Meta-analysis of STEM Education approach effected on students’ learning achievement in Thailand

T Lueangsuwan¹, and S Srikon²*
¹Ed.D. student in Curriculum and Instruction, School of Education, University of Phayao, Phayao 56000, Thailand
²Curriculum and Instruction, School of Education, University of Phayao, Phayao 56000, Thailand

*Corresponding author’s e-mail address: sanit.sr@up.ac.th

Abstract. STEM Education is an area of study that intergrates the four principles of science, technology, engineering, and mathematics through coherent and active teaching and learning approaches which base on problem-based learning in the real-world. Thus, the purpose of this study is to synthesize the research on STEM Education Approach effected on students’ learning achievement in Thailand. There are two sets of variables. The first set is the description of research and the second set is the effect size of research. Data collection and analysis tools are the recording data form for research synthesis, frequency, percentage and meta-analysis. The results showed that (1) description of researches dated by 2009-2019, STEM Education research was mostly published in 2017 (68.18%), Rajabhat Maharasarakham University often produced STEM Education research (59.09%), Sciences Education major usually produced the STEM Education research (68.18%), researchers from the Office of the Basic Education Commission commonly produced the research (72.72%), most of the researchers were female (72.72%), common research objectives found was to compare (35.19%), research design most found was One group pretest-posttest design (77.27%), frequent sampling method found was purposive sampling (59.09%), sampling level of research was upper secondary school (68.18%) and analyzing method largely found was descriptive analysis (48.89%). (2) the effect size (d) from STEM Education on Learning Achievement = 0.445 which means STEM Education can affect the scores of the experimental group more than the control group.

1. Introduction
STEM Education is an area of study that intergrates the four principles of science, technology, engineering, and mathematics through coherent and active teaching and learning approaches which base on problem-based learning in the real-world. It focuses on problem solving in real life that is coupled with improving students’ experience, skill, creativity, and preparedness to apply scientific, mathematical, and technological know-how, which results in developing the innovation in the future [2,5,6].

In Thailand, the STEM education policy announcement, the organizing of Thai education system in the past 5 years has received cooperation from many sectors in the development of Thai education, both public and private agencies to develop science and mathematics educationin many areas such as curriculum improvement, digital textbooks production, modification of the teaching process that
emphasizes on practicality, teacher training for new courses and adjusting measurement and evaluation procedures [1].

Nowadays, there is a lack of the body of knowledge about STEM Education Approach effected on students’ learning achievement in Thailand because there are a few synthetic researches in this context. Consequently, this research mainly aims to synthesize research on STEM Education Approach effected on students’ learning achievement in Thailand which can bring the body of knowledge to develop the curriculum and instruction. Furthermore, the present study was conducted to draw the outline of explicit research studies on STEM Education focusing on students’ achievement and to be study guidance which will be made on STEM Education in the future.

2. **Purpose of the study**
The purpose of this study is to synthesize the research on STEM Education Approach effected on students’ learning achievement in Thailand.

3. **Data of the study**
3.1 The Keywords are STEM Education and Learning Achievement.
3.2 Resource Information includes TDC (ThaiLIS).
3.3 Period of published research papers dated by 2009-2019. Results of searching base were shown in Appendix.

4. **Materials and Methods**
The research methodology of this study was divided into three stages; Preparation, Data Collection, and Data Analysis [4].

4.1 **Preparation**
All available informations were collected and analysed by focusing on STEM Education Approach effected on students’ learning achievement which many scholars discovered in graduate researches in Thailand. The related literatures used in this study were chosen from TDC (Thai Digital Collection), ThaiLIS (Thailand Library Integrated System).

4.2 **Data Collection**
There are two sets of variables. The first set is the description of research including 10 variables: year of completed research, institute, major, office, gender, objectives, research design, status of sample, educational level of sample, analyzing methods. The second set is the effect size of research which is coded of independent variable (learning achievement), and the analysis of the result. Data collection tool was the recording data form for research synthesis which was adapted from the recording data form of the Office of Education Council in Thailand (2009).

4.3 **Data Analysis**
The synthesis of this study is the quantitative research; using frequency and percentage to analyze the research description and Meta-analysis method proposed by Glass was used to analyze the effect size of independent variable (learning achievement).

5. **Results**
The results of this study were as follows;

5.1 **Description of Research**
The results of data analysis describes the nature of 22 research. The details are shown in Table 1-10.
Table 1. Percentage of research categorized by year.

| Year of completed research | Frequency | Percentage |
|----------------------------|-----------|------------|
| 2015                       | 3         | 13.64      |
| 2016                       | 3         | 13.64      |
| 2017                       | 15        | 68.18      |
| 2018                       | 1         | 4.54       |
| Total                      | 22        | 100        |

According to Table 1, the researches on STEM Education approach affected on students’ learning achievement in Thailand, from 2009-2019, were published mostly in 2017 (68.18%) and followed by 2015 (13.64%), 2016 (13.64%) and 2018 (4.54%).

Table 2. Percentage of research categorized by institute

| Institute                                      | Frequency | Percentage |
|------------------------------------------------|-----------|------------|
| Prince of Songkla University                  | 3         | 13.64      |
| Ubon Ratchathani University                   | 1         | 4.55       |
| Rangsit University                            | 1         | 4.55       |
| Mahasarakham University                       | 2         | 9.09       |
| Rajabhat Mahasarakham University              | 13        | 59.09      |
| Nakhon Sawan Rajabhat University              | 1         | 4.55       |
| King Mongkut's University of Technology Thonburi| 1         | 4.55       |
| Total                                         | 22        | 100        |

Table 2 shows that the institutes which conducted the researches on STEM Education approach affected on students’ learning achievement in Thailand, mostly come from Rajabhat Mahasarakham University (59.09%), Prince of Songkla University (13.64%), Mahasarakham University (9.09%), Ubon Ratchathani University (4.55%), Rangsit University (4.55%), Nakhon Sawan Rajabhat University (4.55%) and King Mongkut's University of Technology Thonburi (4.55%) respectively.

Table 3. Percentage of research categorized by major

| Major                                        | Frequency | Percentage |
|----------------------------------------------|-----------|------------|
| Curriculum and Instruction                   | 2         | 9.09       |
| Teaching Science                             | 1         | 4.55       |
| Teaching Science and Mathematics             | 2         | 9.09       |
| Sciences Education                           | 15        | 68.18      |
| Chemical Studies                             | 2         | 9.09       |
| Total                                        | 22        | 100        |

As Table 3 shows, most of the majors which conducted the researches on STEM Education approach affected on students’ learning achievement in Thailand is Sciences Education (68.18%) followed by Curriculum and Instruction (9.09%), Teaching Science and Mathematics (9.09%), Chemical Studies (9.09%) and Teaching Science (4.55%).

Table 4. Percentage of research categorized by office

| Office                                        | Frequency | Percentage |
|-----------------------------------------------|-----------|------------|
| Office of the Basic Education Commission      | 16        | 72.72      |
| Office of the Higher Education Commission     | 3         | 13.64      |
| Department of Local Administration            | 3         | 13.64      |
| Total                                        | 22        | 100        |
From Table 4, the percentage of the researchers who conducted the researches on STEM Education approach affected on students’ learning achievement in Thailand belongs to Office of the Basic Education Commission (72.72%), Office of the Higher Education Commission (16.34%) and Department of Local Administration (16.34%).

Table 5. Percentage of research categorized by gender

| Gender       | Frequency | Percentage |
|--------------|-----------|------------|
| Male         | 6         | 27.27      |
| Female       | 16        | 72.72      |
| Total        | 22        | 100        |

As can be seen in Table 5, the researchers on STEM Education approach affected on students’ learning achievement in Thailand were female (72.72%) more than male (27.27%)

Table 6. Percentage of research categorized by objectives of research

| Objectives of research       | Frequency | Percentage |
|------------------------------|-----------|------------|
| Study                        | 8         | 14.81      |
| Compare                      | 19        | 35.19      |
| Design / construct/ develop  | 14        | 25.93      |
| Analyze                      | 11        | 20.37      |
| Evaluate                     | 2         | 3.70       |
| Total                        | 54        | 100        |

According to Table 6, the highest percentage of the objectives of the researches on STEM Education approach affected on students’ learning achievement in Thailand is to compare (35.19%) followed by to design/ to construct / to develop (25.93%), to analyze (20.37%), to study (14.81%) and evaluate (3.70%).

Table 7. Percentage of research categorized by research design

| Research design                  | Frequency | Percentage |
|----------------------------------|-----------|------------|
| One group pretest-posttest design| 17        | 77.27      |
| One group pretest-posttest time series design | 1 | 4.55 |
| Two groups pretest-posttest design | 1 | 4.55 |
| One-shot case study              | 1         | 4.55       |
| Action research                  | 2         | 9.09       |
| Total                            | 22        | 100        |

Table 7 shows that most of the research designs in the researches on STEM Education approach affected on students’ learning achievement in Thailand was one group pretest-posttest design (77.27%) followed by action research (9.09%), one group pretest-posttest time series design (4.55%), two groups pretest-posttest design (4.55%) and one-shot case study (4.55%).

Table 8. Percentage of research categorized by sampling methods

| Sampling methods             | Frequency | Percentage |
|------------------------------|-----------|------------|
| Simple random sampling       | 2         | 9.09       |
| Cluster sampling             | 6         | 27.27      |
| Multi-stage sampling         | 1         | 4.55       |
| Purposive sampling           | 13        | 59.09      |
| Total                        | 22        | 100        |
From Table 8, the sampling methods which were used in the researches on STEM Education approach affected on students’ learning achievement in Thailand mostly were purposive sampling (59.09%), cluster sampling (27.27%), simple random sampling (9.09%) and multi-stage sampling (4.55%) respectively.

Table 9. Percentage of research categorized by educational level of sample

| Educational level of sample | Frequency | Percentage |
|----------------------------|-----------|------------|
| Primary level              | 2         | 9.09       |
| Lower Secondary level      | 5         | 22.73      |
| Upper Secondary level      | 15        | 68.18      |
| Total                      | 22        | 100        |

As can be seen in Table 9, the educational level of sample in the researches on STEM Education approach affected on students’ learning achievement in Thailand, most were in upper secondary level (68.18%) followed by lower secondary level (22.73%) and primary level (9.09%).

Table 10. Percentage of research categorized by analyzing methods

| Analyzing methods | Frequency | Percentage |
|-------------------|-----------|------------|
| Content analysis  | 2         | 4.44       |
| Descriptive statistics | 22     | 48.89      |
| Dependent t-test  | 16        | 35.56      |
| Independent t-test| 5         | 11.11      |
| Total             | 45        | 100        |

As table 10 shows, most of analyzing methods in the researches on STEM Education approach affected on students’ learning achievement in Thailand was descriptive statistics (48.89%), dependent t-test (35.56%), independent t-test (11.11%), and content analysis (4.44%) respectively.

5.2 Effect size of research

Table 11. Effect size of research

| Independent Variable | N | d   | Sd |
|----------------------|---|-----|----|
| Learning Achievement | 1 | 0.445 | -  |

Table 11 shows the mean of effect size (d) from STEM Education on in Learning Achievement = 0.445. It means that STEM Education can affect the scores of the experimental group more than the control group. Hence, the finding indicates that STEM Education Approach has a positive impact on students’ learning achievement.

Conclusion and Discussion

This meta analysis study was mainly conducted to synthesize research about STEM Education Approach effected on students’ learning achievement in Thailand. Furthermore, the present study was conducted to draw the outline of explicit research studies on STEM Education focusing on students’ achievement and to be study guidance which will be made on STEM Education in the future. In accordance with the study of Yildirim which found that meta analysis study was conducted as a guiding study. Hence, quantitative and hybrid methods were used and the studies that were conducted were examined [6].

The finding of this study showed that STEM Education can affect the scores of the experimental group more than the control group. The relevant literatures have the results of this study. Integrating STEM Education seems to enhance students’ learning achievement more than constructivist approach [3]. According to the fact that STEM Education is process-oriented and evaluated with a result-
oriented achievement test. STEM Education can enhance the learning process through activities and projects that solve the problems in the real world which leads to develop the creativity and innovation [5]. However, the researchers should interrogate the various assessments to evaluate the students’ learning achievement and use STEM Education with other instructional activities and teaching methods in order to promote skill and ability requirements in 21st century such as using STEM Education along with project-based teaching and critical thinking [2].

Acknowledgements

This study was supported by the Unit of Excellence in Research Methodology of Innovations and Learning Sciences based on Educational Neurosciences Research Fund, University of Phayao, Thailand. (ได้รับทุนอุดหนุนการวิจัยจากมหาวิทยาลัยพะเยา)

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