The Effectiveness of an In-Service Training of Early Childhood Teachers on STEM Integration through Project-Based Inquiry Learning (PIL)

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ABSTRACT

This article aims to establish the effect of a provision of an in-service professional development course for early childhood teachers on integrating STEM into early childhood education through **P**roject-Based **I**nquiry **L**earning (PIL). With the participation of 22 early childhood teachers in the three-day STEM Integration through PIL workshop using the context of 10 differing hands-on projects, this study employed an explanatory mixed-methods research design in which the quantitative data and analysis provide the main focus of the results while the qualitative data and analysis are used to elaborate on, refine, or explain the quantitative findings. In this study, the main foci were the effects of an in-service STEM Integration through PIL training workshop on early childhood teachers' self-perceived pedagogical knowledge, skills and attitudes, as well as their self-ratings on the in-service training. These quantitative findings are then elaborated on by means of participants' written comments. The findings indicated that the participants self-rated their STEM-related knowledge, skills and attitudes statistically significantly higher (p < .001) in the posttest as compared to the pretest. The qualitative data from the early childhood teachers with regard to their perceptions on the in-service training on STEM could be categorised into three main themes, namely interesting experiences, acquiring new knowledge, and sharing of ideas. This article culminates in a discussion on the outcome of this study in light of the related literature review on effective in-service training.

Keywords: Early Childhood; STEM; Project-Based Inquiry Learning; Science Education; Inquiry Learning.

INTRODUCTION

Malaysia places great importance on education as a means of becoming a developed nation by 2020. Accordingly, science education plays a big role as the catalyst in meeting the challenges and demands of our present and future economy. This has prompted the Malaysian government to institute the 60:40 Science/Technical: Arts (60:40) Policy in 1967 and started implementing it in 1970, because the National Council for Scientific Research and Development estimates that Malaysia needs 493,830 scientists and engineers by 2020 (Azian, 2015). However, the 60% ratio of students participating in Science/Technical has just yet to

be met. Statistics indicate that, as of 2014, only about 45% of students graduated from the higher secondary schools were from the Science stream, including technical and vocational programmes. Additionally, the percentage of secondary school students who chose not to pursue the Science stream despite meeting the requirement based on their Form 3 National Standardised Examination (PMR) had increased to approximately 15% (Azian, 2015).

The dismal uptake of science-based subjects is not idiosyncratic to Malaysia as it is rather pervasive across the globe. Taking United States of America (USA), for example, the National Science Board [NSB] (2010) reports that the numbers of USA high school graduates choosing to pursue a STEM-related field has declined steadily. In overcoming such decline, the NSB (2010) recommends that, in order to support the identification and development of talented young men and women who have the potential to become the next generation of STEM innovators, research-based STEM preparation should be provided for general education (elementary) teachers in the area of pre-service training and professional development. Besides, early exposure to STEM opportunities and the opportunity for students to engage in inquiry-based learning, peer collaboration, and open-ended real-world problem solving should also be provided to all students. Hence the current interest in promoting STEM (Science, Technology, Engineering, and Mathematics) – an acronym which has spread within the education community since its inception by the National Science Foundation (NSF) in the 1990s (Bybee, 2013).

Research indicates that the development of science talent begins in the early years and as such, the science proneness among children could be nurtured and cultivated through "evocative instruction, stimulating idea-enactive, inquiry-oriented behaviour consistently in the classroom" (Brandwein, 1995, p.41). Lending further support, Keeley (2009) stresses the importance of science in the early grades to maximize the cumulative learning processes involved in developing science talent and argues that if children are not given an early exposure to science instruction, their science achievement and conceptual understanding would subsequently be adversely affected. Moreover, Pratt (2007) claims that the curiosity and enthusiasm for science among children may continually diminish if not fostered in the early grades. Such diminution and attenuation of interest in science will lead to students either pursuing another interest apart from science, or losing the desire to take an advanced course in science.

Accordingly, in the interest of developing Malaysia's future STEM innovators, there is a need to revisit the early childhood program with the aims of uncovering opportunities to explicitly integrate STEM into the existing curricular, and providing in-service training to a group of early childhood teachers in terms of knowledge, skills and attitudes. This culminated in a proposed study on "STEM for Early Childhood Education in Malaysia" which was forwarded to the Early Childhood Division of the Malaysian Prime Minister's Department and was bestowed with a generous grant to conduct the proposed study. Given that the proposed study aimed to explore the feasibility of integrating STEM into the existing Early Childhood Curriculum, the research team, comprising all the authors, developed and trialled ten modules which integrate STEM Education. Since the trialling would be done by the early childhood teachers, a group of early childhood teachers who are willing to trial the STEM Education modules was identified and be given an in-service professional training on the integration of STEM Education in their respective early childhood classrooms.

Research on in-service professional development indicates the need for highly intensive training of 160 hours before any positive changes in teachers' attitudes towards any reform could be observed (Supovitz & Turner, 2000) and for the changes to have long-term effects in that they persisted several years after teachers concluded their training experience (Supovitz, Mayer, & Kahle, 2000). By contrast, some reviews on professional development indicate that narrowly focussed in-service professional development of moderate duration

(e.g., one day in total) can have a considerable and lasting impact on teaching & learning within, for example, narrowly specified aspects of elementary/secondary science such as the use of inquiry methods (Cordingley et al., 2015).

Additionally, it has been recommended that professional development programs aimed at the development of teachers' pedagogical content knowledge (PCK) should be organized in step with teachers' professional practice, providing opportunities to enact certain instructional strategies, and to reflect on their experiences individually and collectively (Evans, 1986; Klein, 2001; Van Driel & Berry, 2012). Accordingly, these beneficial recommendations were taken into account in the planning and implementation of this research.

This article aims to determine the effect of an in-service professional development course on STEM Integration through Project-Based Inquiry Learning for early childhood teachers, establishing its effect on the pedagogical knowledge, skills and attitudes, measured by means of a questionnaire that elicits teachers' self-rating and personal written responses. More specifically, this study aims to seek illumination to the following research questions:

(1) *What are the effects of an in-service STEM Integration through Project-Based Inquiry Learning (PIL) on early childhood teachers' self-perceived pedagogical knowledge, skills and attitudes?*
(2) *What are the participants' views with regard to the in-service training on STEM Integration through Project-Based Inquiry Learning?*

Stem Integration Through Project-Based Inquiry Learning (PIL)

One of the most important goals of education across all levels is to support and strengthen the disposition to go on learning throughout life, promoting life-long learning from early childhood (Katz, 2010). Therefore, a crucial question would be what experiences are most likely to foster the disposition to go on learning, particularly at early childhood?

Research indicates that when children engage in projects in which they conduct investigations and/or involve in creation or invention around their personal questions, their intellectual capacities are very likely to be provoked and utilized (Katz, 2010; Katz & Chard 2000; Helm & Katz, 2001) as supported by a plethora of reports of project work in the early years in each issue of Early Childhood Research & Practice (http://ecrp.illinois.edu). Furthermore, while academic instruction puts children in a passive and receptive role, engagement in projects puts children in an active and interactive role where they take responsibility and initiative in inquiring by means of generating questions which they would like to seek answers to; exploring by means of collecting relevant data or information culminating in a suitable design or procedures; investigating based on the procedures or inventing based on the design; and showcasing or reporting their work (Katz & Chard, 2000). Such positive role which provokes self-regulation, according to Blair (2002), optimizes early brain development when children are involved in synchronous interaction (i.e., interacting with one another rather than being mere passive recipients of isolated bits of information). Additionally, longitudinal studies (Golbeck, 2001; Marcon, 2002) indicate that preschool curriculum and methods which emphasize children's interactive roles and provide opportunities for them to exercise initiative yield better school participation and achievement in the long term. The study by Koc and Boyuk (2012) indicates that the use of hands-on science learning promotes better attitutes towards science amongst students.

Having delved into the literature on engaging in projects or project-based learning as a way forward in fostering the disposition to go on learning throughout life, what then is inquiry learning? Ansberry and Morgan (2005) define inquiry as "an approach to learning that involves exploring the world and that leads to asking questions, testing ideas, and making

discoveries in the search for understanding" (p. 17). Cincera (2014) summarises inquiry as being "interpreted as a holistic, student-centred approach to science education ... [in which] pupils follow a procedure similar to that of real scientists, i.e. they formulate their research questions and hypotheses, plan their research, collect, analyse, interpret data, and finally present what they have found" (p. 119). Meanwhile, The National Research Council (NRC) (1996) defines inquiry as "a multifaceted activity that involves making observations; posing questions; examining books and other sources of information to see what is already known; planning investigations; reviewing what is already known in light of experimental evidence; using tools to gather, analyse, and interpret data; proposing answers, explanations, and predictions; and communicating the results. Inquiry requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations" (p. 23).

In the context of early childhood education in Malaysia, while there is no explicit documentation of STEM in the Early Childhood Curriculum, elements of STEM can be inferred from the conceptual model of its curriculum as shown in Figure 1 which is lifted from PERMATA (2013, p. 34). "PERMATA", in the Malay language, means gemstone or diamond. The Malaysian Government believes that "every child is precious" just like a gemstone/diamond which needs to be cut, shaped, and polished to reveal its brilliant final beauty. Hence, the development of "*Kurikulum PERMATA Negara*" in 2007 which is the National Curriculum for Early Childhood Education for the 0-4 year olds, and was trialled and implemented nation-wide in 2008.
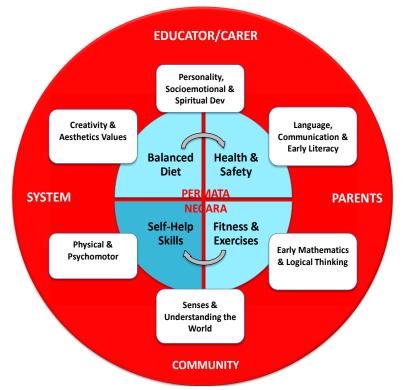

Figure 1. *Conceptual Model for the National Early Childhood Curriculum*

The conceptual model of the Malaysian Early Childhood Curriculum as depicted in Figure 1 shows the amalgamation of the four aspects in the Childcare component with that of the six Learning Areas for the Child Development achievable through the concerted efforts among the "Educator/Carer", "Parents", and the "Community" within a strong supportive "System" from the authorities. The four aspects of Childcare component are *Balanced Diet, Health & Safety, Self-Help Skills,* and *Fitness & Exercises*, while the six learning areas of

children development consisted of: (1) *Personality, Socio-Emotional & Spiritual Development*; (2) *Language, Communication and Early Literacy*; (3) *Early Mathematics and Logical Thinking*; (4) *Senses and Understanding the World*; (5) *Physical & Psychomotor*; and (6) *Creativity and Aesthetics Values*.

Among the six learning areas on children development, two of which allude to STEM, namely the (a) Early Mathematics and Logical Thinking, and (b) Senses and Understanding the World. The former matches the "Mathematics" part of STEM, while the latter, the "Science" part. However, there is a confusion as to what STEM constitutes as indicated by Bybee (2013) who laments that "there seemed to be a lack of clarity about the meaning of STEM" (p. ix), due to the fact that the "meaning or significance of STEM is not clear and distinct" (p. x). Bybee (2013) raises the question of whether STEM refers to "a school discipline such as science or mathematics? … [or, does it refer to] four separate disciplines: science, technology, engineering, and mathematics? Or [does it refer to an integration of] two, three, or all four STEM disciplines?" (p.1). In the context of early childhood education in this article, we take the position of STEM as being an integration of four STEM disciplines which will be further elaborated during the discussion on STEM integration through Project-Based Inquiry Learning (PIL).

One of the characteristics of children is their inquisitive nature, constantly asking questions about the world around them. This leads to the strong advocacy of inquiry-based science education which is in step with the contemporary views on construction of knowledge through active participation. While the early childhood curriculum in Malaysia does introduce "play pedagogy" (PERMATA, 2013, p.34) which entails exploration, experimentation and experiencing (3E), it is nevertheless devoid of the explicitly stated opportunity for children to inquire (I), and to collaborate, create and communicate (3C) which have been strongly advocated for by early childhood educators (Katz, 2010; Katz & Chard 2000; Helm & Katz, 2001). Hence, the theorisation of the Project-Based Inquiry Learning (PIL) which promotes the "I + 3E + 3C" by means of four interdependent phases, namely Inquiry, Exploration, Experimentation/Creation, and Reflection. Figure 2 illustrates the enhancement or up-scaling of Play-Based Learning (i.e., the PERMATA pedagogy) to that of Project-Based Inquiry Learning which is the STEM pedagogy that we proposed.
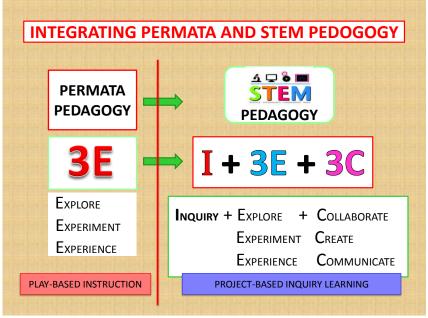

Figure 2. *STEM-Based Teaching and Learning Method*

Project-Based Inquiry Learning consists of four interdependent phases, namely Inquiry, Exploration, Invention/Experimental, and Reflection as depicted in Figure 3. Each of the four phases is briefly discussed in subsequent paragraphs using the context of "My Ship" which is one of the 10 projects designed to be used in familiarising early childhood teachers to the principles and practice of Project-Based Inquiry Learning.
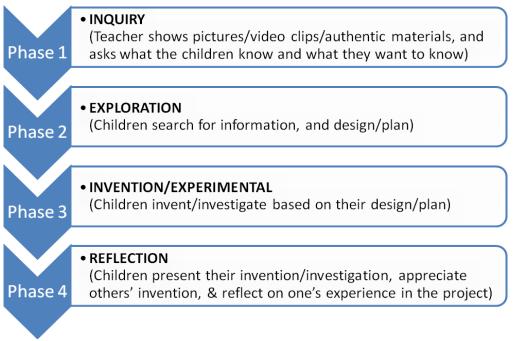
Phase 1
- **INQUIRY**
(Teacher shows pictures/video clips/authentic materials, and asks what the children know and what they want to know)

Phase 2
- **EXPLORATION**
(Children search for information, and design/plan)

Phase 3
- **INVENTION/EXPERIMENTAL**
(Children invent/investigate based on their design/plan)

Phase 4
- **REFLECTION**
(Children present their invention/investigation, appreciate others' invention, & reflect on one's experience in the project)

Figure 3. Project-Based Inquiry Learning Model

In the ***Inquiry Phase***, teacher begins the lesson by showing the children the phenomenon to be investigated in the form of a video clip, picture, and/or even authentic materials. In the context of "My Ship", the teacher shows clips of sailing ships. Two important prompts from the teacher based on the video clips, first being "what I know about ships", and second being "what I want to know about ships". Although many questions will be raised concerning the ships, it is expected that one question will match the learning objective(s), and in this case, "How do we build a ship?" Nevertheless, if the expected question was not posed or raised by the children, teacher can always direct children's attention towards ship construction, thus prompting children to ask the expected question.

In the ***Exploration Phase***, children search for information which will help them in their planning. In the context of "My Ship", children may explore a variety of things around them which float and the things which sink. Additionally, they may also think and attempt to make things which sink to float. They then determine the suitable materials to build a ship and plan a suitable design for their ships.

In the ***Invention/Experimental Phase***, children carry out the project or investigation or building a design according to the pre-planned design in the Exploration Phase. At this juncture, authentic real-life hands-on manipulative activities are used in the invention, and enhanced through the use of technology. The inventions, in this case, the ships, are put to the test in water. Children may even extend their inventions that include the challenge of making the ships move using a rubber band powered propeller. Besides, children are encouraged to work collaboratively, showing enthusiasm in undertaking the project at hand. In the **Reflection Phase**, children showcase and talk about their invention deriving from the project to their teachers, parents, or friends, which they have carried out. Additionally, children are encultured into displaying an appreciation towards the works of their peers. Meanwhile,

teacher displays children's invention to students, other teachers, educators and parents, encouraging them to reflect on how they produced the invention and what could be done to improve it. Essentially, reflection in this phase operates at metacognitive level in which children think about their own learning experiences (Bransford, Brown, & Cocking, 2000; Flavel, 1985).

In essence, the inquiry-based learning centres on "Inquiry" regarding a ship, culminating in a question on "how to build a ship?" which in turn, leads to the "Exploration" of the phenomenon on floating and sinking, and of information pertaining to ships of different shapes and sizes which concludes with a design of a ship. Such design will be accomplished and materialised through project-based "Invention", and this is then followed by showcasing and reflection of the completed projects/inventions/investigations, and appreciation of the projects by peers; hence the conceptualisation of Project-Based Inquiry Learning. The STEM integration in this Project-Based Inquiry Learning encompasses the *science* concepts on buoyancy and energy, the *technology* which is reflected in building ships, the *mathematics* which is manifested in size and symmetry in ships, and *engineering* which involves designing of a ship.

METHODOLOGY

a) Research Design

This study employed an explanatory mixed-methods research design (Creswell, 2005; 2009), in which quantitative data were first collected and it was then followed by the collection of qualitative data in order to help support, explain, or elaborate on the quantitative results. The rationale for this explanatory mixed-methods research design is that "the quantitative data and analysis provide the main focus of the results; the qualitative data and analysis are used to elaborate on, refine, or explain the quantitative findings" (Mertler & Charles, 2008, p. 291). In this study, the main foci were the effects of an in-service STEM Integration through Project-Based Inquiry Learning (PIL) on early childhood teachers' self-perceived pedagogical knowledge, skills and attitudes, as well as their self-ratings on the in-service training. These quantitative findings are then elaborated on by means of participants' written comments.

Specifically, in view of the exploratory nature of this research to determine the impact of the in-service professional development course on STEM Integration through PIL, the "one-group pretest-posttest design" (Gay & Airasian, 2009, p.389) was deemed appropriate. This design involved a single group that was pretested, exposed to a treatment, and posttested. Additionally, qualitative responses in terms of written responses were gathered so as to illuminate what participants say they have learnt. Figure 4 depicts the explanatory mixed-methods research design used in this study.

QUANTITATIVE		**qualitative**
One group pretest-posttest design	Follow-up	Written responses

Legend: **Uppercase letters** = major emphasis
           Lowercase letters = minor emphasis
                Arrow = sequence

Figure 4. *Depiction of Explanatory Mixed-Methods Research Design.*

b) Sampling

Judgmental sampling was used in this study in which the segments of the population represented a variety of early childhood centres in urban and rural parts of Malaysia. In view

of the cost constraint, only 22 early childhood teachers from 19 various childcare centres across urban and rural areas of Malaysia were selected to participate in this in-service training on integrating STEM through Problem-Based Inquiry Learning.

c) Intervention

The participants followed through a three-day (16-18 March 2015) fully residential in-service training workshop on the integration of STEM through Project-based Inquiry Learning (PIL) held at the Centre for the Gifted and Talented, National University of Malaysia (UKM). In the training workshop, participants were familiarised to the concept of STEM and PIL through PIL itself, in which participants took the dual role of a teacher and that of a child for each project, walking through the 4 phases of PIL under the facilitation of the researchers. Table 1 lists the 10 projects that were presented to the participants during the training workshop. Given that it was only a three-day in-service training workshop and that the time allocated was only sufficient to carry out three full cycle of PIL, each group chose one out of the 10 projects in each round (without any overlapping of projects among the groups) to walk through the full cycle of PIL in a collaborative manner, putting themselves in a dual role of a teacher and that of a child. For example, when they assumed the role of a teacher, they asked themselves "what do we want to know about ....", and when they switched role to that of a child, they explicated their questions with one of the team members listing down the questions posed by other members. At the end of each round (i.e., each full cycle of PIL), the groups presented the teaching and learning which took place in each of the four phases – Inquiry, Exploration, Invention, & Reflection. They then showcased their projects with other groups celebrated together with them.

Table 1. *The list of Projects Presented at the Training Workshop*

Project No	Title
Project 1:	Rubber-Band Powered Car
Project 2:	3R – Reduce, Reuse & Recycle
Project 3:	Terrarium
Project 4:	Buttons
Project 5:	Tie and Dye
Project 6:	Composting
Project 7:	Umbrella
Project 8:	Chicken Eggs
Project 9:	My Ship
Project 10:	Paper

d) Instrumentation

The questionnaire contains three parts. Part 1, consisting of 12 five-point Likert-scale items, measures participants' self-rating on their knowledge, skills and attitudes with regard to the Integration of STEM through Problem-Based Inquiry Learning, while Part 2, comprising six five-point Likert-scale items, solicits participants' self-rating on the in-service training workshop. Meanwhile, Part 3, consisting of an open-ended question, garnering participants' self-written views on the things or activities in the in-service training which they found to be interesting or rewarding.

This questionnaire has sufficient content validity in that every single item in Part 1 subsumes within the coverage of the STEM Integration through PIL, and that every single item in Part 2 measures the conduct of the in-service training (Sireci, 1998). Using the dataset of 22 participants, the Cronbach's alpha for Part 1 of the questionnaire was measured at 0.898 while the Cronbach's alpha for Part 2 was measured at 0.739, suggesting that the questionnaire has high internal reliability for Part 1 and adequate internal validity for Part 2

(Nunnally, 1978). In screening the data for normal distribution, the values of skewness and kurtosis for the mean of each of the 12 items were computed. It was found that the means for skewness ranged from 0.03 to 0.65, and these values fall within the acceptable range of not more than +1.00 or not less than –1.00 (Morgan, Griego, & Gloeckner, 2001), suggesting that none of the distributions was markedly skewed and consequently, none warranted the use nonparametric statistics. Meanwhile, the values of kurtosis fall within the acceptable range of not more than +1.00 or not less than –1.00 (Morgan, Griego, & Gloeckner, 2001) except for items 1, 5, and 9 which measured at -1.10, -1.03, and -1.04. Accordingly, the findings from these three items should be interpreted with caution.

While the pretest and posttest were basically the same questionnaire, there was an additional question in Part 3 of the questionnaire which solicits free responses from the participants in the posttest. The question was valid when it asks participants to write down their responses on the things/activities which they found interesting in the in-service training.

e) Data Gathering and Analysis Procedures

At the end of the in-service training, the questionnaire was administered to the participants as (a) pre- and posttest for Part 1 so as to obtain feedback on their perceived level of pedagogical knowledge, skills and attitudes before training and after training on the integration of STEM through PIL; (b) posttest only for Part 2 so as to obtain feedback on their perceptions regarding the conduct of the in-service training; (c) open-ended question to solicit participants' self-written views on the things/activities which they found interesting in the in-service training. The pretest-posttest differences were analysed using a paired-samples t-test, while the qualitative data were analysed recursively to uncover emerging themes (Patton, 2002).

FINDINGS

Research Question 1: What are the effects of an in-service STEM Integration through Project-Based Inquiry Learning on early childhood teachers' self-perceived pedagogical knowledge, skills and attitudes?

Table 2 shows the "before training" (pretest) and "after training" (posttest) means of self-perceived level of a group of 22 participants' on each of the 12 items in Part 1 that pertains to the knowledge, skills and attitudes in the integration of STEM through PIL, and the results of the analysis using a dependent samples t-test.

Based on Table 2, it was heartening to note that the participants had indicated that their ***content knowledge*** had statistically significantly increased ($p < .001$), specifically on the knowledge and understanding on STEM (Items 1 and 2), knowledge on project-based inquiry learning or PIL (Item 4) and the four phases in PIL (Item 5). Equally, the participants had also indicated that their ***practical knowledge*** had statistically significantly increased ($p < .001$), notably on how STEM could be integrated into the National PERMATA Curriculum (Item 3) and the enactment of inquiry, exploratory, invention and reflection phases of PIL (Items 6 through 9). In terms of self-perceived ***skills***, the participants have also indicated that they are able to teach STEM to PERMATA children (Item 11) with confidence (Item 12). In terms of affective domain, the participants indicated that their ***interest*** towards STEM has significantly increased (Item 10) upon the completion of the in-service training.

Table 2. *Results Obtained from t-Test for Paired Samples*

No	Item	Pre-Workshop Mean	Post-Workshop Mean	t	p
1[*]	Knowledge of STEM	1.91	4.18	13.893	<.001
2[*]	Understanding of STEM concept	1.73	4.18	15.588	<.001
3[**]	Knowing how to integrate STEM into National PERMATA Curriculum	1.82	4.00	12.872	<.001
4[*]	Knowing Project-Based Inquiry Learning in STEM	1.82	4.27	22.590	<.001
5[*]	Knowing all the 4 Phases in Project-Based Inquiry Learning in STEM	1.77	4.32	13.917	<.001
6[**]	Understand how to implement Phase 1 in STEM Project	1.68	4.32	12.969	<.001
7[**]	Understand how to implement Phase 2 in STEM Project	1.68	4.14	15.588	<.001
8[**]	Understand how to implement Phase 3 in STEM Project	1.68	4.27	14.229	<.001
9[**]	Understand how to implement Phase 4 in STEM Project	1.73	4.14	13.230	<.001
10[+]	Interest towards STEM	2.59	4.50	8.076	<.001
11[#]	Ability to teach STEM to PERMATA children	2.18	4.32	9.661	<.001
12[#]	Ability to teach STEM with confidence to PERMATA children	2.14	4.14	8.431	<.001

[*]	Content Knowledge
[**]	Practical Knowledge
[#]	Skills
[+]	Attitudes

Research Question 2: What are the participants' views with regard to the in-service training on STEM Integration through Project-Based Inquiry Learning?

Table 3. *Participants' Self-rating on the Conduct of the Training Workshop*

	Min	Max	Mean	Std. Deviation
1. Suitability of Workshop Objectives	4	5	4.55	.510
2. Workshop contents and activities	4	5	4.64	.492
3. Workshop Implementation	4	5	4.64	.492
4. Facilitators' Expertise	4	5	4.95	.213
5. Achieving Workshop Objectives	4	5	4.55	.510
6. Workshop Duration	2	5	4.14	.834

Table 3 summarises the responses of the participants' self-rating on their views regarding the conduct of the workshop. Generally, participants were very satisfied with the conduct of the in-service training workshop which encompasses the suitability of its objectives (Q1), its contents & activities (Q2), its implementation (Q3), facilitators' expertise (Q4), the achievement of its objectives (Q5), and its duration (Q6). While items 1-5 with the means approximately equal to 5 when rounded up indicated that the participants were "very satisfied" with the conduct of the workshop, the mean of item 2 seems to approximate 4 (satisfied) when rounded up. Although the questionnaire does not require participants to

justify their self-ratings, there were a few participants who rated dismally on Q6 and specifically scribbled some comments which, taken together, suggests that the duration of workshop should be longer so that they will have more grounded understanding and more knowledge to be learned.

The self-rating results are further triangulated by participants' written responses when asked to provide additional comments or responses on the things/activities which they found interesting in the in-service training workshop. Three resounding themes emerged from the qualitative data analysis of participants' responses, namely the ***Interesting Experiences***, ***Acquiring New Knowledge***, and ***Sharing of Ideas***.

Theme 1: Interesting Experiences

The participants indicated the in-service training workshop has given them interesting experiences especially in (a) learning about STEM through hands-on and minds-on manner and not through boring didactic method; (b) doing interesting projects; and (c) seeing the products of their projects. These interesting experiences were evidentially supported by the following excerpts from the participants' written comments:-

Many interesting activities in this workshop and the most interesting is the way in which we implemented Phases 1 through 4. I am so excited looking at the products of our projects.

(P-01)

The process through which we completed our projects was very hands-on. This is truly a very interesting new experience.

(P-08)

All the activities in each phase [of the PIL] are very interesting and I got new experience and better understanding of STEM.

(P-21)

It is an interesting experience and also new knowledge to me in seeing so many different projects and learning about these new projects

(P-20)

Theme 2: Acquiring New Knowledge

The second theme that emerged from the analysis of participants' written comments through a recursive process was the acquisition of new knowledge, particularly with regard to STEM pedagogy. They reckoned that the acquisition of such new knowledge is beneficial and applicable in their respective early childhood classrooms or educational contexts. We attributed such classroom applicability to the way in which the training was conducted. Instead of a didactic, lecture, and teacher-centred mode, the training was conducted in a constructivist and simulative manner where a PIL was espoused in a simulative way in which the participants acted as students as well as teachers while the facilitator was just guide on the side instead of sage on the stage. The following quotes from participants' comments, when cohere together, seem to support such contention.

I learned new ways or methods to expose my children to STEM

(P-02)

I learned much new knowledge about STEM Projects.

(P-09)

I received new knowledge in STEM field especially in invention activities

(P-11)

I now understood about the concept of the integration of STEM in teaching or integration of STEM into children's activities which I could use it for my early childhood children.

(P-12)

The invention activities are something new that l learned from this workshop.

(P-13)

Theme 3: Sharing of Ideas

The third theme that emerged was the sharing of ideas. Participants indicated that this workshop was interesting in that there were many opportunities where they could share their ideas among themselves which is akin to cross-fertilising of ideas among the early childhood teachers from different childcare centres.

I was able to share so many ideas [with other participants] which I am so thankful for.

(P-02)

I was able to share my experiences [with other participants] while undertaking the STEM process with other early childhood teachers from PAPN, KEPAS, JPNIN & YPKT [i.e., different childcare centres in Malaysia]

(P-07)

The group work was interesting and we could share and expand our ideas.

(P-11)

CONCLUSION and DISCUSSION

The findings of this study indicated that participants of the in-service training workshop perceived that their knowledge, skills and attitudes have been elevated as the outcome of the three-day in-service professional development course on STEM integration through Project-Based Inquiry Learning, evident in the differences of pretest and posttest scores across the 12 items in Part A which were all statistically significant. Additionally, based on the analysis of Part B of the questionnaire, the participants self-perceived that they were "very satisfied" with the conduct of the workshop which encompasses the suitability of its objectives, its contents and activities, its implementation, facilitators' expertise, and the achievement of its objectives, but were only "satisfied" with its duration with suggestions from the participants that the duration of the training should be extended. The significant gains observed in Parts 1 and 2 were further supported by the participants' self-written responses which, when qualitatively analyzed, gave rise to three major themes, namely "interesting experiences", "acquiring new knowledge" and "sharing of ideas".

This workshop was facilitated by the second author, assisted by all the other co-authors over the three-day duration. Even though the schedule was tight and that the participants had to complete each project by simulating through the complete cycle of four-phase Project-Based Inquiry Learning (PIL), there was no sign of boredom among the participants. This could be attributed to the employment of simulative and participants-centred hands-on, minds-on, hearts-on, and reality-on activities in the training where the underlying pedagogical principles of integration of STEM through PIL were revisited at each of the three plenary sessions with the opportunity to showcase their "inventions" and to celebrate together their achievement and the achievements of their colleagues.

While many reforms in science education have been initiated throughout the past two decades and these reforms advocated the use of inquiry-based instruction (American Association for the Advancement of Science [AAAS], 1993; National Science Teachers

Association, 1998), Capps, Crawford, and Constas (2012) reported that little has changed regarding how science is taught in majority of the US classrooms and subsequently, recommend that the key to the desired changes in the way teachers teach science is to provide innovative professional development for both pre-service and in-service teachers. Extrapolating this scenario to the integration of STEM through PIL of which the four-phase PIL approach was conceptualised and supported by 10 projects that exemplify how STEM could be integrated into the early childhood curriculum and be taught using the PIL approach, a nucleus of 22 early childhood teachers from various government-funded child care centres in urban and rural areas in Malaysia were familiarised through a three-day "innovative" in-service training workshop to the concept and pedagogy of STEM, with a particular focus on PIL. Innovative in the sense that, for each project, groups of participants carried out their respective chosen projects assuming a dual role of a child and that of a teacher, switching the roles as and when they deemed fit. For example, they asked themselves what they wanted to find out about a particular phenomenon by wearing the hat of a teacher, and subsequently changed their hats to that of a child, posing questions on what they wanted to find out.

The review of literature on the effectiveness of professional development shows that the quantity of professional development on inquiry-based teaching in which teachers participate is strongly linked with both inquiry-based teaching practice and investigative classroom culture (Supovitz & Turner, 2000) and that highly intensive (160 hours), inquiry-based professional development changed teachers' attitudes towards reform, their preparation to use reform-based practices, and their use of inquiry-based teaching practices, and that these changes have long-term effects in that they persisted several years after teachers concluded their experience (Supovitz, Mayer, & Kahle, 2000). In this study, while the early childhood teachers self-perceived that their pedagogical knowledge, skills, and attitudes had been elevated, the quantity of intensive training time spent in the three-day workshop was only 30 hours. Despite having less than 160 hours of training, such training was effective because it narrowly focussed on a pedagogical aspect, namely the integration of STEM through PIL, thus providing further support to the reviews on in-service training by Cordingley et al. (2015).

Although these early childhood teachers have been integrating STEM through PIL in their respective classrooms (Ayob et al., 2015) upon the completion of the in-service training, one question remains uncertain: Will the integration of STEM persist for a longer period, and if so, for how long? This necessitates a thoughtful plan for longer term monitoring and that teachers should be given a STEM Integration through PIL "booster dose" periodically to ensure continuous impact on their classroom practice.

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