 23, 2020). Many of these teachers are assigned from a pool of mostly science teachers who may not necessarily have the experience of teaching the subject. Doganay and Ozturk

(2011) pointed out that inexperienced teachers have poorer judgments in conducting and implementing classroom assessments affecting the overall performance of the learners, and the failure to attain the intended objectives of the curriculum. They suggested that in-service programs covering various topics including classroom assessment must be conducted to promote metacognitive strategies into their classes.

Summary, Conclusions, and Recommendations

Both the Philippine STEM Junior High School system and Japan's Super Science High School system are founded on the same general idea, which is to provide advanced learning experiences for gifted and advanced students through the offering of advanced curricula that emphasize a higher understanding of the sciences and mathematics. Both systems believe in the importance of research and see it as an integral part of the whole STEM implementation in the basic education through the project-based (research) curriculum).

The present study attempted to quantitatively compare perceptions of the teachers as to the effectiveness of their respective project-based (research) curriculum along the four dimensions of Tyler's Objective-centred Model: (1) learning objectives; (2) learning experiences; (3) organization of learning experiences; and (4) evaluation methods. The perceived effectiveness of the learning objectives for both systems is very high citing that these objectives are laid out clearly to suit the needs of STEM students pursuing scientific and mathematical research. However, with the problem of resources available, the Philippines finds a lack of confidence in the feasibility in the achievement of some of its set objectives in which Japanese teachers do not find a significant predicament. On the other hand, Filipino and Japanese teachers differ in their perceptions of the effectiveness of the learning experiences, in which the

former indicates lower favourability of their set learning experiences which are limited to classroom teaching and theoretical knowledge acquisition with few to no practical knowledge acquisition. Furthermore, in terms of the organization of these learning experiences, the Philippines and Japanese project-based curricula are perceived to be effective. Personal experiences of some Filipino teachers reveal a lack of organization in the latter research courses due to missing learning competencies and its non-feasibility to be implemented. Again, this boils down to one major reason for the Philippines side, that is, lack of resources, funding, facilities (Rita, 2020), and support from the local to national government units (Julve, 2018). This is in contrast with the implementation of the curriculum in SSH-designated schools in which various Japanese funding authorities put priority in this area (JST, 2010). Lastly, Filipinos and Japanese teachers perceived similarly high effectiveness in the evaluation of the project-based (research) curriculum with differences in assessment practices. The latter implemented conceptual understanding and problem solving while the former prevalently relied on traditional assessments.

The Philippine implementation of the project-based research curriculum in special science high schools can learn a lot from their Japanese counterpart who has been successful and nationally recognized (MEXT) for introducing innovative practices for effective acquisition of both theoretical and practical knowledge about research. Philippine's curriculum must emphasize a balance of these two types of knowledge to develop human resources of well-rounded and holistic STEM professionals in the future. With the decline of the performance of Filipino students in international assessments in which Japanese students are ranking highly, a shift into this kind of theoretical and practical-based curriculum may just be the key.

Furthermore, the Philippines Department of Education, whilst having allocated funding

for STEM schools, must ensure that implementing rules and guidelines for its use are strictly followed and enforced. Furthermore, the department must give more fund allotment, support, and priority to STEM-implementing schools for teacher development, purchase of equipment, setting up of facilities, and amenities, to ensure that the learning experiences of students go beyond theoretical knowledge acquisition.

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