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APPROPRIATE STEM EDUCATION DESIGN FOR KINDERGARTEN

Abstract:

The purposes of this study were to develop an appropriate design for teaching kindergarten in Thailand. One thousand questionnaires were sent to early childhood educators from the Office of Basic Education Commission, Office of the Private Education Commission, Minster of Interior, Office of the Higher Education Commission, and Department of Education Bangkok Metropolitan Administration in Thailand. A total of 607 completed questionnaires were used to analyze the data. The questionnaires were developed with a focus group of experts, IOC: Index of Item-Objective Congruence and the Cronbach's Alpha Coefficient (0.98). They were divided into five rating scales. This study is divided into two parts: demographics of the participants and opinions of participants (principles and purpose, methods and theories, instruction, contents, environment and media, assessment, teachers and administrators, and parents and communities). Results of this study stated that Thai teachers agreed to use early childhood theories and instruction. They concerned on ages, development, and children’s interests to teach STEM education. Collaboration among schools, parents, and communities are necessary to support STEM education. Assessments on children development and observation should be used to teach STEM education. Descriptive statistics was used to compute percentage, mean, standard deviation to obtain the results. Future studies should examine the developing of STEM education for teaching kindergarten.

Keywords:

STEM Education, Kindergarten, Teaching, Thailand

JEL Classification: I29

Introduction

Investments in early childhood education lead to promote national development because humans are able to learn best in the early ages. Research states that the early years in a child's life are the time when an otherwise unattainable opportunity to develop and shape their brain exists. The average weigh of an adult brain is approximately three pounds. When humans are born, their brain weight approximately 2/3 pound and increases to 2 2/3 of pounds by the age of two. It has been stated that human brains have the biggest growth rate during the first two years (Morrison, 2012). The Center on the Development Science, Harvard University (2015) stated that it was important to provide quality education for young children for sustained social development. Researchers have found that a young child's brain learns best from birth to five years old. Human brains work as follows: 1) from the time of birth, children learn from their environment and their brains continue to develop until they are adults. Their experiences connect to their brains can be either stable or fragile. They learn from sensory-motor activities by listening, seeing, and using language to develop their intellect. 2) Nurture and experience influence the children's developmental areas and their growing brains. Children learn by interacting with parents, caregivers, and teachers. 3) As children grow up, their brains become more complex and the rate of brain development decreases. Although the window of opportunities is still open, it is not as easy for adults to develop their brains as much as children. 4) The abilities to learn intellectually, socially, and emotionally are linked together throughout a person's entire life. A healthy body, a healthy mind, abilities of language skills, and intellectual skills are fundamental issues to lead children to succeed in learning and excel in their future lives, and 5) Stress can affect children's brains, impairing their abilities to learn, their health, behaviors, and mental capacity for their whole lives. Young children may be stressed because of poverty or harassment. Mothers who are depressed during pregnancy may even lead to unborn children becoming stressed. In addition, High/Scope foundation studied children with and without the High/Scope curriculum when children were in preschool until 40 years old. The study showed that students with the High/Scope curriculum succeeded in their learning and their life more than students with other approaches. Students with the High/Scope curriculum graduated from high schools and earned larger salaries than students taught with other approaches (High/Scope, 2015). Quality early childhood education is therefore fundamental to the development, background, and experience of people. Developmental skills: social, emotional, physical, and intellectual, as well as, experience support children to succeed in their schools and careers in the future.

Education in Thailand

Thailand has also stated the necessity of early childhood education between birth and five years of age as the foundation for all learning (Office of the Education Council, Thailand, 2010). Thailand also has developed a quality educational system by providing the 10-year plan and policy for Early Childhood Development (2006–2015). The blueprint for this plan

aims to support all Thai children to succeed in early childhood education. The three main strategies are as follows: 1) to support early childhood development; 2) to support parents and other stakeholders; and 3) to promote an environment that assists early childhood development (UNESCO-1, 2015). Quality of education should start with a good method of learning that endue young children with a capacity to think, to do, to create, and to succeed in their learning. Moreover, a commitment of Thailand Educational Reform: Revised (2012 – 2016) plans to increase educational quality and standards to international levels (Office of the Education Council, 2010). There has been many reasons for Thailand to concerns on education: First, as a member of the ASEAN community, Thailand is responsible to follow these three pillars: security community (living in peace), economic community (cooperating and facilitating in trade and economic issues), and socio-cultural community (understanding of other cultures). As world education is in steady advance, it is necessary to improve education in all ASEAN countries. Thailand is located in the center of ASEAN, and Thailand may serves as a hub of education (Ramkhamhaeng University Library, 2015). Second, Thai students at 15 years old earned low scores on the Programme for International Student Assessment (PISA) for students at the same age level. In 2010 for the Ordinary National Educational Test (O-Net), 50% of students achieved the O-net scores in English, mathematics, sciences, and social studies lower than the mean scores (Office of the Education Council, 2010). Third, the Committee on Basic Education Curriculum Reform agreed that the new curriculum should provide six groups of knowledge: 1) language and culture, 2) STEM (science, technology, engineering, and mathematics, 3) work life, 4) media skills and communication, 5) society and humanity, and 6) ASEAN and the world. Fourth, the National Economic and Social Development Plan (2555-2559 B.E.) supports the educational development of Thailand by preparing students to be ready for economics and societal changes in the future. Education should provide students with an ethical code that prepares them to become life-long learners. Moreover, education should relate to the culture and environment in which the students live. Last, according to Nelson Mandela education is the most powerful instrument to change the world. It is fundamental to develop charismatic leaders and capable citizens able to solve problems and to create new ways for a better future (UNESCO-2, 2015).

STEM Education

STEM education, an influential integrated approach towards educations, has become a priority issue for the development of education in the United States. Government of states, institutes, universities, and schools set up programs, curricula, and methods to teach children in the United States from K-12. The goals of STEM education are as follows: 1) increasing the number of students who studied and graduated in STEM fields specifically women and minorities, 2) increasing STEM careers for women and minorities, and 3) increasing STEM literacy for all students (It is necessary for students to understand concepts and processes of sciences and mathematics.). Students should be involved in social culture and economy of their country (National Research Council, 2011). The

acronym STEM may mean the stalk of a plant (noun) or plant or to originate (verb). It means developing or changing human behavior in the future. STEM education curriculum that integrates science, technology, engineering, and mathematics for students from kindergarten to college level. It is relevant to Thai education because Thailand is a developing country. In recent years, Thailand has recognized the important of STEM education and had begun implementing STEM education into the curriculum. The Institute for the Promotion of Teaching Science and Technology (IPST) has supported STEM education in Thailand that their priority level is high school years. Early childhood is an important period of life for learning that will lead students to achieve success in their schools and their future. STEM education will conduct students to understand the world because STEM education consists of four important subjects and skills, which are important for the 21 Century. “STEM education is an interdisciplinary approach to learning where rigorous academic concepts are coupled with real-world lessons as students apply science, technology, engineering, and mathematics in contexts that make connections between school, community, work, and the global enterprise enabling the development of STEM literacy and with it the ability to compete in the new economy” (Tsupros, 2009). Schools, universities, institutes, and governments should be ready to implement STEM education in Thailand. STEM education should start from kindergarten level but educators should understand how to implement it for kindergarten students. They need to know what is the strategy to implement STEM education for kindergarten, and what is the fundamental issue to provide STEM education for kindergarten.

The purposes of the study were:

1) To study methods and strategies to implement STEM education in Thailand.

2) To create a STEM education design for Kindergarten students.

3) To estimate the possibility of implementing STEM education for kindergarten students in Thailand.

Methods of the Study

Sample

Population in this study was early childhood educators in Thailand. The sample was randomly chosen from educators from every parts of Thailand who volunteered in answering questionnaires for examples: Bangkok and Petchabun (Central); Chiang Rai (Northern); Ubon Ratchathani and Nakhon Ratchasima (North Eastern); Trang and Prachuap Khiri Khan, (Southern); and Rayong (Eastern). The sample of this study consisted of 607 subjects from five groups: 1) Office of Basic Education Commission, 2) Office of the Private Education Commission, 3) Minster of Interior, 4) Office of the Higher

Education Commission, and 5) Department of Education Bangkok Metropolitan Administration. They were early childhood teachers, educators, and principals in Thailand. All of teachers in these groups have taught from preschool to kindergarten level, except a group of the Higher Education Commission comprising instructors who have taught university students or students at demonstration schools.

Developing the material: focus group and questionnaires

This study was divided into four steps. Step 1: Researchers studied documents, research, journals, and books on STEM education. Step 2: Then, we used focus group by inviting ten leaders, principals, and professionals of early childhood education in Thailand to discuss fundamental issues for implementing STEM education in early childhood levels. The eight categories concerned with on STEM education were: 1) principles and purposes, 2) method and theories, 3) instruction, 4) contents, 5) environment and media for teaching, 6) assessment, 7) teachers and administrators, and 8) parents and communities. Step 3: After determining the scopes to implement STEM education, researchers created survey questions in eight areas and asked five educators to choose the survey questions. The first educator was a university instructor, expert in early childhood education, elementary education, and STEM education. The second educator was an expert in sciences and research, and the third educator was a principal of a kindergarten school and an expert in early childhood education. The fourth educator is an expert in research and human development, and the last educator is a kindergarten teacher at a demonstration school.There were 111 items of questions. Rating scales were divided into five categories: Most agreement (4.21-5.00), Agreement (3.41-4.20), Moderate (2.61-3.40), Disagree (1.81-2.60), and Totally Disagree (1.00-1.80). Step 4: We asked an expert to examine the validity of the set of questionnaires with IOC: Index of Item-Objective Congruence. Then, we developed and tried out the material with 30 early childhood educators. Then, we determined the Cronbach's Alpha Coefficient, which was 0.98.

Collection of the data

We sent questionnaires of an appropriate STEM education design for kindergarten to 1,000 of early childhood educators and received back 700 questionnaires. An expert examined completed questionnaires and used 607 of them to analyze the data (60%). Participants were from five categories: 1) Office of Basic Education Commission, 2) Office of the Private Education Commission, 3) Minster of Interior, 4) Office of the Higher Education Commission, and 5) Department of Education Bangkok Metropolitan Administration for six months. Some teachers or principals in this study had workshop on STEM Education before they answered the questions. Some teachers were just new to STEM education but they all had background in early childhood teaching and suitable experience. The researchers investigated the estimation of possibilities of the early-childhood STEM model by using descriptive statistics (percentage) to analyze the data in the part of demographics

(sex, ages, years of teaching, education levels, and subordinations). For the second part, the researchers used rating scale to analyze the data. The second part was divided into eight sections: 1) principles and purposes, 2) theories and approaches, 3) instruction, 4) contents, 5) environment and medias for teaching, 6) assessment, 7) teachers and administrators, and 8) parents and communities. Descriptive statistics were used to compute percentage, mean, and standard deviation (SD) to obtain the results on the second part.

Results

Demographics of this study

Demographics of this study were divided into five categories: sex, ages, years of teaching, education levels, and subordinations. The majority of participants were female (568 or 93.88 %), and the minority of the participants was male (37 or 6.12%). There were 217 participants or 35.87% of 31-40 years of age; 180 participants or 29.75% of 20-30 years of age; 109 participants or 18.02% of 41-50 years of age; 98 participants or 16.20 % of 51-60 years of age; and 1 participant or 0.17% from total 100 participants.

Educational level

Most of the participants graduated from bachelor degree (479 or 79.17%). There were 96 participants or 15.87% who graduated from master Degree, 29 participants graduated from other educational levels, and one of participant graduated from doctoral degree.

Table 1: Experience in teaching early childhood levels

Years of teaching Experiences	Participants	Percentages
Less than one year	18	2.98
1-5	274	45.29
6-10	125	20.66
11-15	63	10.41
16-20	61	10.08
21-25	31	5.12
26-30	22	3.64
31-35	11	1.82

Total	605	100.00

Table 2: Subordinations of participants

Subordinations	Participants	Percentages
Office of Basic Education Commission	253	41.82
Office of the Private Education Commission	184	30.41
Office of Higher Education Commission	27	4.46
Department of Education Bangkok Metropolitan Administration	18	2.98
Minster of Interior	80	13.32
Others	43	7.11
Total	605	100.00

An Appropriate STEM Education Design for Kindergarten

An appropriate STEM education design for early childhood education is divided into eight categories: 1) principles and purposes, 2) method and theories, 3) instruction, 4) contents, 5) environment and media for teaching, 6) assessment, 7) teachers and administrators, and 8) parents and communities.

1) Principles and purposes of STEM Education for Early Childhood:

We asked early childhood educators on principles and purposes of STEM education. They concerned mostly as follows: sensory integration, integrated curriculum, thinking skills, loving to learn sciences and mathematics, children's interests, developing whole children especially in sciences and mathematics, integrated with ethics, arts and social study, child development, environment around children, sciences process skills, basic skills on STEM education for the 21 Century, asking skills, and Thailand's environment.

Table 3: Principles and purposes of STEM Education for Early Childhood

Principles and purposes of STEM education for early childhood levels	X	SD	Rating
Sensory integration	4.46	0.62	Strongly Agree
Integrated curriculum	4.39	0.63	Strongly Agree
Thinking skills	4.39	0.66	Strongly Agree
Loving to learn sciences and mathematics	4.36	0.66	Strongly Agree
Children's interests	4.36	0.66	Strongly Agree
Developing whole children especially in sciences and math	4.34	0.64	Strongly Agree
Integrated with ethics, arts and social study	4.32	0.67	Strongly Agree
Child development	4.32	0.65	Strongly Agree
Environment around children	4.31	0.67	Strongly Agree
Sciences process skills (Observation, identify problems, and experiment)	4.30	0.67	Strongly Agree
Basic skills on STEM education for the 21 Century	4.30	0.68	Strongly Agree
Asking skills	4.26	0.65	Strongly Agree
Thailand's context	4.16	0.67	Strongly Agree

2) Theories and approaches to STEM Education for early childhood

To implement STEM education for young children, teachers should understand which approach and theory are appropriate and relate them to early childhood education. In this way, they can apply teaching with STEM education. Young children learn different from adults. According to Piaget's Theory, young learn by stages of learning. They learn from their sensory motors, concrete objects and then abstract (Morrison, 2012). Using descriptive methods to analyze the data, it has been shown that participants agreed most with both applied Cooperative Learning Approach (4.34) and Brain-Based Learning (4.34)

to teach young children with STEM education. They concerned Brunner's Theory on learning by doing, learning with sensory motor skills and language (4.32), following with John Dewey's Theory of Learning by doing (4.37), Multiple intelligences (4.28), Piaget's Theory: Physical knowledge, Logical Mathematic and Social knowledge (4.23), Bloom's Taxonomy (4.25), Constructivist (4.27), and Vygotsky's Theory: Zone of Proximal Development (4.17).

3) Instruction

Participants believed that teaching STEM education should provide field trips as an essential part of the instruction. They agreed mostly with field trips (4.30) and Project Approach (4.23) for teaching STEM education. Then, they agreed most with the following: Integrated STEM subjects and other subjects (4.16), Inquiry Based Learning (4.16), Problem-Based Learning (4.11), Engineering Process (4.09), and 5Es (4.06).

4) Contents for teaching STEM education

All countries provide their national curricula and standards on early childhood sciences and mathematics. Schools and teachers have to follow their national curricula and standards but they can also choose contents to teach young children upon structures of their school curricula. Teachers, instructors, and principals agreed mostly to teach contents that are appropriate to the ages of their students (4.38) and to their students' interests (4.36). Although STEM education provides contents on sciences and mathematics that contain many interesting issues about the world, teachers should not teach students too much content (4.35). Last, teachers should teach STEM education by themes (4.30). Kindergarten teachers or preschool teachers usually teach their children through themes so that children learn deeply in contents through themes.

5) Environment

To learn about the environment is a necessary issue for teaching young children because they learn from their environment. Environment means teachers, friends, materials, classrooms, and everything around the children. Teachers, instructors, and principals agreed mostly with environment including materials that children can touch and use (4.41). Then they agree mostly with environment that is appropriate for early childhood (4.39) and environment outside classrooms (4.39) to provide for teaching STEM education. It may be that STEM education is contained in the natural sciences, so children can learn about sciences and nature outside their classroom. There should be a variety of materials for teaching young children as well as materials from the nature (4.37). Teachers take young children to learn about STEM education outside their schools such as a park, a public library, or a Sciences museum (4.33). Teachers believe in the use of themes and activities (4.32), and learning centers (4.32).

6) Assessment

Many teachers wonder how to assess students after teaching STEM education. Assessments of teaching in STEM education can relate to regular teaching or may be as an extra assessment. It depends on each school policy to allow assessment STEM education as newly integrated subjects to assess students or to use their regular assessments. To assess STEM education, participants still agreed on developmental assessments (4.35) and the use of observation (4.35). Teachers also assessed their students when they work with others (4.32).

7) Teachers

Teachers are keys persons to change schools to be STEM schools. If they believe in teaching STEM education and are ready to teach STEM education, they can change their classrooms to be STEM classrooms.

Table 4: Participants strongly agreed as follows: 1) teachers concerned on their students' abilities (4.40); 2) teachers concerned on their students development (4.35); 3) teachers concerned on developing their teaching (4.30); and 4) teachers learn with students and learn as life long learners (4.28).

STEM Teachers in early childhood	X	SD	Rating
Concerning their students' abilities	4.40	0.66	Strongly Agree
Concerning on their children development	4.35	0.67	Strongly Agree
Concerning on developing their teaching	4.30	0.65	Strongly Agree
Learning with students and learn as life long learners	4.28	0.68	Strongly Agree
Using assessments	4.27	0.68	Strongly Agree
Finding and creating teaching materials	4.26	0.69	Strongly Agree
Listening to their students	4.25	0.66	Strongly Agree
Working with other teachers	4.25	0.67	Strongly Agree
Working as facilitators	4.25	0.70	Strongly Agree
Being ready to change	4.24	0.68	Strongly Agree
Answering parents	4.24	0.69	Strongly Agree

Working with parents and communities	4.23	0.68	Strongly Agree
Having asking skills	4.20	0.68	Strongly Agree
Using anecdotes	4.13	0.71	Strongly Agree
Using documentation for young children	4.13	0.69	Strongly Agree
Using curriculum	4.11	0.73	Strongly Agree
Able to write STEM lesson plans	4.07	0.75	Strongly Agree
Understanding STEM Education	3.99	0.78	Strongly Agree

8) Administrators, schools, parents, and communities

STEM education can be implemented and taught in schools well if administrators support teachers. Principals, teachers, and instructors agreed mostly that administrators realized on child development (4.35), curriculum (4.28), working with teachers (4.28), working with parents (4.27), developing their schools (4.26), supporting STEM education with policies, money, materials, and knowledge (4.22), and working as a teamwork with other administrators (4.22).

For implementing STEM education, a school should state to teach of STEM education. Principals, teachers, and instructors agreed mostly as follows 1) sending news to parents; 2) providing knowledge on activities that they teach students; 3) working with their communities; 4) communicating with parents in varied ways; and 5) Being like learning resources for their communities. They strongly agreed in four issues: 1) providing knowledge on STEM education for parents; 2) training parents about STEM education; 3) promoting STEM education for parents; and training teachers from other schools on STEM education.

Participants agreed mostly that parents should do as follows: 1) cooperate among schools, parents, and communities; 2) become involved with schools; and 3) receiving school' news. They agreed most as follows: 1) using community resources such as parents' factories or shops and public libraries; 2) taking students to field trips with schools; 3) provide supporting materials and money; 4) providing activities in classrooms; and 5) supporting STEM-related activities. Moreover, for communities, they agreed that parents provided materials, places and funds for STEM education, to promote STEM education at schools and examples of people in STEM field.

Discussion

In recent years, educators in Thailand have been conducting discussion about STEM education. Only the IPST has taken a leadership role in Thailand to promote STEM

education. In fact, it is the responsibility of all educators to develop education in the country. In the US, after President Obama announced the educational reform, priority was given to improve STEM education. State governments, departments of education, institutes, university, and schools have followed the plan (The White House Education Government, 2010). It seems like that they all have had the responsibility to develop their National Education under the support of the US. Government. It is accepted that investment in education when children are very young would offer great benefits to develop a country not only in education but also in economics and more so because young children are in the golden year of learning.

An appropriate STEM Education Design for Early Childhood Education consists of eight categories: 1) principles and purposes, 2) method and theories, 3) instruction, 4) contents, 5) environment and media for teaching, 6) assessment, 7) teachers and administrators, and 8) parents and communities

This study has found that principles and purposes lead teachers to understand what the goal of STEM education to teach young children is. Thai early childhood educators strongly believe in early childhood foundations. They are concerned that children should learn STEM education with sensory integration. Sensory motors are basic skills for young children. Young children learn from their five senses especially from birth to two years old (Essa, 2007). Moreover, participants believed in theories of teaching early childhood with cooperative learning approach, brain-based learning, learning by doing, learning with sensory motor skills and language, multiple intelligences, Piaget's theory: Physical knowledge, logical mathematic, and social knowledge, Bloom's taxonomy, constructivism and Vygotsky's theory: zone of proximal development. They all agreed to use instruction as follows: field trips, project approach, integrated curriculum, inquiry based learning, problem-based learning, engineering process, and 5Es. Early childhood curriculum in Thailand followed the National Early Childhood Curriculum of 2003 (Department of Education, Thailand). Participants stated that contents for early childhood should be related to ages appropriate and to students' interests. Thai educators agreed with the developmentally appropriate practice (DAP) that stated on ages' appropriate of children and children' interests (Copple, Bredekamp, Koralek & Charner, 2014). Moreover, they realize that contents for teaching should not be too much. Thematic is still important for teaching young children. Teachers, instructors, and principals agreed mostly with environment with materials that children could touch and use. In addition, educators agreed mostly with an environment that is appropriate for early childhood levels and an environment outside classrooms for teaching STEM education. Hands on materials and field trips are part of teaching STEM education according to Moomaw (2015). For assessments STEM education, participants still agreed on developmental assessments and the use of observation. It is the vision of teachers and principals to be concerned with student abilities and developmental areas. In addition, participants believe in cooperating among schools, teachers, and communities. As Bronfenbrenner's Ecology Theory states that parents, schools, and community provide direct experiences for children and influence

children (Morrison, 2014). Researches state that parent involvement provides many benefits for children (National Education Association for Education of Young Children, 2015). Last, a STEM education design for kindergarten should be based on early childhood education.

Suggestion

Further studies should examine the developing of STEM education for teaching kindergarten.

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