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Trends and Issues on STEM and STEAM Education in Early Childhood

The research aims to focus on Thai national and international studies regarding STEM and STEAM education in early childhood education. After a detailed search by using the five databases, 33 researches published during 2008 and 2018 were accessed and analyzed using content analysis. The research finding signifies that STEM and STEAM education in early childhood classrooms have aroused both Thai national and international interest from an educational perspective to prepare students for the 21st century. Furthermore, classroom implementation and instruction design to incorporate STEM and STEAM education have been more challenging to fulfill the expected benefits, such as, effective of learning both formal and informal education, building of STEM literacy, preparing of professional development of pre-service and in-service teacher.

1. Introduction

After the economic decline and growing competition among developing economies, STEM education is an integrated learning model in four areas of study: science, technology, engineering and mathematics which has aroused a global interest from educational perspective for an increase in advanced training and careers in STEM fields, an expansion of the STEM-capable workforce, and an increase in scientific literacy among the general public (NRC, 2011; Guyotte et al, 2014). In addition, STEM education also aims to give students required competence, knowledge and an interdisciplinary point of view towards problems by eliminating the barriers of the conventional education system which presents children STEM disciplines separate from each other (Vasquez, Sneider, & Comer, 2013). Besides of improving their academic achievement, STEM education meets children with the critical knowledge required for future's workforce (Quigley & Herro, 2016).

Some researchers claim that STEM is a puzzle which constitutes complementary disciplines, however, there is a lacking part; "Arts" (Kim & Park, 2012 and Sochacka, Guyotte, Walther, 2016). Moreover, arts offer an important way to cultivate creativity therefore visual arts, reading and music are added on STEM education for preparing children to sort the world's issues by means of innovation, creative and critical thinking, cooperation, effective

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communication in the light of new information (Spector, 2015, p. 5). The STEAM-based education aims to prepare children to sort the world's issues by means of innovation, creative and critical thinking, cooperation, effective communication in the light of new information (Quigley & Herro, 2016).

Many studies have shown that providing meaningful STEM and STEAM experience for early childhood age children positively impacts not only their perceptions and disposition towards STEM and STEAM education but also increasing the diversity of students who are interested in STEM and competent to be successful in STEM fields (Bagiati, et al., 2015; DeJarnette, 2018). Next Generation Science Standards (NGSS) also recommends that early childhood is a critical time to begin quality STEM education (National Research Council, 2011).

It is in line with the Thai national strategies of early childhood for 2017-2061 and the Thai national core curriculum for early childhood education 2017 also attempt to propose a policy to improve the quality of education to prepare children to have 21st century skills and to meet the challenges of the rapid changing of economic society and technology (Office of the Education Council, 2016). Therefore, they should be introduced to STEM and STEAM concepts from younger ages which provides them meaningful learning underlying future educational experience Moomav & Davis, 2010).

This paper aims to review the research conducted over the past decade regarding the STEM and STEAM education practices in early childhood education, and in the light of these studies, to present some implications for enhancing the STEM and STEAM education practices in Thailand.

2. Research Questions

(1) How has STEM and STEAM education in early childhood been positioned in Thai and international research in the period of 2008-2018?

(2) How did the research participate toward the published articles in Thai and international research in the period of 2008-2018?

(3) What was the link between research findings of Thai and international research in the period of 2008-2018?

3. Research Methodology

The methodological process for systematic reviews of educational research literature followed the steps of review methods, which were developed by the Evidence for Policy and Practice Information and Coordinating Centre (EPPI Centre), the Social Science Research Unit, Institute of Education, and University of London for systematic reviews of educational research literature (Bennett et al., 2004) as follows:

3.1 Selection of research papers for analysis
The criteria by which studies are to be included in, or excluded from, the review were determined.

(1) Criteria for document selection for data analysis was based on the review of published article from the Thai Journal Citation Index Centre group 1 database for national research, the EBSCOhost, and Education Full Text: H.W. Wilson databased for international research, and the three top academic journals: Science Education, International Journal of Science Education, and Journal of Research in Science Teaching for science education community by using Naresuan University Online Library.

(2) Criteria for selection of related research papers were to include the keyword "STEM education in early childhood", "STEM education in early years" and "STEAM education in early childhood" to detect all articles related to STEM and STEAM Educations in Early Childhood Education. In these samples, 'editorial', 'commentary', 'responses', 'replies', 'erratum' and 'book review' papers were all excluded. Consequently, abstracts were initially screened for a second-level in-depth screening by reading the abstracts resulted in the exclusion of some of the articles since the keyword 'STEAM education and early childhood' was relevant to another context in science education like arts integration STEM in early childhood education", "preschool children" and "kindergarten" were related early childhood was relevant to the data collection. Consequently, abstracts were initially screened for a second-level in-depth screening.

3.2 Identifying and generating systematic categories and in-depth review and data extraction
The categorization of coding system was created for use as a structured observation including titles, author(s), publication years, purposes, participants, countries, main focuses, main

findings. This research examined and content analyzed by using quantitative and qualitative techniques.
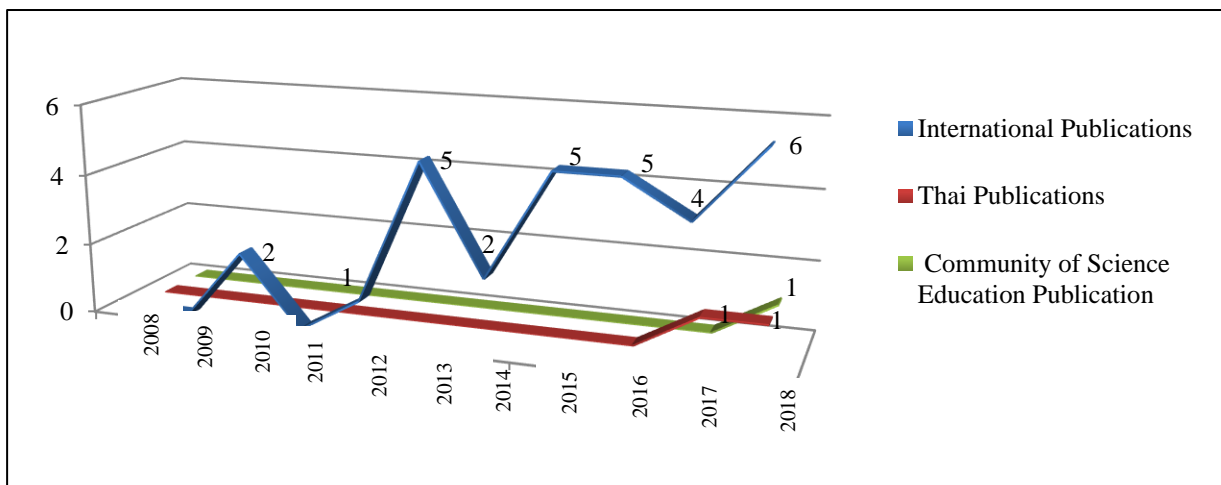
4. Research Findings

After a detailed literature review, a total of 3 academic studies published in academic journals and conducted between the dates specified were accessed. The findings are given in relation to the research questions.

4.1. Positions of STEM and STEAM education of early childhood in Thai and international research

(1) Finding with regard to the years of publication

All examined studies of international publication were carried out in or after 2010. At the same time two studies carried out in or after 2016 were found in Thai publications (Vasinee, 2016 and Thammaprateep & Cartisathian, 2018). Findings presented in graph 1.

Graph 1: Distribution of the accessed studies in term of year of publication

(2) Finding with regard to the location

Examination of literature with regard to the locations where research was conducted may enable understanding the popularity of STEM research among diverse countries as presented in graph 2.
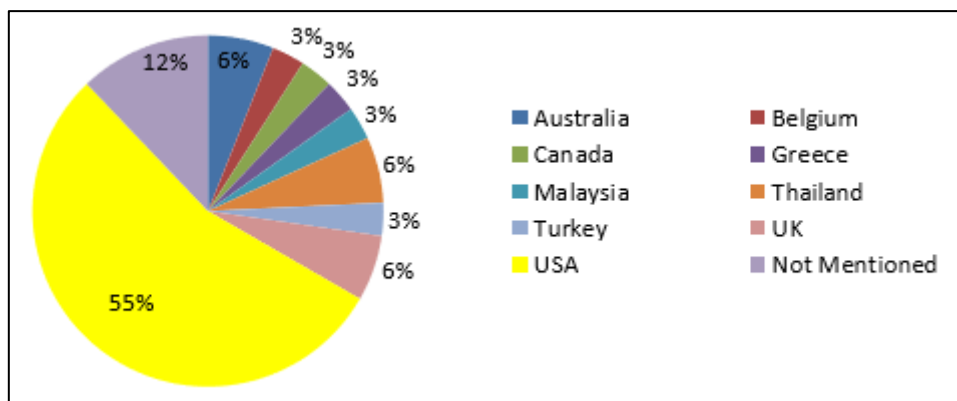
Graph 2: The percentage of the research related to STEM and STEAM Education with regard to the countries

A great majority of examined empirical studies were conducted in the United States (n=18; 55.0 %). Other studies were conducted in Australia (n=2; 6.0 %), Thailand (n=2; 6 %), United Kingdom (n=2; 6.0 %), Belgium (n=1; 3.0 %), Canada (n=1; 3.0 %), Greece (n=1; 3.0 %), Malaysia (n=1; 3.0 %), Turkey (n=1; 3.0 %), respectively while no information was given about the location where the studies carried out in four studies (12%).

4.2. Research participants of the published articles in Thai and international research

The results illustrated indicated that a large group of participants (n=20; 64.0 %) conducted research with preschool children aged from 3 -7 year old. On the other hand, six studies were conducted with pre-service and in-service preschool teachers (n=6; 21.0 %), while the remaining four studies focused on both preschool children and preschool teachers and their STEM and STEAM practices (n=4; 12.0 %) and one study in Thailand focused on parents' knowledge and understanding of integrated STEM Education with Arts and Ethics; ESTEAM (3.0 %). The results can be seen in graph 3.
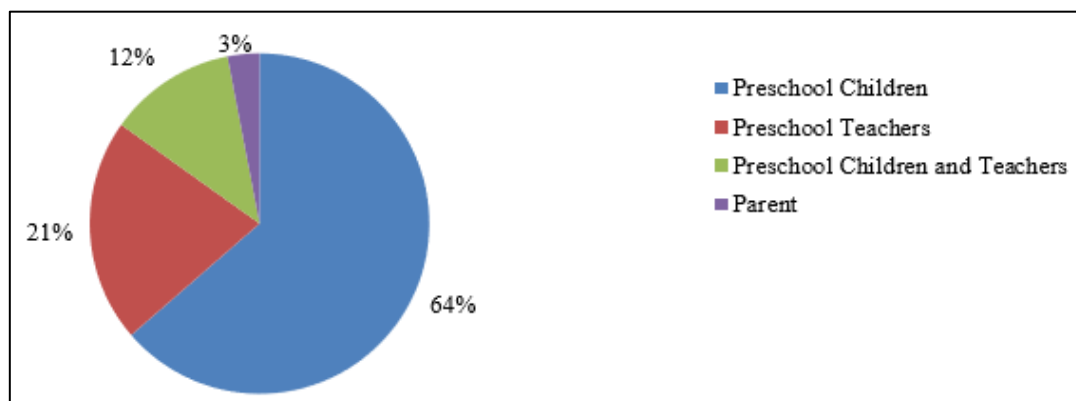
Graph 3: Distribution of Accessed Empirical Research in term of Participants

In addition, the empirical studies were considered in terms of their participants with regard to three groups of publication including the international publications, community of science education's publications and Thai publications, it was revealed that international publication were conducted with preschool children (n=20) and preschool teachers (n=6) and preschool children and teachers (n=4).The study from community of science education's publications conducted with preschool children's learning, meanwhile, the two studies of Thai publications were conducted with preschool teachers and parents (see graph 4).
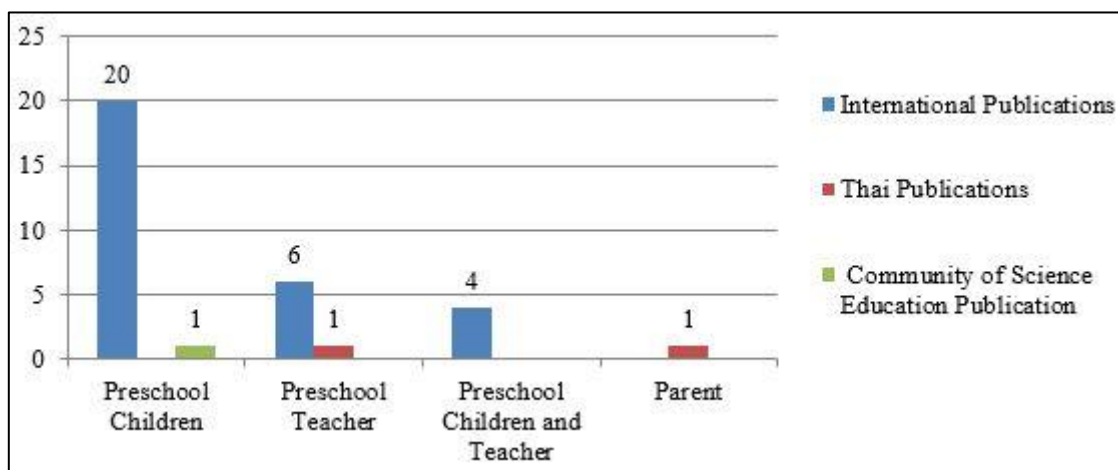
Graph 4: Distribution of accessed research in term of group of publication

4.3. Main Focus Point of the published articles in Thai and international researches

After the in-depth review and data extraction examination, it was revealed that the studies varied in terms of their focuses. The majority of the studies focused on the planning and implementing STEM activities (n = 11; 33.33%). The second major point of the studies focused on the integrating of engineering (n = 7; 21.21%). Next, the studies focused on the integrating of technology including iPad, computer, programing and Robotics (n = 4; 12.12%) and the professional development for STEM education (n = 4; 12.12%). The fourth major point of the studies focused on the planning and implementing STEM activities with inclusive students (n = 2; 6.06%), the planning and implementing STEAM activities which arts consisted of visual art and dance (n = 2; 6.06%), and the integration of literacy into science and engineering (n = 2; 6.06%). The last major of the studies focused on students' learning in a STEM classroom (n = 1; 3.03 %) as presented in graph 5.
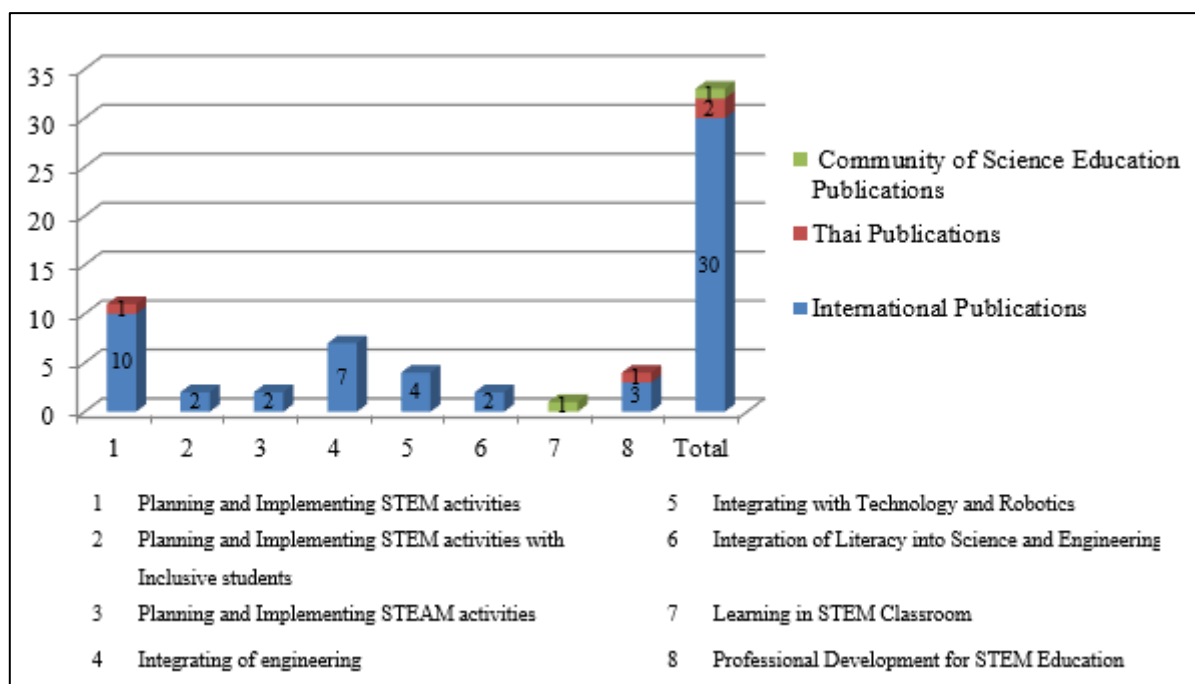
Graph 5: **Distribution of the focus points of the studies**

5. Conclusion and Implementations

All examined studies of publication about the implication of STEM and STEAM education particularly in preschool from both international and Thai were carried out in or after 2010 are limited. When the main findings of the research were examined; it was revealed that STEM education might be effective for preschool children's learning in STEM and STEAM concepts and skills for 21st century such as critical thinking, problem solving, creativity, innovations skills, curiosity, and collaboration with their peers.

5.1 Learning with STEM and STEAM Education in Early Childhood Education

The results found that the majority of the studies focused on the planning and implementing STEM and STEAM activities which aligns with the current philosophy of play-based programs such as free play with blocks, Legos, puzzles, picture book where children are encouraged to explore and observe the world according to their own interests. In addition, Vasinee (2016) found that parents respond positively to ESTEAM where STEM education integrated with arts and ethics in their childs' pre-K classroom. This is in line with the foundations for STEM education begin in early childhood through their play experiences with family environment, children engage with the world in ways that can promote learning related to science, technology, engineering and mathematics for developing their curiosity, inquisitiveness, critical-thinking, and problem-solving capacities through primary and post-primary school experience.

Moreover, despite research evidence of STEM education in early childhood demonstrates that language, literacy, programming, robotic, ethics has been linked to other educational benefits in addition to science. Kelley & Knowles (2016) also recommence that instead of introducing content and expecting from students to comprehend the connections to real-life practices.

However, STEM and STEAM education for classroom and outside of schools such as family environment, science museum still have challenge for more effective learning included not only learning with the key characteristics of STEM and STEAM education, learning progression, science practice, engineering practice, addressing of STEM literacy but also prediction and association with long term positive to STEM workforce.

5.2 Professional Development of STEM and STEAM Education for Early Childhood Teacher
Currently, the research findings found that the preparation of teachers for dealing with STEM and STEAM education in early childhood years is very limited. There were three studies of international research which were conducted with in-service preschool teachers (Atiles at al., 2013; Bers et al., 2013; Bagiatti & Evangelou, 2015; Aldemir & Kermani, 2016). In Thailand, only one study was conducted the STEM collaborative teacher professional development with in-service preschool teachers' understanding and teaching practices (Thammaprateep & Chartisathian, 2018). None of studies focus on preparing pre-service teachers of early childhood education from both Thai and international research. This could affect the quality of STEM and STEAM instruction in classroom because the National Research Council of the United States of America (NRC, 2011) suggested that STEM at the early childhood level, if approached correctly, could offer opportunities for teachers to engage young children in activities that capitalize on students' interests, experiences, and prior knowledge. The challenge for educators supports of pre- and in- service professional development and development of professional learning communities effected to high quality STEM and STEAM education in early childhood education.

In consequence, the STEM and STEAM education for early childhood education should be planed and implemented correctly for developing concepts and skills for 21st century with formal and informal education. The professional development of STEM and STEAM education is required for high quality of STEM and STEAM education.

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